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## Factorial structure of the Community of Inquiry Survey in a South African open and distance e-learning environment

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We aimed to determine the factor structure and reliability for the Community of Inquiry Survey in a South African Open and Distance e-Learning Environment. Participants were 572 honours students. Confirmatory factor analysis was performed to determine the factorial structures. Structural equation modelling yielded a three-factor structure including perceptions of teaching, social, and cognitive presence. The reliability of scores for the total scale was 0.96. The three-factor structures of the Community of Inquiry Survey had a high internal consistency ranking from 0.90 to 0.95. The Community of Inquiry Survey appears valid for student advisement and support in the South African distance learning environment.

**Keywords:** cognitive and social presence, community of inquiry, student engagement, teaching

### Introduction

Open and e-learning are becoming a global norm, particularly post-COVID-19 (Adnan & Anwar, 2020; Almaiah et al., 2020; Aristeidou & Cross, 2021; Baber, 2021; Borkotoky & Borah, 2021). In the open and distance e-learning (ODEL) environment, pedagogies seek to create and host communities of inquiry (Garrison et al., 2000; Stoytcheva, 2021) that bring the same vitality to learning as in-person instruction. With the broader adoption of open and e-learning by traditionally in-person programs, it will be critical to have validated measures of student engagement. Measures of the Community of Inquiry (CoI) Survey have operationalised three factors, including teaching presence (TP), cognitive presence (CP), and social presence (SP) (Garrison et al., 1999). According to the CoI, deep and meaningful learning should occur if all three presences are present (Anderson, 2008). This study aimed to validate the Community of Inquiry Survey in a South African open and distance e-learning environment. Findings contribute to the validation of online student collaboration and engagement measures within a South African context.

### Measures of community of inquiry

Arbaugh and colleagues (2008) conducted one of the first studies to validate the CoI survey instrument and created the groundwork to construct the instrument (Garrison, 2017). Swan and colleagues (2008) used factor analysis to confirm that the CoI survey is reliable and valid. The Cronbach alphas of the study yielded high inter-correlations leading to internal consistencies with teaching presence (0.94), social presence (0.91), and cognitive presence (0.95) (Swan et al., 2008). This aligns with Stewart's (2019) findings. A study conducted by Akyol and colleagues (2010) established a three-factor structure from the CoI survey, and Díaz and colleagues (2010) used factor analysis to support the findings. Horzum and Uyanik (2015) found the CoI survey instrument valid and reliable using the Classical Test Theory and Item Response Theory. Caskurlu's (2018) study reported that

the data fit well with the CoI survey instrument through confirmatory factor analysis. This supports the CoI survey as a valid instrument to assess the CoI in an online learning environment (Garrison, 2017).

Various studies were conducted to validate the CoI survey using different techniques and contexts. Abbitt and Boone (2021) used a Rasch analysis of the CoI survey, which indicated strong reliability of the measurement properties of the survey. Wei and colleagues (2020) conducted a study using item analysis, exploratory factor analysis, and confirmatory factor analysis to validate and develop a presence questionnaire for K-12 education. The new questionnaire yielded strong internal reliability and a moderate structural validity. Further, Ma and colleagues (2017) verified the casual relationships amongst the three presences in the Chinese context. Yu and Richardson (2015) used exploratory and confirmatory analysis to examine the reliability and validity of the CoI Survey in a Korean context. Similarly, Olpak and Kiliç Çakmak (2018) examined the reliability and validity of the CoI survey in the Turkish context using confirmatory factor analysis to validate a three-factor structure of the CoI instrument, and all three presences had high reliabilities (TP = 0.965; SP = 0.953, and CP = 0.972) which confirms the validity of scores from the CoI survey within the Turkish context. Another study by Ballesteros and colleagues (2019) validated the CoI survey within the Spanish version from the view of construct validity and internal consistency reliability ( $\alpha > 0.90$  for each presence). A study conducted by Befus (2016) confirms that the CoI continues to be one of the most significant models for distance and blended online learning research within various contexts, environments, and practices.

Garrison (2017) and Dempsey and Zhang (2019) suggest future research to refine the constructs of the CoI framework, re-evaluate the factor structure, and exploring the pathways among the three presences. Establishing the factorial structure among the presences is essential to set the stage for purposeful and collaborative learning processes and activities (Garrison, 2017). Although

previous studies established the CoI Survey's validity in developed countries, the research exploring the factor analytic in an open and distance e-learning institution in South Africa is still unknown.

### Goal of the study

This study sought to validate the Community of Inquiry Survey in a South African open and distance e-learning environment. The following questions guided our validation study:

- (i) Does the CoI Survey demonstrate a three-factor structure solution?
- (ii) Is the CoI survey a valid and reliable instrument for use within a South African open and distance e-learning environment?

### Method

#### Participants and setting

Participants were 572 open and e-learning students (female = 61.4%, mean age = 3.38 years, SD = 1.34 years). Participants were enrolled in various online honours-level courses in either the College of Economic and Management Sciences (CEMS: 79.5%) or the College of Science and Engineering Technology (CSET: 20.5%) at the University of South Africa (Unisa).

#### Measures

The study used the Community of Inquiry (CoI) survey instrument (Arbaugh et al., 2008) to gather data using an online survey. The CoI is a 34-item self-report measure of the dimensions of teaching, cognitive, and social presences. The CoI was scored on a five-point Likert scale ranging from 1 = strongly disagree, to 5 = strongly agree. Examples items include "The lecturer clearly communicates important course objectives"; "You feel motivated to explore content-related questions"; and "You feel comfortable participating in the course discussions". A previous study by Garrison and colleagues (2010) found Cronbach alpha coefficients ranging from 0.87 to 0.93 for the CoI. The present study obtained an internal consistency Cronbach alpha coefficient ranging between 0.90 and 0.95.

#### Procedures

The University of South Africa Research Ethics Review Committee approved the study (2019\_CRERC\_006 and 2019\_RPSC\_010). Participants provided informed consent to participate in the research project. Each participant received an e-mail link consisting of an invitation letter indicating the study's objectives and explaining the individual's consent and voluntary participation in the

project. Furthermore, we assured the participants of the confidentiality of responses.

### Data analysis

We analysed the survey using the Statistical Package for Social Sciences (SPSS) version 27 of 2021 for Windows and AMOS 27.0, applying confirmatory factor analysis (CFA) and structural equation modelling (SEM). The following Goodness of Fit Indices were used to assess the relationship between the constructs: the chi-square statistics (non-significant  $\chi^2$ , CMIN/DF < 0.05); the Root Mean Square Error of Approximation (RMSEA values of 0.05 and below = good fit); the Comparative Fit Index (CFI); the Tucker-Lewis Index (TLI values of 0.90 and greater = good fit); the Normed Fit Index (NFI); and the Relative Fit Index (RFI).

### Results

#### Descriptive statistics

Table 1 presents the variables' means, standard deviations, Cronbach's alpha coefficients, and correlations. Cognitive presence obtained the highest mean scores ( $M = 3.78$ ,  $SD = 0.61$ ), followed by social presence ( $M = 3.70$ ,  $SD = 0.68$ ). Teaching presence obtained the lowest mean scores ( $M = 3.37$ ,  $SD = 0.83$ ). The reliability of scores for the overall CoI scale was 0.96, indicating good reliability.

Further, Table 1 indicates the significant relationships between TP, CP, and SP variables. The results show that the TP variable related significantly and positively to CP ( $p \leq 0.001$ ) and SP ( $p \leq 0.01$ ). The CP variable related significantly and positively to SP ( $p \leq 0.001$ ). The overall CoI scale positively related to all three variables at the 99% significant level.

#### Confirmatory factor analysis

Confirmatory factor analysis using the varimax rotation yielded a KMO-MSA value of 0.956, which is well above 0.5, suggesting the data were adequate for CFA. The Bartlett's test of sphericity  $\chi^2 (630) = 14363,421$ ,  $p < 0.01$  showed patterned associations between items. Eigenvalues for the three variables were 14.361 for TP, 4.168 for CP, and 2.350 for SP, supporting the three-factor model. Table 2 provides details of the confirmatory factor analysis results for individual items of the CoI instrument.

Table 2 depicts the factor loadings ranging from 0.68 to 0.83 for teaching presence, 0.59 to 0.72 for cognitive presence, and 0.60 to 0.83 for social presence. The composite reliability ranged from 0.885 to 0.943 which is well above the recommended 0.70 (Hair et al., 2019; Fornell & Larcker, 1981). Further, Table 2 indicates that

**Table 1.** Descriptive statistics and correlations

Variables	Mean	SD	$\alpha$	1	2	3	4	5	6
1) Overall CoI	3.60	0.59	0.96	1	0.88***	0.87***	0.71***	-0.06	0.10*
2) TP	3.34	0.82	0.95		1	0.66***	0.38**	-0.02	0.10*
3) CP	3.78	0.61	0.91			1	0.55***	-0.06	0.09
4) SP	3.70	0.68	0.90				1	-0.10*	0.06
5) Sex	1.64	0.49	-					1	-0.18*
6) Age	3.38	1.34	-						1

Note:  $N = 572$ , SD = standard deviations,  $\alpha$  = Cronbach alpha coefficient, TP = teaching presence, CP = cognitive presence, SP = social presence; \*\*\* $p \leq 0.001$ ; \*\* $p \leq 0.01$ ; \* $p \leq 0.05$

**Table 2.** Confirmatory factor analysis

Items	Question	F1*	F2	F3	CR	AVE	$\alpha$
TP6	The lecturer is helpful in identifying areas of agreement and disagreement on course topics that help you to learn.	0.825			0.943	0.625	0.95
TP9	The lecturer is helpful in guiding the students towards understanding course topics in a way that helps you clarify your thinking.	0.824					
TP5	The lecturer helps keep the student participants on task in a way that assists you to learn.	0.820					
TP8	The lecturer helps to keep student participants engaged and participating in productive dialogue.	0.814					
TP11	The lecturer helps to focus discussion on relevant issues in a way that assists you to learn.	0.811					
TP10	Lecturer actions reinforce the development of a sense of community among student participants.	0.809					
TP3	The lecturer is helpful in guiding you towards understanding course topics in a way that helps you to clarify your thinking.	0.789					
TP7	The lecturer encourages student participants to explore new concepts in this module.	0.747					
TP1	The lecturer clearly communicates important course objectives.	0.730					
TP4	The lecturer provides clear instructions on how to participate in course learning activities.	0.726					
CP7	Finding relevant information helps you resolve content-related questions.		0.723		0.885	0.437	0.91
CP9	You develop solutions to course problems that can be applied in practice.		0.701				
CP6	Combining new information helps you to answer questions raised in course activities.		0.682				
CP8	Reflection on course content and discussions helps you to understand fundamental concepts in this module.		0.669				
CP4	You can apply the knowledge created in this course to your work or other non-class related activities.		0.668				
CP5	Learning activities help you construct explanations/solutions.		0.654				
CP3	Course activities intrigue (arouse) your curiosity.		0.650				
CP11	You can describe ways to test and apply the knowledge created in this module.		0.639				
CP12	You utilise a variety of information sources to explore the problems posed in this module.		0.623				
CP2	Problems posed increases your interest in course issues.		0.589				
SP3	You feel comfortable interacting with other student participants.			0.825	0.914	0.545	0.90
SP4	You feel comfortable disagreeing with other student participants while still maintaining a sense of trust.			0.811			
SP8	Online discussions help you to develop a sense of collaboration.			0.782			
SP2	You feel comfortable participating in the course discussions.			0.780			
SP6	Getting to know other student participants gives you a sense of belonging in the module.			0.756			
SP5	You feel that other student participants acknowledged your point of view.			0.738			
SP9	You are able to form distinct impressions of some student participants.			0.670			
SP7	Online or web-based communication is an excellent medium for social interaction.			0.658			
SP1	You feel comfortable conversing through the online myUnisa platform.			0.592			
Eigen-values		14.361	4.168	2.350			
% of variance		25.084	11.659	16.252			

Note. CR = Composite reliability; AVE = Average Variance Extracted;  $\alpha$  = Cronbach alpha coefficients. \*F1 = TP; F2 = CP and F3 = SP

except for cognitive presence, all the AVE were above 0.50. Based on the survey, Cronbach's alpha values indicated high internal consistency or reliability indices for teaching presence (0.95), cognitive presence (0.91), and social presence (0.90).

**Structural equation modelling (SEM) of the measures**

Table 3 summarises the fit statistics of the three measurements. Teaching presence (TP) produced a good fit with the data with CMIN = 130.80; CMIN/df = 2.255;  $p < 0.01$ ; NFI = 0.98; RFI = 0.97; TLI = 0.98; CFI = 0.99; RMSEA = 0.05; and RMR = 0.03. Cognitive presence (CP) produced a good fit with the data with CMIN = 50.34; CMIN/df=1.291;  $p = 0.11$ ; NFI = 0.99; RFI = 0.98; TLI = 0.99; CFI = 0.99; RMSEA = 0.02; and RMR = 0.01. Lastly, social presence (SP) produced a good fit with the data with CMIN = 1.018; CMIN/df= 1.476;  $p = 0.12$ ; NFI = 0.99; RFI = 0.98; TLI = 0.99; CFI = 0.99; RMSEA = 0.03; and RMR = 0.00.

Further, as is clear from Table 3, the first-order model fitted well after some modification. Fit indices were CMIN = 1.108; CMIN/df = 3.714;  $p < 0.01$ ; NFI = 0.87; RFI =

0.86; TLI = 0.90; CFI = 0.90; and RMSEA = 0.07. As depicted in Figure 1, except for the NFI and the RFI the other indices were above the cut-off of 0.90.

Furthermore, Table 3 showed that the second-order model also fitted well after modifications. Fit indices were CMIN = 700.48; CMIN/df = 1.683  $p < 0.01$ ; NFI = 0.95; RFI = 0.94; TLI = 0.97; CFI = 0.98; RMSEA = 0.04; and RMR = 0.04. This is also depicted in Figure 2. According to Levesque and colleagues. (2004), a RMSEA of 0.05 or smaller indicates a perfect fit. Furthermore, from the comparative fit index (CFI), the values were all above 0.90, which showed that the model fitted well, and the empirical data conformed to the presumed model. Therefore, it is reasonable to assume that the model indicated a perfect fit.

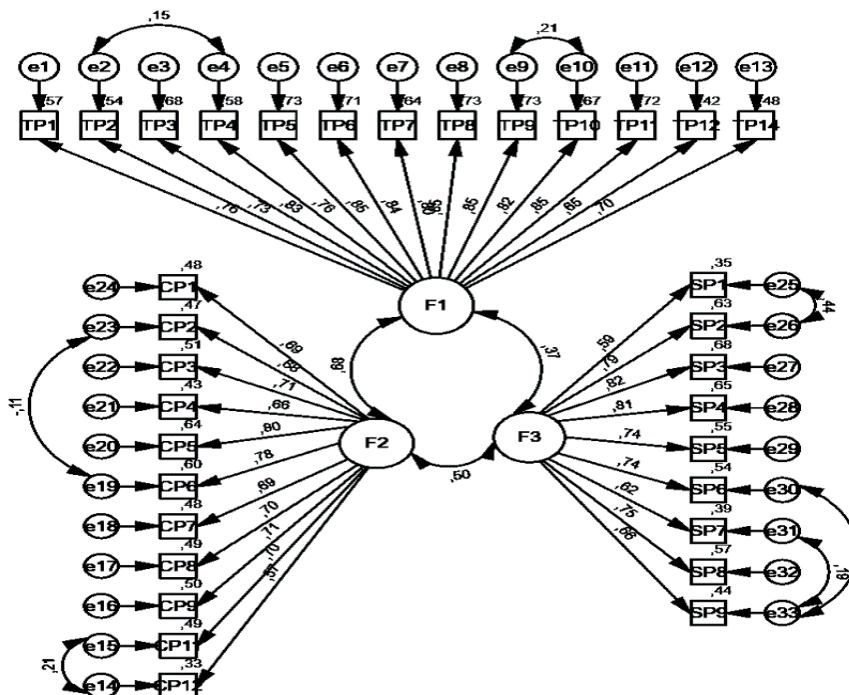
**Discussion**

We aimed to determine the factor structure and reliability for the Community of Inquiry Framework as measured by the CoI Survey in an open distance institution in South Africa. The factor structure analysis yielded a three-factor solution: teaching presence (0,726 to 0,825), cognitive presence (0,589 to 0,723), and social presence (0,592 to 0,825). This is similar to the findings of Akoyl and

**Table 3.** SEM fit statistics

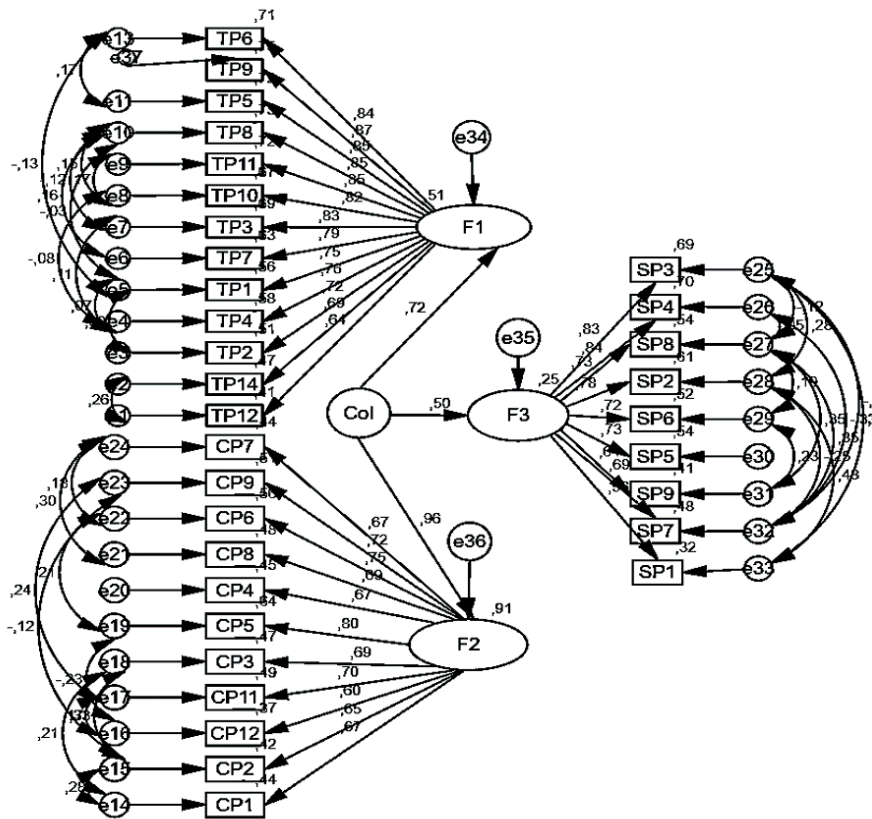
Model	CMIN	df	CMIN/df	<i>p</i>	NFI	RFI	TLI	CFI	RMSEA	RMR
TP	130.80	58	2.255	< 0.001	0.98	0.97	0.98	0.99	0.05	0.03
CP	50.34	39	1.291	0.11	0.99	0.98	0.99	0.99	0.02	0.01
SP	1.018	13	1.476	0.12	0.99	0.98	0.99	0.99	0.03	0.00
First-order model	1801	109	3.714	< 0.001	0.87	0.86	0.90	0.90	0.07	–
Second-order model	700.48	445	1.683	< 0.001	0.95	0.94	0.97	0.98	0.04	0.04

Note: CMIN(X2) = chi-square; df = degree of freedom; *p* = significance level; NFI = Bentler-Bonett normed fit index; RFI = relative fit index; TLI = non-normed fit index; CFI = comparative fit index; RMSEA = root-mean-square error of approximation. RMR = Root-mean-square residual.



Note. \*F1 = TP; F2 = CP, and F3 = SP

**Figure 1.** First-order model



Note. \*F1 = TP; F2 = CP, and F3 = SP

Figure 2. Second-order model

colleagues (2010); Ballesteros and colleagues (2019); Caskurlu's (2018); Díaz and colleagues (2010); Olpak and Kiliç Çakmak (2018); Swan and colleagues (2008); and Wei and colleagues (2020). These findings are consistent with previous studies that found that the CoI instrument items cohere into interpretable constructs congruent with the three CoI presences (McKerlich et al., 2011; Shea & Bidjerano, 2009). This implies that although all presences are important, cognitive presence indicates that the students can construct and confirm meaning in online courses and connect knowledge. These results are in tandem with the findings of McKerlich and colleagues (2011).

The structural equation modelling findings reported in this study support the theoretical predictions of the CoI framework in that the teaching presence appears to be the most significant among the three presences. These findings mirror those of previous studies (Arbaugh et al., 2008; Garrison et al., 2010), who indicated that the epistemic engagement approach, which emphasises students' collaborative knowledge builders, is fully articulated and extended through the CoI framework.

Previous research has shown that all three presences need to be cultivated in online and blended courses for communities of inquiry to develop and for higher-order thinking to take place (Garrison, 2017; Gutiérrez-Santiuste et al., 2015). These results support the views of Anderson and colleagues (2001) and Olpak and colleagues (2016) that teaching presence designs, facilitates, and directs cognitive and social processes create meaningful personal learning outputs. The study's findings reinforce that teaching presence is core to establishing and sustaining an

online learning experience (Garrison et al., 2010; Kozan & Richardson, 2014; Saadatmand et al., 2017; Shea & Bidjerano, 2009; Yu & Richardson, 2015).

### Implications for the use of validated measures of Communities of Inquiry in open and distance e-learning environments

This study expands research in authenticating the CoI survey to open and distance e-learning environments in a developing country setting. Further, the CoI survey appears valid for student advisement and support in the South African distance learning environment. Finally, the results confirmed that the CoI survey could be used for online e-learning, especially during the COVID-19 pandemic as many institutions turned to open and e-learning education.

### Limitations and future direction

This study had several limitations. Firstly, this cross-sectional study was conducted in a single academic institution, and findings cannot be generalised to other open and distance learning environments in South Africa or elsewhere. Future research should focus on obtaining a larger and more representative sample from a more diverse group of open distance learning institutions. There is also the need to explore the possible mediating effect of social presence on teaching and cognitive presences, particularly in the large-scale adoption of online learning in South Africa and globally.

## Conclusion

The research aimed to determine the factor structure and reliability for the CoI Survey in a South African Open and Distance e-Learning environment. Confirmatory factor analysis factorial structures and structural equation modelling yielded a three-factor structure: perceptions of teaching, social, and cognitive presence. The reliability of scores for the total scale was excellent. From the results obtained, we conclude that the CoI Survey as a reliable instrument to improve student support strategies, collaboration, and engagement in an online learning context in South Africa.

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