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Design and Validation of a Questionnaire to Assess Digital Communicative Competence in Higher Education

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This paper shows the design and validation of a questionnaire aimed at college students to assess digital communicative competence. Starting from the theoretical framework presented, we conceptualized digital communicative competence as the intersection between communicative and digital competences. To that effect, we hereby explain the analysis and validation procedure of the psychometric properties of the assessment instrument. The survey respondents consisted of 260 students were in the first semester of their degree program in Computer Engineering who were taken through for convenience technique. These responses were randomly divided into two samples (for exploratory factor analysis and for confirmatory factor analysis) to prevent unrealistic fit values. The exploratory factor analysis result shows that the model forms six factors, which are factor 1 (publication of information), factor 2 (creation and editing of digital contents), factor 3 (digital content production preferences), factor 4 (operation and search for information), factor 5 (collective intelligence through technology) and factor 6 (digital content consumption preferences). The result of the goodness of fit model shows that the instrument has met all the criteria with a value of $\chi 2/df = 1.64$, RMSEA = .078, TLI = .897, and CFI = .907. The results revealed the existence of significant psychometric features of the constructed questionnaire.

Keywords: questionnaire development, constructing digital communicative competence, construct validity and reliability, questionnaire validation, higher education

INTRODUCTION

The incorporation of Information and Communication Technologies (ICT) has led to changes in the way learning is approached, leading simultaneously to the consideration

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of Digital Competence (DC) as a medium to acquire a level of literacy appropriate to the demands of contemporary society (Mengual-Andrés et al., 2016). For Higher Education, DC has been defined as a combination of concepts, including information literacy, media literacy and ICT literacy (Khlaisang & Koraneekij, 2019). The many and varied terms related to DC include 21st-century skills, digital literacy, digital skills, e-skills, ICT skills and ICT literacy (Van Laar et al., 2017). These concepts primarily emphasize information retrieval and processing, consider production as important, stress the importance of responsible and ethical use of ICT, and include communication-related issues (Siddiq et al., 2016). DC is considered one of the most demanded skills, and includes the use of technological, informational, multimedia or communication skills and knowledge (Esteve-Mon et al., 2020). However, it is believed that with the emergence of emerging technologies in the 21st century, traditional DC is no longer sufficient for an individual to survive competently (Zhao et al., 2018).

For years, digital literacy and competence have been the focus of interest in numerous works from different perspectives. For example, the case of DC has been analyzed with students in secondary school to verify whether teenagers' digital skills are limited to simple technical aspects or include skills related to conceptual understanding of technology, social-relational knowledge and high order cognitive skills (Calvani et al., 2012). In recent years, the incidence of gender and socioeconomic situation in the development of ICT competences has been analyzed (Aesaert & Van Braak, 2015), the integration of professional digital competence in teacher education (Instefjord & Munthe, 2017), as well as the importance of looking at the degree to which teachers emphasize digital skills in classrooms beyond the frequency of using ICT (Siddiq et al., 2016). In turn, has been conducted a literature review on DC, suggesting that researchers should engage in new approaches to improve DC in educational settings (Pettersson, 2018).

Similarly, the relationship between learning and digital literacy has been studied (Greene et al., 2018). This study built on previous research on the role of digital literacy in the acquisition of knowledge by conducting a similar study with a learning task focused on the acquisition of scientific knowledge. Others studies has been analyzed the relationship between digital literacy and informal learning (Meyers et al., 2013; Tan, 2013). Some authors illustrate an inclusive Digital Literacy Learning Framework for vulnerable populations in rural areas (Nedungadi et al., 2018). Motivational predictors of ICT literacy has also been analyzed (Senkbeil & Ihme, 2017). With the objective of measuring students' ICT literacy, has been conducted a systematic analysis of assessment tools in the context of primary and secondary education studies (Siddiq et al., 2016). In addition, has been analyze digital literacy in teachers (Zhao et al., 2018) and, in the field of Higher Education (HE), the dimensions of this competence (Tadesse et al., 2018).

International research has established a consensus regarding the components of the DC (Ferrari, 2013; INTEF, 2017; ISTE, 2002, 2007, 2017; Janssen et al., 2013). All of them agree on aspects of creativity, communication and collaboration, problem-solving and information management. Some research has analyzed the students' self-perception of

their DC using a questionnaire (Tadesse et al., 2018) and others authors have developed questionnaires in the field of HE that address issues related to DC (Lukitasari et al., 2022; Ng, 2012). In particular, has been developed an questionnaire to identify students' identify skills related to communicating digital content, exploring digital content, and creating and using digital content (Lukitasari et al., 2022). Another reference study for several research projects, explores the digital nativeness and digital literacy of a group of undergraduate students enrolled in the course Introduction to e-Learning at a university in Australia (Ng, 2012). These questionnaires have been validated and make it possible, among other things, to diagnose students' DC. In both questionnaires, one element used to measure DC is communication.

On the other hand, has been considers that communicative competence is the tacit knowledge of the language and the ability to understand and use the language effectively for communication purposes (Mart, 2018). In recent years, communicative competence has not only been marked by textual and oral skills, but others have appeared such as visual skills, as well. Thus, others authors consider that with the advent of the Internet, the rise of video has progressively transformed the nature of visual communication (Peters & Allan, 2018). In addition, in other study conclude that the most appropriate method for assessing communicative competence depends on several elements, so that no method is superior to another (Spitzberg & Cupach, 2012). In this sense, these authors advise the use of actor's self-report, communication partner's judgment of the actor to ensure that both methods have met the measurement objective. While others authors consider the use of self-report to be a legitimate and appropriate research strategy (McCroskey & McCroskey, 1988). This authors state that self-report helps to understand communicative behavior and is less valid for analysing real communicative competence.

We believe, however, that the changes produced in today's society imply an updating and deepening of communication. Communication is currently carried out through written, audio, visual and audiovisual media, and allows the search, management and creation of digital content with the purpose of participating and collaborating in a network for the resolution of everyday and academic problems. Over the past decade, increasing academic attention has been devoted to the rapid emergence of online visual communication (Peters & Allan, 2018). However, there are no questionnaires or studies that analyze communicative competence with these languages or perspectives: written, audio, visual and their interrelations. Therefore, the purpose of this study is to empirically validate the theoretical model described here, starting with the data obtained using a questionnaire designed and validated to assess Digital Communicative Competence (DCC) in Higher Education.

Conceptualization of DCC

Communicative processes are relevant in almost all situations of our daily life, in addition, the ability of people to achieve their goals depends largely on their communicative competence (Rickheit et al., 2008). In a similar way, university students consider that communicative competence is relevant for their academic formation and that it is an important aspect for the later development of their professional life (Núñez

& Moreno-Núñez, 2017). At the same time, in a society that advances together with technologies and where human relations are based on communication, the established interactions—for professional, personal and social reasons—are in many cases delivered through digital channels. This is why cognitive, technological and social skills are required in different media: written text, audio, visual and audiovisual. We understand the visual medium as a static image (image, diagram, graphic ...) and the audiovisual medium as a multimedia resource.

Communication constitutes part of different dimensions of DC (Appendix A). Due to the importance of developing Communicative Competence (CC) in a digitalized world—including education—this competence must be considered as intersecting with DC. Figure 1 illustrates our view of DCC.

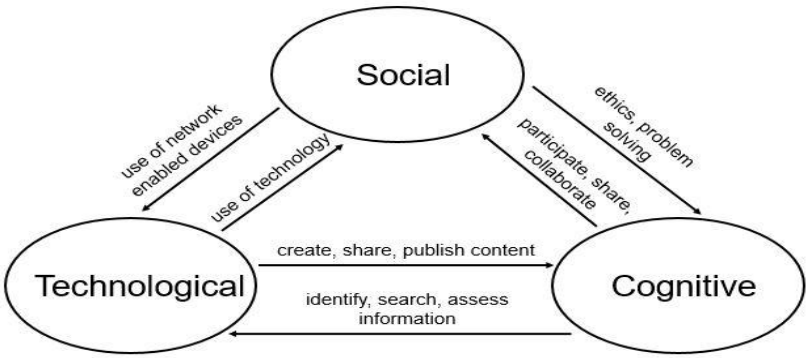

Figure 1
Conceptualization of the DCC

Digital communicative competence is defined as the intersection between digital and communicative competence. We understand that this competence requires the development of a series of cognitive, technological and social skills in order for people to be able to communicate ethically through the network.

- Cognitive: identifying, searching for, and evaluating information, as well as creating, editing, and publishing content.
- Technological: handling different types of devices, including mobile devices, and accessing and publishing resources using different communication channels.
- Social: participating, sharing, and collaborating by making use of different technological tools to solve every day and/or academic problems, recognizing diversity of culture, and making ethical use of information.

The concept of DCC concentrates a number of skills that have been identified individually, in a dispersed manner, in previous research. In this study, we group the skills into six facets:

- Operation and Search for Information (OSI): Students identify and search for information through different browsers using devices that enable Internet connection. This facet contains four items (OSI_01 to OSI_04).

- Creation and Editing of Digital Contents (CEDC): creation and editing of content in various formats: textual, auditory, audiovisual, and visual. This facet includes four items (CEDC_01 to CEDC_04).
- Publication of Information (PI): publishing content in various formats. This facet is composed of four items (PI_01 to PI_04).
- Digital Content Consumption Preferences (DCCP): consumption preferences for digital content in different formats. This facet contains four items (DCCP_01 to DCCP_04).
- Digital Content Production Preferences (DCPP): preferences in the development of content in various formats. This facet includes four items (DCPP_01 to DCPP_04).
- Collective Intelligence through Technology (CITT): students are able to contribute to collective critical thinking, solve everyday problems, and work in a collaborative manner, making ethical use of information. This facet is composed of seven items (CITT_01 to CITT_07).

Items were constructed based on the research objectives and prior literature indicated below. An item pool was made with 45 items, which after an analysis of redundancy, ambiguity, length, adequacy to the construct of interest (DeVellis, 2017) and corrections in the wording provided the questionnaire version 1. This questionnaire consists of 23 items, grouped into six facets and inspired by these studies:

- OSI: (Ferrari, 2013); (ISTE, 2017); (Mengual-Andrés et al., 2016); (Ng, 2012); (Lukitasari et al., 2022).
- CEDC: (Ferrari, 2013); (ISTE, 2017); (Mengual-Andrés et al., 2016); (Lukitasari et al., 2022).
- PI: (Ferrari, 2013); (ISTE, 2017); (Lukitasari et al., 2022).
- DCCP: (Ng, 2012); (Senkbeil & Ihme, 2017).
- DCPP: (Ng, 2012); (Senkbeil & Ihme, 2017).
- CITT: (Ferrari, 2013); (ISTE, 2017); (Mengual-Andrés et al., 2016); (Ng, 2012).

From Ferrari (2013), elements related to the identification, location, retrieval, organization and analysis of digital information were assumed. In addition, aspects related to content creation and editing (which includes text processing up to images and video) were taken into account. Likewise, issues related to collaboration through digital tools were used, as well as the creative use of technology to solve technical problems. Based on the standards established by the ISTE (2017), we rely on the aspects related to the planning and use of strategies to locate information. Likewise, we took as a starting point aspects referred to the selection of information using a variety of methods and tools. In addition, we assumed the elements referred to the communication of ideas through the creation or use of different digital resources, as well as the publication or

presentation of contents. Finally, we used the issues related to the use of collaborative technologies to work with others.

According to Mengual-Andrés et al. (2016), elements related to the mastery of image, audio and digital video processing tools are assumed. In addition, aspects related to the effective use of digital tools for the location, analysis, and evaluation of information resources. Likewise, we took into account issues related to the planning of information searches for problem solving, as well as the identification and evaluation of relevant information. In addition, we assumed aspects referred to the communication of information using a variety of formats. Finally, we relied on aspects related to ethics in the use of digital information and technologies. Assumed from Ng's (2012) research, were elements related to access to computers, familiarity with a range of tools, competence in the use of digital tools, and frequency of use of web-based resources.

From the research by Lukitasari et al. (2022), we used as a starting point items referring to students' skills related to the use of programs to perform tasks, the use of mobile devices to access information, the ability to search for and evaluate information, and the ability to create and edit visual and audiovisual content. We assume from Senkbeil & Ihme (2017) elements related to the use of the computer and the Internet to search for information in different sources and formats, as well as to create content.

The items were statements to which the responses were recorded scales (DeVellis, 2017):

- Likert scale (Type A Scale) with four levels: 1 = *I completely disagree with the statement*, 2 = *I partially disagree with the statement*, 3 = *I partially agree with the statement*, 4 = *I completely agree with the statement*.
- Semantic differential (Type B Scale) with four levels: 1 = *None*, 2 = *Basic*, 3 = *Medium*, 4 = *Expert*.

Figure 2 shows the relationship established between the skills required for achievement of DCC and the questionnaire items.

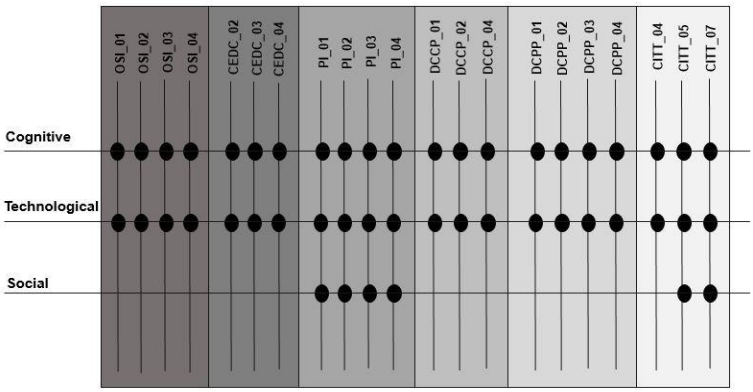

Figure 2
Relationship between the skills required to achieve DCC and the items of dimensions

The items in each facet mostly cover the three skills that comprise DCC. In the analysis, however, it was difficult to demonstrate the link between some items and a certain skill. For example, a weak relationship was established between technological ability and item OSI_03 because the information in this case is digital. Similarly, there was no link between social skills and item CITT_05, since ethics was considered as a social construct.

METHOD

Research design and sample

In this study, a quantitative research design was used, specifically the alternative selected was survey design (Creswell & Creswell, 2017). Survey research is the method in which, through a quantitative description, the opinions of a sample of individuals are studied. The study is descriptive and cross-sectional in nature. It is a descriptive study because information was obtained on a phenomenon in a given context (Bisquerra et al., 2014). It is a cross-sectional study because variables were described and their incidence and interrelationship were analyzed at a single moment in time (Hernández-Sampieri et al., 2014).

The present research was conducted during the 2021-2022 academic year and involved 260 students. Students were in the first semester of their degree program in Computer Engineering and enrolled in the subject Introduction to Computer Science. The sample, for convenience and is within the established range of 50 to 400 values (Guadagnoli & Velicer, 1988). Table 1 summarizes the characteristics of the participants.

Table 1
Sample profile

Variables	Frequency	Percentages
Gender		
Female	69	26.5 %
Male	191	73.5 %
Age		
<20 years	84	32.3 %
20–29 years	141	54.2 %
30–39 years	29	11.2 %
≥40 years	6	2.3 %

Data collection and analysis procedures

We published the questionnaire online using Moodle platforms v.3. The students took approximately 30 minutes to complete the questionnaire. SPSS v.24 and SPSS Amos v.22 were used to analyze the quantitative data.

To verify that the questionnaire is valid and reliable, content and construct validity tests were carried out (DeVellis, 2017). Content validity was performed intimately linked to the definition of the construct (DeVellis, 2017), trying to make the items reflect the aspects of the phenomenon indicated in the conceptual definition. The version 1 of the questionnaire was sent to a group of five experts in digital communication and the use of

educational technology. Their comments were reviewed and we used Cochran's Q test to check the parity of several related samples in one dichotomous variable. No items were discarded, and the appropriate lexical adaptations were made. The version 2 of the questionnaire—resulting from the experts' analysis—contained 27 items.

To obtain version 2 of the questionnaire, the experts evaluated the items according to the following criteria: wording, clarity, and type of scale. The corrections made to obtain the construct's final items behaved as follows:

- Seven items showed 100% agreement in the evaluators' observations.
- Eight items showed 80% agreement in the evaluators' observations. The reason for disagreement was wording issues of the sentences.
- Five items showed 60% agreement in the evaluators' observations. The reasons for disagreement were problems with wording in four items and the change of scale in one item.
- Three items showed 40% agreement in the evaluators' observations. The reason for disagreement was problems with wording.

The experts made 45 comments, of which 37 (82.22%) were accepted and distributed as follows: six changes in wording, one change of scale, and a division of one item into two (e.g. original wording "My skill in producing and editing visual content", final wording "My skill in producing and editing audiovisual content" and "My skill in producing and editing visual content (pictures and charts)".

To measure the agreement among experts, the Fleiss Kappa coefficient was used; this coefficient has been adapted for multiple evaluators who evaluate different units independently (Bernal-García et al., 2020). As a result of this analysis, a value of (k=.78) was obtained. These data showed that there is good agreement in the experts' assessments (Fleiss et al., 2013).

When measuring variables that are not directly observed, construct validity is a key element for the soundness of the questionnaire (López et al., 2015). In this study, validity was reported from the factor structure. Specifically, analyzed data using Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). To perform the EFA, we performed correlation analysis, evaluated the behavior of the items and verified the normality conditions. In addition, we computed the Kaiser-Meyer-Olkin (KMO) sample adequacy measure and Bartlett's sphericity test. CFA was computed to determine the fit and the number of factors to retain from the studied samples. The indices that help to determine the model's fit quality are the likelihood ratio index chi-square, the Tucker-Lewis Index (TLI), the Comparative Fit Index (CFI) and the Root Mean Square Error of Approximation (RMSEA). For the reliability, we calculated the Cronbach Alpha.

A total of 260 responses were collected, of which all were valid for analysis. These responses were randomly divided into two samples (for EFA and for CFA) to prevent

unrealistic fit values for the model in the CFA as a result of using the same sample used in the EFA.

FINDINGS

Study 1. EFA

The purpose of EFA was to examine the advisability of grouping the items by facets and to establish a correspondence with the proposed theoretical facets. Correlation analyzes were performed to determine the internal consistency of the items within each facet. The resulting correlations ranged from .34 to .83, except for items DCCP_03 and CITT_06, which presented indices below 0.30 and were therefore not taken into account in subsequent analyzes. The items' behavior was evaluated through descriptive statistics measuring central tendency and dispersion. The response averages ranged from 2.05 to 3.26, with σ values between .68–1.21. To verify the normal conditions, a frequency analysis was performed, since normality must be fulfilled to perform the EFA and CFA (Douglas & Strobel, 2015). Based on bias and kurtosis, items CITT_02 and CITT_03 did not meet the criteria for normality and were discarded in subsequent analyzes.

Bartlett's sphericity test produced a value of χ^2 (261, N = 98) = 1500.10, p <.05, allowing rejection of the H_0 that the correlations between the items were not large enough for an EFA. This result permits us to consider the correlation matrix, R, suitable for factoring. The overall value obtained in the KMO test (=.85) indicated suitability of the sample for this analysis for the scale of the 23 variables constituting the six facets as shown in Figure 3. This result provides evidence supporting the use of factor analysis, as did analysis of the correlation matrix (determinant (R) = 2.090E-7). We begin the EFA by obtaining the communalities through principal components analysis. The values obtained ranged from .56 (CEDC_01) to .90 (PI_02).

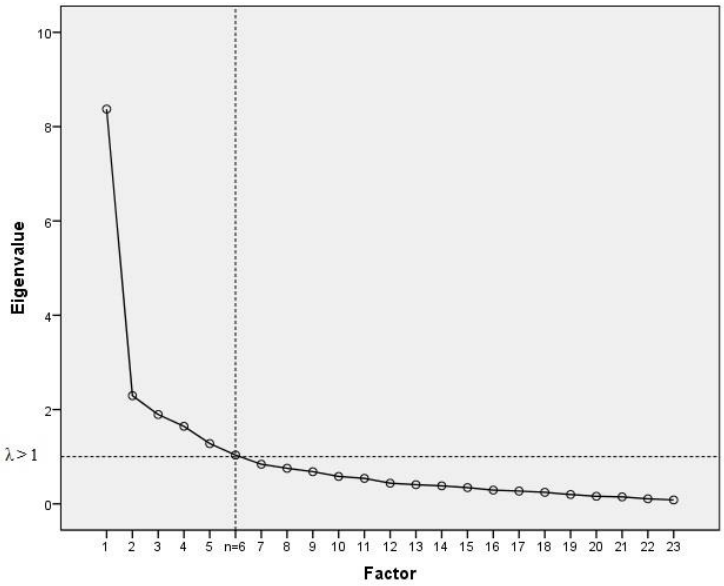

Figure 3
Principal component analysis scree plot

Table 2 and Figure 3 show the eigenvalues and the scree plot for our principal components analysis. Both the Kaiser rule of eigenvalues greater than 1 and the scree plot indicated that six-factor solution would fit the data the best. These six factors accounted for 72.73% of the total variance in scores. More than one-third (38.40%) the total variance in this six-factor solution is attributed to the first factor.

Table 2
Eigenvalues from principal component analysis

Component	Initial eigenvalues		
	Total	Percentage of variance	Cumulative percentage
1	8.27	38.40	38.40
2	2.20	9.08	47.48
3	1.87	8.22	55.70
4	1.66	7.16	62.86
5	1.29	5.57	68.43
6	1.02	4.30	72.73

Finally, factor rotation (Varimax with Kaiser normalization, which converged in eight iterations) was performed to detect whether any modifications occurred; none were found. As can be seen in the Table 3, it was not necessary to eliminate items since none obtained load values below .30 (Siembida et al., 2018), the minimum and maximum values for each rotated component ranged from .47 (CITT_01) to .88 (PI_04). In general, item loadings on these six factors pictured a clear loading profile that included no bad or erroneous loadings.

As a result, the 23 items loaded on six factors corresponding to the theoretical facets initially proposed: OSI, CEDC, PI, DCCP, DCPP, and CITT.

Table 3
Factorial loads for EFA with principal component analysis

Items	PI	CEDC	DCPP	OSI	CITT	DCCP
OSI_01. My skill in the use of different mobile devices (laptops, smartphones, tablets, ...) is:				.753		
OSI_02. My skill in different browsers is:				.715		
OSI_03. My skill in identifying relevant information is:				.623		
OSI_04. My skill in searching for information is:				.668		
CEDC_01. My skill in creating and editing text content is:		.599				
CEDC_02. My skill in creating and editing audio content is:		.642				
CEDC_03. My skill in creating and editing audiovisual content is:		.841				
CEDC_04. My skill in creating and editing visual content (photos, graphics) is:		.752				
PI_01. My skill in publishing written content (e.g., on Facebook, forums, etc.) is:	.747					
PI_02. My skill in publishing audio content (e.g., on Facebook, blogs, etc.) is:	.809					
PI_03. My skill in publishing audiovisual content is:	.733					
PI_04. My skill in publishing photos and graphics (e.g., on Facebook, forums, etc.) is:	.880					
DCCP_01. I prefer to consume digital content when it is written in text.						.806
DCCP_02. I prefer to consume digital content when it is audio.						.839
DCCP_04. I prefer to consume digital content when it is visual (photos, graphics).						.617
DCPP_01. I prefer to create digital content when it is written in text.			.515			
DCPP_02. I prefer to create digital content when it is audio.			.826			
DCPP_03. I prefer to create digital content when it is audiovisual.			.808			
DCPP_04. I prefer to create digital content when it is visual (photos and graphics).			.855			
CITT_01. I am able to come up with novel ideas using ICTs.					.471	
CITT_04. I can analyze the pros and cons of digital resources.					.624	
CITT_05. I use ethical information from a variety of sources and media.					.770	
CITT_07. I am able to work collaboratively using technological tools.					.721	

As Table 3 shows, the PI factor includes four items that refer to the skills that students possess to publish digital content in various formats. These items obtain loadings with

values ranging from .73 to .86. The CEDC factor includes four items that reflect students' abilities to create and edit digital content in different formats. The items in this factor show loadings ranging from .50 to .84. The DCPP factor includes four items that focus on students' preferences regarding the development of digital content in different formats. The items in this factor show loadings ranging from .51 to .85. The OSI factor includes four items that refer to students' abilities to identify and search for information through different browsers when using devices that allow connection to the Internet. The items in this factor show loadings ranging from .63 to .74. The CITT factor includes four items that reflect students' abilities to contribute to collective critical thinking, solve everyday problems, and work collaboratively; making ethical use of information. The items in this factor show loadings ranging from .46 to .77. The DCCP factor includes three items that focus on students' preferences in relation to the consumption of digital content in different formats. The items in this factor show loadings ranging from .51 to .85.

Study 2. CFA

The purpose of using the CFA was to cross-check the structure of the factors found in the data collected in the EFA. The main objective of a CFA is to determine how strongly the data support the proposed model or the adequacy of its goodness-of-fit to the sample data (Byrne, 2016; DeVellis, 2017). Several indices are available to help determine the model's fit quality. It is worth noting that the likelihood ratio index χ is the only one of these indices that tests statistical significance. This index is strongly influenced by sample size and is based on the central distribution of χ (Byrne, 2016). However, the relationship between this index and the degrees of freedom provides more accurate information about the goodness-of-fit (Douglas & Strobel, 2015). It is good fit values if χ^2/df takes a value between 0 and 3 (Duisembekova, 2021).

The TLI and the CFI are incremental adjustment indices that compare the hypothetical model to the proposed model (Douglas & Strobel, 2015). Values of CFI and TLI range from 0 to 1, and when approaching—from .95 and above—, they are considered to indicate good model fit. The RMSEA estimate is used to determine how well the proposed model actually fits the data, in absolute terms, rather than by comparison (Douglas & Strobel, 2015). Values below .05 indicate good fit and values between .05 and .08 acceptable fit (Duisembekova, 2021) and a perfect fit is represented by a nil value (González-Ramírez & García-Hernández, 2022).

Based on the criteria presented in Table 4, the independent model (model that maintains the non-existence of a relationship between the model variables) was lower than our Model 1 composed of 23 items and six factors. With the data from this sample, however, items CEDC_01 and CITT_01 cross-loaded onto two factors. These results matched the values of skewness and kurtosis, as neither item met the criteria for normality. Both items were thus eliminated and Model 2 proposed, consisting of 21 items and six factors. Table 4 shows the comparison of the fit indices of the three models.

Table 4
Model fit indices

Model	$\chi 2$	*Df*	$\chi 2$/ *df*	*TLI*	*CFI*	*RMSEA (90% CI)*
Independent	1601.35	257	6.23	.000	.000	.217 [0.203, 0.223]
Model 1 (23 items, 6 factors)	378.85	217	1.75	.861	.882	.083 [0.067, 0.092]
Model 2 (21 items, 6 factors)	288.50	176	1.64	.897	.907	.078 [0.059, 0.089]

The results for all fit indexes of the stand-alone model were below the level considered acceptable. The indices derived from Model 2 present acceptable values (*TLI*=.897, *CFI*=.907, and *RMSEA*=.078) that confirm the proposed factor model. The expected result of the likelihood ratio index χ was statistically significant $p<.05$. The relationship between this index and the degrees of freedom was found to be lower in this model, indicating that the model fits more closely (Byrne, 2016).

The Cronbach Alpha was recalculated for the remaining items comprising the instrument (α = .92). As removal of any items would not improve the results, all questions were relevant and through item-total analysis, all items behave in a normal statistical way (min., α = .91; max., α = .92). The statistical results of reliability for each of the instrument's facets are as follows: OSI α = .81, CEDC α = .88, PI α = .94 DCCP α = .63, DCPP α = .84, and CITT α = .70. The final questionnaire is shown in Appendix B.

DISCUSSION

The findings concluded that DCC requires the development of a series of cognitive, technological and social skills in order for people to be able to communicate ethically through the network. To this end, the theoretical foundations of the present study coincide to a lesser extent with previous proposals where divide DC into basic and contextual skills only (Van Laar et al., 2017), although they recognize elements of the technical and cognitive dimensions within these basic skills. While our work coincides with previous research in terms such as intersection of dimensions (Ng, 2012), and also that we use the term ethics for what the author called the socio-emotional dimension.

On the other hand, the DigComp model has provided the consideration of problem solving, in this case defined as the ability to communicate to create or to collaboratively discover knowledge using technological tools (Ferrari, 2013). Thus, our study points out the cognitive skills related to the identification, search, evaluation, and creation, edition and publication of contents, through sharing and collaboration. Technological skills are related to the use of devices that allow access through various means of communication (written text, audio, visual and audiovisual). Social skills are related to the management of devices that connects to networks, making an ethical use, to solve every day professional or academic problems.

The DCC is a construct that can be analyzed through the following facets: OSI, CEDC, PI, DCCP, DCPP, and CITT. In this sense, the relationship between these facets and the skills required to achieve DCC has been established and taken into consideration in the design of an instrument. Hence, the proposed instrument is important in HE since it is

being developed with technological tools, however, it is possible that it could be used in other fields, for example, in the selection of personnel or in professional development when it is necessary to know the preferences and competences of the members of the organization.

The results indicate that the DCC instrument has a good level of internal consistency and fits the theoretical model initially proposed. The factor analyzes performed identified different components that coincide with the conceptual delimitation of the construct, demonstrating the coherence of the theoretical and factor models. Through the EFA, we obtained a value of *KMO* = .85 which demonstrated the suitability of the sample selected for this analysis. The total variance explained by the six factors that resulted, as well as the rotation of the factors, led to the loading of the 23 items into the corresponding factors aligned with theoretical facets initially raised.

However, when the CFA was carried out with the data from the selected sample, the items CEDC_01 and CITT_01 crossloaded into two factors. These items were eliminated and a model consisting of 21 items and six factors was proposed (final version of the questionnaire). The indices resulting from this model present acceptable values that confirm the proposed factor model (Byrne 2016). The relationship between the likelihood ratio index χ^2 and the degrees of freedom, turned out to be lower in this model, indicating that the model fits better (Byrne 2016). The facets CITT and DCCP had less internal consistency as measured by the Cronbach Alpha, but the correlations between the elements that comprise these facets range from moderate to good.

CONCLUSION

This paper analyzed the validity and reliability of a questionnaire aimed at college students to assess digital communicative competence. The exploratory factor analysis result shows that the digital communicative competence questionnaire is divided into six factors, which are factor 1 (publication of information), factor 2 (creation and editing of digital contents), factor 3 (digital content production preferences), factor 4 (operation and search for information), factor 5 (collective intelligence through technology) and factor 6 (digital content consumption preferences). The results of the confirmatory factor analysis find that the hypothesized six-factor, 21-item model indicates a very good fit to the data, which is supported by the 90% confidence interval. Thus, the items that are adequate for use in the digital communicative competence instrument are 21 items. The suggested answer scale is 4 levels. Moreover, Cronbach Alpha has been classified as good. Overall, the questionnaire has met the construct and empirical validity to be considered valid and reliable for exploring students' digital communicative competence skills.

DCC is defined as the intersection between digital and communicative competence. We understand that this competence requires the development of a series of cognitive, technological and social skills in order for people to be able to communicate ethically through the network. The concept of DCC concentrates a number of skills that have been identified individually, in a dispersed manner, in previous research. In this sense, it is important to develop a questionnaire that facilitates administrators, employers,

teachers, students, technicians or specialists to know which is the DCC of an individual to adapt and/or facilitate relevant processes.

SUGGESTIONS

This study has been conditioned by the sample selected and the profile of the students. Future research on the DCC instrument should focus on additional statistical analysis to extend the validity of the instrument. In addition, research should be developed on larger samples of other populations from different professional fields. The questions in the questionnaire were closed-ended, an element that limits student responses. It would be advisable to include open-ended questions to conduct a qualitative study. We propose these problems for future research.

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APPENDIX

Appendix A: Review of tools and conceptual frameworks on DC

Author/ Year	Name of Instrument/ Study	Objective	Participants	Analysis	Results
Ferrari (2013)	DIGCOMP conceptual framework.	To build European consensus on the components of DL.	95 experts, 17 external participants, and 40 stakeholders.	Analysis of 15 existing frameworks. Online inquiry and discussion between experts and external participants. Stakeholders contributed to revision of the first proposal.	DL with 21 sub-competences organized into five dimensions: information, communication, content creation, security, and problem solving.
Kennedy, et al. (2008)	First year students' experiences with technology: Are they really digital natives?	Know how to access, use, and determine preferences for an array of established and emerging technologies and technology-based tools.	First-year university students (N = 1973).	Frequency and percentage of items. Chi-Square test to determine association between intention to use the technology and its actual use in education.	Most students are highly knowledgeable about entrenched technology. If they are in the educational field, however, the percentage of access and use decreases. Basic skills related to use of technologies do not necessarily translate into knowing how to use them for learning.
Mengual-Andrés, et al. (2016)	Questionnaire on Digital Competences in Higher Education.	To assess the acquisition of digital skills in Higher Education.	27 experts and 100 students in Spanish context.	Mann-Whitney U-test, median test, Cronbach Alpha, and total item correlation analysis.	52 items organized in five dimensions: technological literacy, access to information and use, communication and collaboration, digital citizenship, and creativity and innovation.
Ng (2012)	Can we teach digital natives digital literacy?	Explore "*digital nativeness"* and investigate the DL of a group of professors teaching undergraduates enrolled in an eLearning course at a university in Australia.	Two experts in ICT in education. Pre- and post-test with 28 students.	Central tendency, dispersion, and frequency measurement statistics. Tests and Cronbach alpha.	Students were generally able to use unknown technologies in their learning, but needed to be made aware of educational technologies and given the opportunity to use them to achieve meaningful use.

Author/ Year	Name of Instrument/ Study	Objective	Participants	Analysis	Results
Tadesse, Gillies, & Campbell (2018)	Assessing the dimensionality and educational impacts of integrated ICT literacy in the higher education context.	Illustrate the construct validity and internal consistency of the model for assessing undergraduate students' integrated information and communication technology (ICT) literacy capacity.	Undergraduate students the College of Natural Sciences (n = 206) and College of Social Sciences and Law (n = 330).	A multi-method approach was used, which comprises correlation, reliability multiple regression and factor analyses.	4-factor model consisting of ICT use, cognitive process, reading task and writing task; that can be used by other Higher Education institutions to assist in the evaluation of students' ICT literacy capacities.

Appendix B: Final version of the DDC instrument

Items
Type A Scale
DCCP_01. I prefer to consume digital content when it is written in text.
DCCP_02. I prefer to consume digital content when it is audio.
DCCP_04. I prefer to consume digital content when it is visual (photos, graphics).
DCPP_01. I prefer to create digital content when it is written in text.
DCPP_02. I prefer to create digital content when it is audio.
DCPP_03. I prefer to create digital content when it is audiovisual.
DCPP_04. I prefer to create digital content when it is visual (photos and graphics).
CITT_04. I can analyze the pros and cons of digital resources.
CITT_05. I use ethical information from a variety of sources and media.
CITT_07. I am able to work collaboratively using technological tools.
Type B Scale
OSI_01. My skill in the use of different mobile devices (laptops, smartphones, tablets, ...) is:
OSI_02. My skill in different browsers is:
OSI_03. My skill in identifying relevant information is:
OSI_04. My skill in searching for information is.
CEDC_02. My skill in creating and editing audio content is:
CEDC_03. My skill in creating and editing audiovisual content is:
CEDC_04. My skill in creating and editing visual content (photos, graphics) is:
PI_01. My skill in publishing written content (e.g., on Facebook, forums, etc.) is:
PI_02. My skill in publishing audio content (e.g., on Facebook, blogs, etc.) is:
PI_03. My skill in publishing audiovisual content is:
PI_04. My skill in publishing photos and graphics (e.g., on Facebook, forums, etc.) is: