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Instrument to analyse communication in a Community of Inquiry when using emerging methodologies

Instrumento para analizar la comunicación en una comunidad de aprendizaje cuando se usan metodologías emergentes

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Abstract
There is a growing interest in learning in Higher Education using flipped classroom and m-learning. This study constructs an original instrument to obtain information on the levels perceived by the students of the three presences of the Community of Inquiry model with these emerging methodologies. The instrument consists of 21 items, based on the instrument developed by Arbaugh et al. (2008), which were adapted to flipped classroom and m-learning. This instrument was distributed to 121 students from two different universities. Cochran's *Q* test was run to verify whether there was agreement between the opinions of five experts. Student *t*-test results for independent samples indicate similarity in the opinions of the two groups of students. Information analysis techniques, exploratory factor analysis, and reliability tests were also used to validate it. The analysis revealed three factors coinciding with cognitive presence, social presence and teaching presence as proposed by the theoretical model. Cronbach's Alpha confirmed the reliability of the tool as a whole α = .957 and its several dimensions. The results indicate that it is a valid and reliable instrument for measuring the levels perceived by the students of the three presences of the Community of Inquiry model when using flipped classroom and m-learning.

Resumen
Existe un creciente interés en el aprendizaje en la Educación Superior utilizando el aula invertida y el aprendizaje móvil. Este estudio construye un instrumento original para obtener información sobre los niveles percibidos por el alumnado de las tres presencias del modelo CoI cuando se hace uso de estas metodologías emergentes. El instrumento está formado por 21 ítems, construidos a partir del instrumento desarrollado por Arbaugh et al. (2008), que fueron adaptados al uso del aula invertida y el aprendizaje móvil. Este instrumento se distribuyó a 121 estudiantes de dos universidades diferentes. Se ejecutó la prueba *Q* de Cochran para comprobar si existía concordancia entre las opiniones de los expertos. Los resultados de la prueba *t* de Student para muestras independientes indican similitud en las opiniones de los dos grupos de estudiantes. Para validarlo se utilizaron técnicas de análisis de información, análisis factorial exploratorio y pruebas de confiabilidad. El análisis reveló tres factores que coinciden con la presencia cognitiva, social y docente tal y como propone el modelo teórico. El Alpha de Cronbach confirmó la fiabilidad de la herramienta en su conjunto α = .957 y de sus diversas dimensiones. Los resultados indican que es un instrumento válido y fiable para medir los niveles percibidos por el alumnado de las tres presencias del modelo CoI cuando se usa el aula invertida y el aprendizaje móvil.

Palabras clave / Keywords
Community of inquiry model, flipped classroom, mobile learning, blended learning, validity, reliability.
Comunidad de aprendizaje, aula invertida, aprendizaje móvil, enseñanza semipresencial, validez, fiabilidad.

1. Introduction

Communication in virtual educational environments has been attempted to systematize through various models, which deal with dissimilar elements such as the social aspect and the development of high-level cognitive functions, the actions of teachers to facilitate student learning, among others. Over the last 20 years the theoretical and methodological model proposed by Garrison et al. (2000) of the Communities of Inquiry (CoI) has been used for the analysis of the interactions and typology of communication in virtual communities of learning and questioning in Higher Education.

However, it was not until 2008 that an instrument was developed to obtain information on the levels perceived by students in relation to the three presences of the CoI model (Arbaugh et al., 2008). To the best of our knowledge, no further instruments have been developed to validly, reliably and effectively measure the dimensions of the CoI model. Researchers such as Diaz et al. (2010) and Swan et al. (2008) found supporting evidence for the three different constructs (Castellanos-Reyes, 2020), but did not design a new instrument. The instrument designed by Arbaugh et al. (2008) has been accepted in many studies and it has been used to evaluate both blended learning and MOOC courses but its adoption when using FC or ML has been limited. The study by Kim et al. (2014) used FC together with the proposal on the CoI model in which a fourth presence, learning presence, is included. In spite that the CoI instrument has been validated in many cases, the new emerging technologies make necessary to re-validate this instrument. As Lowenthal and Dunlap (2014) argue, the CoI instrument should be “revisited and adjusted over time” (p. 26).

One of the benefits of m-learning (ML) is precisely to facilitate communication regardless of time and geographical location of the participants in the teaching-learning process. ML also includes personalized, flexible and context-based teaching and learning, which in turn provides interactivity, mobility and opportunity (Jou et al., 2016). At the same time, the ML “can accommodate both formal and informal learning in collaborative or individual learning modes, and within almost any context” (Y. A. Zhang, 2015, p. 43). Meanwhile, Ireri and Omwenga (2016) suggest to students to introduce ML in a flipped classroom (FC) model. This will help them to overcome the distance with the teachers and improve their performance. In this model, learning begins individually online and then moves to the classroom or virtual group space, where teachers guide students as they apply concepts and actively participate in knowledge creation (Ireri & Omwenga, 2016). The work of the teaching staff in this case is associated with the design of the activities prior to the study and those carried out in the classroom, as well as with the facilitation of learning and its evaluation. The students outside the classroom must assume a leading role in the construction of their own learning and at their own pace from the proposed teaching materials.

We believe that emerging methodologies and new ways of communication are suitable in today's society. Hence, it is necessary to describe the development and validation of an instrument to measure communication when applying FC combined with ML (FC-ML).

The objectives that guided this research are:

- Build a valid and reliable measuring instrument on FC-ML.
- Explore the relationships between the dimensions that make up the instrument.

1.1 Community of Inquiry model

Theoretical foundations of the CoI model explain that high-level learning can take place in collaborative communities where individual meaning and socially constructed knowledge interact (Garrison et al., 2000). This model, as illustrate in Figure 1, is structured around three elements that are present in communication in education: cognitive presence, social presence, and teaching presence.

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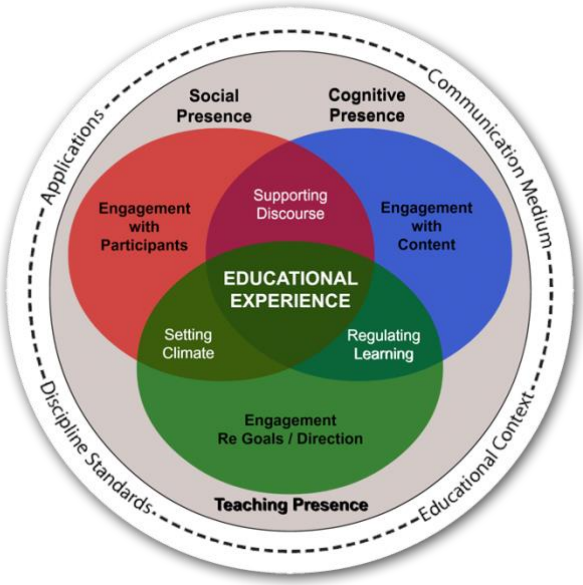

Figure 1. Community of Inquiry model. Source: Garrison (2017, p. 25)

Cognitive presence is defined as the extent to which students are able to construct and confirm meaning through reflection and discourse sustained in a CoI (Garrison et al., 2000). In summary, it is a process model that describes the development of higher order thinking rather than individual learning outcomes; it is associated with perceived and real learning outcomes (Akyol & Garrison, 2011). For this presence, the proposed model identifies four categories: triggering event, exploration, integration and resolution (Garrison, 2017).

Social presence is described as the participants' ability to identify with the community (e.g., course and group), communicate openly in an environment of trust, and develop personal and affective relationships through the projection of their individual personalities (Garrison, 2017). This presence contains three categories: group cohesion, open communication and personal/affective (Garrison, 2017).

Teaching presence is presented as the action of designing, facilitating, and directing cognitive and social processes in order to obtain learning outcomes that have personal meaning and are worthwhile from an educational point of view (Anderson et al., 2001). The idea of using the term teaching and not teacher presence to reflect the roles and responsibilities to be shared by participants in a CoI, associated with e-learning approaches (Garrison, 2017) has recently been raised. This dimension covers three categories: design and organization, facilitating discourse, direct instruction (Garrison, 2017).

1.2 Community of Inquiry instrument

The instrument developed by Arbaugh et al. (2008) to measure the levels perceived by students of the three presences of the CoI model consists of 34 five-point Likert type items. Arbaugh et al. (2008) validated the instrument with a sample of 287 participants from institutions in the United States and Canada enrolled in graduate-level courses in either Education or Business. Cronbach's alpha evaluated the instrument's reliability for cognitive presence (α = .95), social presence (α = .91) and teaching presence (α = .94). Construct validity was assessed using Exploratory Factorial Analysis (EFA) using Principal Component Analysis. The Kaiser-Meyer-Olkin value (KMO = .96) indicated the suitability of the sample for this analysis. The factor loads for the 34 items support the validity of the conceptual framework of the CoI model. The total variance explained by these three factors was 61.3%. Although the analysis of the main components yielded a fourth factor, the results of scree test do not report the possibility of an additional fourth factor. In summary, the results of the study suggest that the instrument is valid and reliable, providing additional support to the CoI model. This instrument has been widely accepted:

- to examine participants' perceptions of the three presences (Lawrence-Benedict et al., 2019; Mills et al., 2016; Sun et al., 2017).
- to explore the relationship between presences (Bangert, 2009; Garrison et al., 2010; Gutiérrez-Santiuste et al., 2015; Kozan & Richardson, 2014; Sen-Akbulut et al., 2022).
- to explore the relationship between presences and their categories (Caskurlu, 2018; Heilporn & Lakhal, 2020).
- to validate the theoretical model in different languages (Ballesteros et al., 2019; Heilporn & Lakhal, 2020; Olpak & Kiliç Çakmak, 2018; Yu & Richardson, 2015).
- to validate the theoretical model in different disciplines (Carlon et al., 2012; Heilporn & Lakhal, 2020; Lau et al., 2021).

2. Method

2.1 Research design and sample

A previous analysis was made of the studies on the levels perceived by the students of the three presences of the CoI model. The design of the instrument was based on the instrument developed by Arbaugh et al. (2008) but was modified to incorporate other research (Al-Emran et al., 2016; Kim et al., 2014) and to adapt the items to FC and ML.

An item pool of 44 candidate questions was built. After an analysis of redundancy, ambiguity, length, adaptation to the construct and corrections (DeVellis, 2017), the version 1 of the instrument was obtained, consisting of 34 items. This version was reviewed by five judges to verify the validity of the content. The judges were researchers in areas related to communication and/or the use of technologies in education with extensive research experience. Through a review sheet, they had to evaluate the questions (correct/incorrect) and, in the latter case, indicate the reason in terms of clarity, appropriateness, wording and a space for observations. A total of eight comments were made during the review, of which six (75%) were accepted, although several were repeated. The judges' responses were reviewed and Cochran's *Q* test was used to check the equality of several related samples in one dichotomous variable (Cochran, 1950). As a result of this test it could be verified that there are no significant differences between the opinions of the experts (Q = 2.400, df = 4, p > .675). After modification, deletion and merging processes, it resulted in version 2 of the instrument with 22 item. In general, the judges indicated that the instrument is adequate and that it could respond in detail to the intended research objectives.

Following the criteria of DeVellis (2017), the 22 items were affirmations whose answers were recorded on four-level scales (1 = *I strongly disagree with the statement*, 2 = *I partially disagree with the statement*, 3 = *I partially agree with the statement*, 4 = *I strongly agree with the statement*). A pilot test was carried out with 16 students from the first semester of the degree in Computer Science Engineering, taking the course Introduction to Computer Science. Among the respondents, 62.5% were men and 37.5% women. As well, 56.25% were between 20 and 29 years old, while 43.75% were under 20 years old. Respondents were asked to comment on the clarity and duplicity of the items, as a result the instrument was kept unchanged. This test was also applied to test the relevance and effectiveness as well as the conditions of the application and the procedures involved (Hernández-Sampieri et al., 2014).

The instrument was developed and applied in Spanish language. For seven days in the academic year 2017-2018, the instrument was published online (in Moodle v.2 at UGR and v.3 at UCI). The time required for completion was approximately 15 minutes. The quantitative data were analyzed through the statistical programs SPSS v.24 and SPSS Amos v.22. Students were in the first semester of their degree program in Computer Engineering and enrolled in the subject Introduction to Computer Science (at University of Computer Sciences, UCI, Cuba) and Software Fundamentals (at University of Granada, UGR, Spain). Table 1 shows the sample profile. Our sample for convenience. The sample size (n = 121) is consistent with Kass and Tinsley's (1979) recommendation of five to ten participants per item, with an absolute minimum of 100 subjects.

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Table 1
Sample profile

Variables	Frequency	Percentages (%)
Gender		
Female	26	21.5
Male	95	78.5
Age		
<20 years	42	34.7
20–29 years	65	53.7
30–39 years	13	10.7
≥40 years	1	0.8
University of origin		
UCI	83	68.6
UGR	38	31.4

2.2 Data collection and analysis procedures

It was necessary to verify the equality of averages between the two groups (UCI and UGR) because they came from different samples. Following the criteria of Tabachnick and Fidell (2013), the data were examined for unanswered items, which were less than 5% and replaced by the mean. Data were checked for outliers, but no cases had to be removed. Finally, the normality of the data was assessed using skewness and kurtosis coefficients. The data exhibited skewness and kurtosis outside recommended range of -1 to +1 (Ferrando & Anguiano-Carrasco, 2010). The most data did not follow a normal distribution due to the size of the sample (Field, 2009). According to Tabachnick and Fidell (2013), transformations can improve "the statistical evaluation of data" (p. 98). Appropriate transformations (e.g. square root and logarithmic) were carried out without producing significant improvements. However, as the scales used are four-level, it is difficult to assume normality in this type of scale (Wu, 2007). Nevertheless, it was considered that with the size of the sample used, the violation of the normality assumption does not cause problems (Pallant, 2007). Therefore, although violating the normality assumption weakens the solution, "may still be worthwhile" (Tabachnick & Fidell, 2013, p. 618).

Once the non-normality of the data was assumed, the Mann-Whitney U test was carried out with the scores of the responses to the items in order to evaluate whether there were significant differences between the opinions expressed by the UCI-Cuban and UGR-Spanish students. The results of the test show that there are no significant differences in any of the answers in relation to the variable university of origin ($Z < 1.96$, $p > .05$). Therefore, it was considered that the opinions issued by both groups have the same distribution of scores and the following analyses were carried out jointly.

Descriptive analyses were performed and Cronbach's Alpha was calculated. The KMO sample adequacy measurement and Bartlett's sphericity test were found for the purpose of using EFA to validate the construct. Correlations were carried out to explore the relationships between the dimensions that make up the instrument.

3. Results

The purpose of using EFA was to determine how and to what extent observed variables are linked to latent variables or factors (Byrne, 2016). In our case, to check the extent to which the items were related to the three dimensions theoretically proposed. First, the behavior of the items was evaluated through descriptive statistics that measure the central trend and dispersion. Average item scores ranged from 3.30(.666) to 3.74(.629) for cognitive presence, 3.04(.995) to 3.65(.642) for social presence, and 3.50(.709) to 3.59(.679) for teaching presence. This suggests, "the online learning environment studied may have comprised an effective learning community based on learner perceptions" (Kozan & Richardson, 2014, p. 42).

The sample size is a factor that interacts with some aspects, among which the input matrix to the EFA stands out (Lloret-Segura et al., 2014). In this matrix, a distinction is made the product-moment correlation matrix and the polychoric correlation matrix. As previously mentioned, the items had four response categories in addition to following a non-normal distribution. For such reason, the items had to be analyzed according to their ordinal measurement level, i.e., using the polychoric correlation matrix (Lloret-Segura et al., 2014). However, since

the sample size is small and the distributions are adequate it was decided to perform the AFE based on Person's product-moment correlations matrix (Lloret-Segura et al., 2014). Correlation analyses were conducted to determine the internal consistency of items within each dimension. The resulting correlations ranged from .441 to .952, except for item PC_HD02 (*CP_TE02. The problems raised by the students trought the videos, and their associated resources, increased my interest in the course topics*) which had indices lower than .30 and therefore was not taken into account in subsequent analyses.

Subsequently, the analysis for the selection of the most appropriate factor extraction method was carried out. Given the ordinal level of measurement of the items, we had to resort to the ordinary least squares method. However, this estimation method could not be chosen as it is based on the matrix of polychoric correlations (Morata-Ramirez et al., 2015), moreover, it may have convergence problems if the sample is small (López-Aguado & Gutiérrez-Provecho, 2019). On the other hand, it is considered that one of the most suitable methods for factor extraction is based on ordinary least squares, especially principal axis factoring method (López-Aguado & Gutiérrez-Provecho, 2019). In addition, this method of principal axes factoring has been the recommended option when the normality assumption is not met (Lloret-Segura et al., 2014).

A first EFA was performed using the principal axis factoring extraction method with oblimin rotation to extract the factors "in consideration of the theoretical interdependence of the presences" (Garrison et al., 2010, p. 33). In other words, on the basis of the theoretical assumption that the factors are correlated. All communalities obtained values above 0.6 with only three factors and six or seven indicators per factor, following the criteria of MacCallum et al. (1999) that even samples with less than 100 can be sufficient when communalities are consistently high. Bartlett's sphericity test gave a value of (χ2 (210, N = 121) = 3486.425, p < .05), which indicated that the correlations between the variables were large enough for an EFA (Henson & Roberts, 2006). The value of KMO = .910 indicated the suitability of the sample for this analysis (Kaiser, 1970) as shown in Figure 2, which is greater than the suggested minimum value of 0.6 (Tabachnick & Fidell, 2013). It is worth noting that the difference between the three factors is large because the first self-value is greater than 12, while the second is close to the value 2, and the value of the third is close to the unit. On the other hand, it was not necessary to eliminate items since none obtained load values below .40 (Floy & Widaman, 1995); therefore, three factors with 21 elements were determined to show the best matrix.

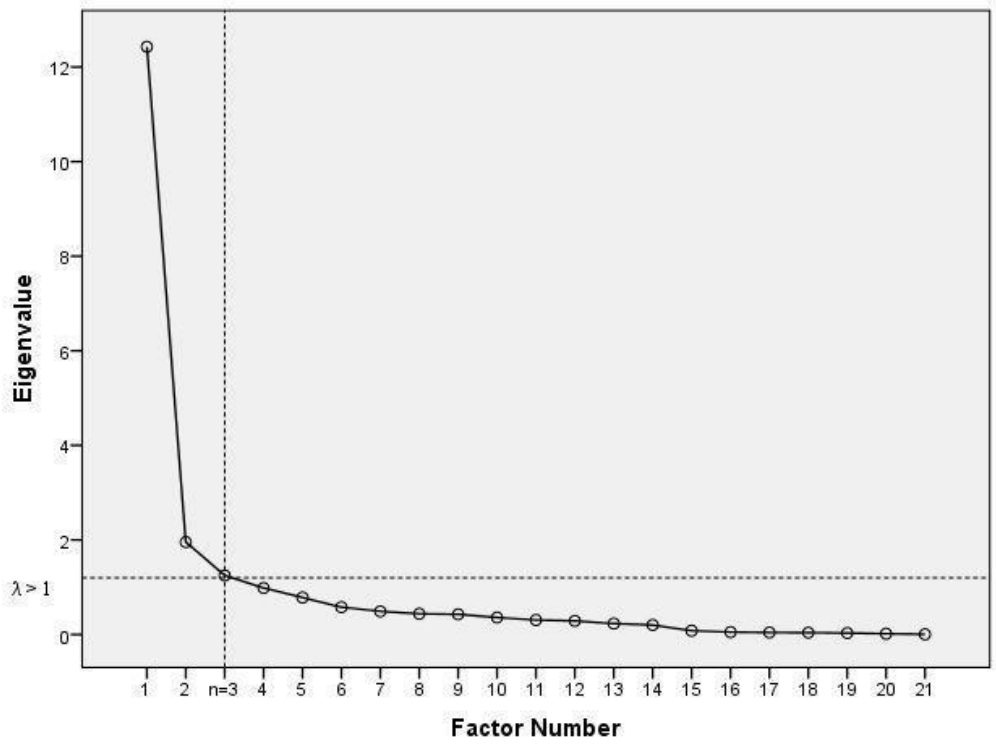

Figure 2. Principal Component Analysis plot

The total variance explained for the three factors resulting was 69.96%. The first factor represented the largest amount of variance (57.99%), followed by the second factor (7.98%) and the third (3.99%). These three factors

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were named as teaching presence (TP), cognitive presence (CP) and social presence (SP) respectively; coinciding with the CoI model. Table 2 shows the factorial loads for each of the items of the instrument.

Table 2
Factorial loads for EFA with Oblimin rotation

Items	TP	CP	SP
PC_HD01. Los problemas planteados por el profesorado a través de los videos (y sus recursos asociados) han incrementado mí interés por los temas del curso (*CP_TE01. The problems raised by the teacher through the videos (and their associated resources) increased my interest in the course topics*).		.757	
PC_EXP01. El uso de videos (y sus recursos asociados) me ha facilitado el intercambio de información del contenido de la asignatura (*CP_EXP01. The use of videos (and their associated resources) has facilitated the exchange of information about the content of the course*).		.739	
PC_EXP02. El trabajo colaborativo me ha facilitado el intercambio de información del contenido de la asignatura (*CP_EXP02. Collaborative work has helped me to exchange information about the content of the course*).		.800	
PC_INT01. El uso de videos (y sus recursos asociados) me ha facilitado la asociación de ideas relacionadas con el contenido de la asignatura (*CP_INT01. The use of videos (and their associated resources) has helped me to associate ideas related to the content of the course*).		.797	
PC_INT02. El trabajo colaborativo me ha facilitado la asociación de ideas relacionadas con el contenido de la asignatura (*CP_INT02. Collaborative work has helped me to associate ideas related to the content of the course*).		.782	
PC_RES01. El uso de videos (y sus recursos asociados) me ha facilitado aplicar nuevas ideas (*CP_RES01. The use of videos (and their associated resources) has helped me to apply new ideas*).		.813	
PC_RES02. El trabajo colaborativo me ha facilitado aplicar nuevas ideas (*CP_RES02. Collaborative work has helped me to apply new ideas*).		.796	
PS_AFE01. Trabajando colaborativamente, he podido expresar mis emociones (*SP_AFE01. By working collaboratively, I have been able to express emotions*).			.610
PS_AFE02. Trabajando colaborativamente he podido demostrar gratitud con algún miembro del grupo (*SP_AFE02. By working collaboratively, I have been able to show gratitude with a member of the group*).			.723
PS_CA01. Trabajando colaborativamente he podido expresarme libremente (*SP_OC01. By working collaboratively, I have been able to express myself freely*).			.622
PS_CA02. Trabajando colaborativamente me he sentido cómodo interactuando con otros participantes del curso (*SP_OC02. By working collaboratively, I have felt comfortable interacting with other course participants*).			.637
PS_COH01. Trabajando colaborativamente me he sentido unido al grupo (*SP_COH01. By working collaboratively, I have felt united to the group*).			.609
PS_COH02. Sentí que mi punto de vista fue reconocido por otros participantes del curso (*SP_COH02. I felt that my point of view was recognized by other participants of the course*).			.573
PD_DO01. A través de los videos (y sus recursos asociados) se han expresado claramente los contenidos del curso	.922		

Items	TP	CP	SP
(*TP_DO01. The videos (and their associated resources) have clearly expressed the contents of the course*).			
PD_DO02. A través de los vídeos (y sus recursos asociados) se ha expresado claramente la organización del curso (*TP_DO02. The videos (and their associated resources) have clearly expressed the organization of the course*).	.945		
PD_DO03. A través del trabajo colaborativo he obtenido información sobre los contenidos del curso (*TP_DO03. I have obtained information about the contents of the course through collaborative work*).	.937		
PD_DO04. A través del trabajo colaborativo he obtenido información sobre la organización del curso (*TP_DO04. I have obtained information about the organization of the course through collaborative work*).	.943		
PD_FD01. A través de los videos (y sus recursos asociados) me he animado a consultar los contenidos del curso y fuentes externas para generar conocimientos entre todos (*TP_FAC01. The videos (and their associated resources) have encouraged me to consult the contents of the course and external sources to generate knowledge among all*).	.931		
PD_FD02. A través del trabajo colaborativo se ha promovido la construcción de conocimientos (*TP_FAC02. The construction of knowledge has been promoted through collaborative work*).	.943		
PD_ED01. A través de los videos (y sus recursos asociados) se me han dado orientaciones explicitas para centrarme en los contenidos (*TP_DI01. The videos (and their associated resources) I have been given explicit guidance to focus on the contents*).	.968		
PD_ED02. A través del trabajo colaborativo he obtenido orientaciones explicitas para centrarme en los contenidos del curso (*TP_DI02. I have obtained explicit orientations through collaborative work to focus on the contents of the course*).	.949		

As Table 2 shows, the TP factor included eight items that focus on efforts made in relation to design and organization, facilitation of discourse and direct teaching to obtain results in correspondence with the needs of the student body. Items in this factor showed strong loads ranging from .922 to .968. The CP factor included seven items that refer to the extent to which the student body is able to construct meaning in a CoI. These items obtained loads with values ranging from .739 to .813. The SP factor included six items that reflected participants' ability to socially engage in a CoI. Items in this factor showed loads ranging from .573 to .723.
On the other hand, the CP factor had high positive correlations with the TP factor (r = .701) and the SP factor (r = .620). The TP and SP factors had a moderate positive correlation (r = .560). This suggests that the three factors extracted were sufficiently different from each other (Kozan & Richardson, 2014).
One of the assumptions of Cronbach's Alpha coefficient is the continuous nature of the variables (Elosua & Zumbo, 2008). When this assumption is not met, a valid alternative is the ordinal alpha (Espinoza & Novoa-Muñoz, 2018). The ordinal alpha is based on the polychoric correlation matrix (Elosua & Zumbo, 2008). For that reason, in this study the ordinal alpha could not be chosen. However, the difference between the values of these coefficients may be due to high values of skewness and kurtosis (González Alonso & Pazmiño Santacruz, 2015). In this study the values of skewness and kurtosis are not considered high as they ranged between -2.5 and +2.5. In fact, some authors consider the range of -2 to +2 acceptable (Muthen & Kaplan, 1992). Finally, Cronbach's Alpha turned out to be .96 for the entire instrument while TP was .98, SP .84 and CP .92. These values did not improve if any item was removed, indicating that all questions were relevant.

4. Discussion

The objective that guided the research was to develop a FC-ML instrument based on the CoI model (Arbaugh et al., 2008) to be adapted to learning experiences using FC and ML. Specifically, the validity and reliability of

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the instrument, the relationships between its dimensions were analyzed and it was examined if there were significant differences between these dimensions in relation to gender and age. Obtaining satisfactory results associated with each of the three presences that support the CoI model.

The results of the descriptive statistics, the Bartlett sphericity test and the KMO value, confirmed the suitability of the sample to carry out EFA. As the data did not follow a normal distribution, the appropriate extraction method —as in the Carlon et al. (2012) and Kovanović et al. (2018) investigations-— was the principal axis factoring with oblimin rotation. This differs from previous research that implemented principal component analysis and oblimin rotation (Arbaugh et al., 2008; Bangert, 2009; Garrison et al., 2010). Sample size of 121 is consistent with the recommendation of five to ten participants per item, with an absolute minimum of 100 subjects (Kass & Tinsley, 1979). As well as the recommendation of MacCallum et al. (1999) that with all communalities above 0.6 and a high overdetermination of factors the sample may be sufficient. The first factor to load was the teaching presence explaining 57.99% of the variance, followed by the cognitive presence explaining 7.98% of the variance and the third was the social presence explaining 3.99% of the variance. The order of load of the factors coincides with the studies of Garrison et al. (2010), Kozan and Richardson (2014), Yu and Richardson (2015) and Kovanović et al. (2018), but not with that of Carlon et al. (2012).

Based on the results of the EFA, this study found a model of three factors coincident with the instrument developed by Arbaugh et al. (2008) and the research of Bangert (2009), Garrison et al. (2010), Carlon et al. (2012) and Caskurlu (2018). In the present study, cognitive presence is made up of four factors, while social presence and teaching presence are made up of three factors. These results are consistent with what is proposed in the CoI model and is also consistent with the findings of Caskurlu (2018). The FC-ML instrument that fits the data has a three-factor structure composed of seven items for CP, six items for SP and eight items for TP. The instrument reliability of the three presences is high (CP =.92, SP =.84 and TP =.98).

On the other hand, our results indicate a strong correlation between cognitive and teaching presence (r = .701), and a moderate correlation of social presence with teaching presence (r = .560); aligned with studies by Kozan and Richardson (2014), Kovanović et al. (2018) and Chen (2022). This study also showed a high positive correlation between cognitive and social presence (r = .620), in correspondence with Kozan and Richardson (2014), with R. Zhang (2020) but not with Kovanović et al (2018). The difference of our study with respect to Kovanović et al. (2018) may be due to the difference in the tools, with FC and ML in our case. The findings of this study are also inconsistent with those of Sidiropoulou & Mavroidis (2019), who found a weak and statistically significant positive correlation between TP and SP. The difference of our study with respect to Sidiropoulou & Mavroidis (2019)'s study may be involved postgraduate students, while in our study involved undregrate students.

5. Conclusions

Finally, the validity and reliability of the FC-ML instrument is important from a practical point of view as it can be applied at the end of a course in which FC and ML are used in a CoI. This is particularly true if we think of FC not as a technology but as a way of using different digital resources to enrich teaching and learning. At the same time, we consider ML as a learning technology that constitutes an important advance in educational technology and that within a year or less it may be adopted in Higher Education (Alexander et al., 2019). Therefore, the results obtained would provide an opportunity to examine how advances in the use of emerging technologies, the context or the discipline in which they are applied, influence virtual communication. Specifically in the levels perceived by students of the cognitive, social and teaching presences of the CoI model.

However, there are still limitations to this study that should be noted. The sample of this study was by convenience, coming from a Cuban university and a Spanish university. In the future, more and larger representative samples will be needed to assess the extent to which the results are applicable to other population groups to confirm the conclusion of the study. When applying the instrument to more and larger representative samples, the researchers recommend performing confirmatory factor analysis to determine the extent to which the data support the proposed model.

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