



Scientific Communication among Peruvian University Students: Psychometric Evidence

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ABSTRACT

This study aims to analyse university students' scientific communication competence through a questionnaire designed to assess how they perceive, practise and value this competence within the context of open science and digital environments that are reshaping the production and dissemination of knowledge. The study adopts a quantitative, instrumental methodological approach and employs statistical techniques to assess the validity and reliability of the instrument. The sample comprised 1,261 students from a Peruvian public university, who responded to items related to academic dissemination, social engagement and the critical appropriation of science. The results provide evidence of construct validity and high internal consistency of the questionnaire, confirming its suitability for measuring scientific communication competence. Strengths and limitations were also identified in students' appropriation and translation of scientific knowledge. In summary, scientific communication is essential for academic and civic development, and the availability of a valid and reliable instrument contributes to the design of policies and practices aimed at fostering the democratization of knowledge and students' critical participation.

PALABRAS CLAVE

Comunicación científica
Competencias
comunicativas
Estudiantes
universitarios
Ciencia abierta
Democratización del
conocimiento

RESUMEN

Este estudio tiene como objetivo analizar la competencia en comunicación científica de estudiantes universitarios mediante un cuestionario diseñado para evaluar cómo perciben, practican y valoran dicha competencia en el marco de la ciencia abierta y de los entornos digitales que están reconfigurando la producción y socialización del conocimiento; el enfoque metodológico es cuantitativo e instrumental, y emplea técnicas estadísticas para evaluar la validez y confiabilidad del instrumento; la muestra estuvo conformada por 1261 estudiantes de una universidad pública peruana, quienes respondieron ítems vinculados con la difusión académica, la proyección social y la apropiación crítica de la ciencia; los resultados evidencian validez de constructo y alta consistencia interna del cuestionario, lo que confirma su idoneidad para medir la competencia en comunicación científica, y además se identificaron fortalezas y limitaciones en la apropiación y traducción del conocimiento científico por parte de los estudiantes; en síntesis, la comunicación científica resulta esencial para el desarrollo académico y cívico, y disponer de un instrumento válido y confiable contribuye al diseño de políticas y prácticas orientadas a fomentar la democratización del conocimiento y la participación crítica del estudiantado.

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1. Introduction

Scientific communication is becoming increasingly important in higher education and contemporary civic life. It not only facilitates the circulation of academic knowledge but also shapes future professionals' ability to interpret evidence, participate in informed public debate and connect research with social issues. In Latin American contexts—and particularly in Peru—the relationship between university education and scientific communication skills is of strategic importance, as it affects both scientific production and the social appropriation of knowledge in an environment marked by access gaps and challenges in scientific literacy (Council for Science, 2025). This is compounded by the proliferation of fake news and conspiracy theories, which has made it more difficult for students, teachers, researchers, scientists and policymakers to communicate scientific advances and evidence effectively, creating new challenges for credibility and scientific communication (Sánchez-Soto et al., 2024).

In considering the interrelationship between communication and science, it is useful to understand the historical theoretical evolution of both concepts, together with the research, experiences and positions that have enabled closer engagement with different problems, situations and contexts over time. From the perspective of science, two fundamental approaches are taken as points of reference: one, described as classical, traditional or inherited, rooted in positivism; and another, referred to as the social or Science-Technology-Society (STS) approach, which addresses the interrelationship between science, technology and society (González y Valderrama, 2021).

Recent international research shows that scientific communication continues to be constrained by structural, symbolic and professional barriers that reduce the visibility of knowledge, particularly that produced by women scientists, and weaken the relationship between science and the media (Sánchez-Holgado et al., 2026). These findings are consistent with international assessments pointing to fragmented science communication (Barceló-Hidalgo y Dávila-Lorenzo, 2022). Gaps have also been identified in collaboration, diversity and the equitable circulation of knowledge, alongside persistent theoretical tensions and profound transformations in the media landscape (Parejo-Cuéllar et al., 2023). This is compounded by shortcomings in impact assessment and specialised training, underscoring the need for more inclusive, bidirectional institutional strategies and practices (Caferra et al., 2025; Arboledas-Lérida, 2026).

In Latin America, the terminology used to refer to scientific communication is characterised by marked polysemy and a lack of conceptual consensus, as evidenced by Massarani's (2017) and Rocha et al.'s (2017) analysis of 609 articles, which identifies the simultaneous use of terms such as "dissemination", "science communication", "popularisation", "scientific literacy", "public communication of science" (PCS), supported by the PCST Network (Fernández, Bello & Massarani, 2016), "public communication of science and technology" (PCST) as an unavoidable feature of contemporary societies (Vilaplana-Camús, 2019; García Rodríguez et al., 2024), and related expressions such as "social appropriation", "science journalism", "diffusion" and "promotion" (García Rodríguez et al., 2024). Nevertheless, there is a growing tendency in regional scholarship towards the use of "popularisation", "science communication" and "dissemination" (Rocha et al., 2017). At the same time, within the university sphere, scientific communication has shifted from a unidirectional model centred on the transmission of information towards participatory and bidirectional approaches that place dialogue between researchers, teachers, students and citizens at the heart of the democratisation of knowledge and the strengthening of academic and civic education (Ventura & Pozo, 2025). This process has been driven by digital environments, which are transforming modes of information production, circulation and consumption and giving rise to fragmented and culturally diverse audiences that require new communication skills (Scolari, 2008).

In this context, the university assumes a strategic role not only as a producer of science but also as a communication mediator. In this capacity, it is responsible for managing integrated processes of knowledge generation, transfer and social feedback (Suazo-Galdames et al., 2025). However, despite advances in the use of social media and local media to strengthen links between universities and society (Fernández-Bermúdez et al., 2021), conceptual fragmentation and a predominance of descriptive approaches persist. This situation limits the theoretical articulation of the scientific

communication construct and highlights the need for further development of theoretical models of communication competence that can underpin its appropriate operationalisation and assessment in university settings.

At the same time, innovative forms of mediation are emerging. Science influencers reach broader youth audiences through accessible language, while collectives such as Aleph Experimental integrate art, science and community collaboration (Fernández-Beltrán et al., 2024; Cardona-Echavarría y Escobar-Ortiz, 2024). Nevertheless, challenges persist, including the lack of communication training among some researchers. These are compounded by the inadequate adaptation of scientific publications to digital environments (Kippes, 2021) and inequalities in disciplinary representation, which restrict the visibility of the social sciences (Bisserier, 2024). Against this backdrop, science journalism is emphasised as a means of translating knowledge (Urrego-Zuluaga, 2024). Attention is also drawn to the integration of open science and democratic principles, as well as the responsible use of Artificial Intelligence in academic communication (Lopezosa, 2023). In addition, the ethical use of Artificial Intelligence in scientific production and a stronger citizen science approach are recommended, encouraging student participation in addressing problems within their regional context. Taken together, these developments reaffirm scientific communication as a strategic process for the critical, inclusive and ethical appropriation of knowledge, with a decisive role in reconfiguring relationships between science, universities and society in changing historical and digital contexts (Villegas-Tripiana, 2024; Estrada-Araoz, 2025).

Peruvian universities face a context marked by structural, cultural and pedagogical barriers that constrain the development and reach of scientific communication. The persistence of an underdeveloped scientific culture, the weak institutionalisation of dissemination policies, digital divides and insufficient training in communication skills create a context in which, although scientific production has grown steadily, its circulation, understanding and social appropriation remain limited (Turpo-Gebera y González-Miñán, 2019; Pacheco, 2023). This disconnect between knowledge production and communication reveals not only a dissemination problem but also a more fundamental limitation in education and training. Consequently, there is a lack of standardised, valid and reliable tools for assessing communication skills among university students, which restricts evidence-based pedagogical decision-making and hinders the design, implementation and evaluation of educational interventions aimed at strengthening scientific communication.

Against this background, the aim of the present study is to analyse scientific communication competence among university students through a questionnaire specifically designed for its assessment in the context of higher education. This analysis seeks to generate robust psychometric evidence supporting the validity and reliability of the instrument, thereby facilitating its systematic application in university settings. In this way, the study contributes to strengthening academic and civic education focused on developing capacities for the responsible communication of science, openness of knowledge and critical, informed participation in contemporary public debates.

2. Methodology

The research adopted a quantitative approach. An instrumental, cross-sectional design was used, aimed at the systematic evaluation of the psychometric properties of a measurement instrument. This type of design is appropriate when the primary objective is to analyse the validity and reliability of questionnaires intended to assess complex constructs, such as scientific communication competencies. In this way, the instrument's theoretical coherence and empirical consistency are ensured (Mikulic et al., 2016).

2.1. Methodological Design

The study aimed to rigorously evaluate the psychometric properties of the Scientific Communication Questionnaire administered to students at a Peruvian public university. The instrument comprised 20 items, organised into five theoretically grounded dimensions: dissemination of scientific and technological knowledge, critical understanding, civic participation, social and ethical implications,

and informed decision-making. Its development followed a systematic process of conceptual delimitation of the construct, seeking to achieve a balanced representation of its cognitive, critical and social components. From an instrumental perspective, the questionnaire was designed to ensure the relevance of the items and their semantic clarity. It also sought to ensure alignment with the objectives of assessing scientific communication in the university context (De Souza y Costa, 2017).

2.2. Psychometric Validation of the Instrument

The validation of a new scientific communication instrument in the Peruvian context is necessary given the absence of scales specifically designed for students at public universities in the south of the country. These institutions have institutional and sociocultural characteristics that differ from the contexts in which most existing instruments have been developed. Within this framework, psychometric validation focused on analysing validity and reliability through quantitative procedures. These procedures included analysis of the instrument's internal structure and the coherence between the items and theoretical dimensions (Romani-Romani, 2024). The aim was to ensure the conceptual robustness and statistical consistency of the instrument. This approach is consistent with the literature highlighting the importance of context-specific, conceptually grounded empirical validation in developing robust, relevant and useful instruments for research and evidence-based decision-making (Asriadi et al., 2026).

2.3. Study Context and Sample

The study was conducted at a public university in southern Peru, recognised for its academic provision and its Science and Technology Park, within a regional context characterised by a high Human Development Index (0.831) and rising levels of poverty (Instituto Nacional de Estadística e Informática, 2023). The research process followed rigorous ethical criteria, including informed consent, confidentiality and equity in participation (Miranda-Novales y Villasís-Keever, 2019). Data were processed using Jamovi 2.2.5 for reliability analysis and SPSS v.22 for exploratory factor analysis, ensuring accurate and responsible statistical treatment. Overall, the study provides a valid and reliable tool for assessing science communication in university contexts, fostering critical education and the social appropriation of scientific knowledge.

Table 1

Distribution of enrolment and study sample by area and stage of study

Field of study	Faculty of studies	Enrolment in 2024		Sample Faculty		Sample by field of study	
		n	%	n	%	n	%
Social Sciences	Business Administration	2,797	11.3	32	5.5	579	46
	Accounting and Finance	1,303	5.3	34	5.9		
	Education	1629	6.6	131	22.6		
	History and Social Sciences	1427	5.8	34	5.9		
	Law	1255	5.1	64	11.2		
	Economics	1010	4.1	110	18.9		
	Philosophy and Humanities	273	1.1	71	12.2		
	Psychology and Communication	2744	11.1	103	17.8		
Subtotal		12,438	50.3				
Basic Sciences and Engineering	Architecture and Urban Planning	897	3.6	36	6.6	546	43
	Natural and Formal Sciences	717	2.9	120	21.9		
	Civil Engineering	775	3.1	90	16.5		
	Process Engineering	1962	7.9	85	15.6		
	Production and Services Engineering	4,083	16.4	115	21.1		
	Geological and Mining Engineering	989	4.1	100	18.3		
Subtotal		9,423	38.2				
	Agronomy	547	2.2	40	29.4	136	11

Biomedical Sciences	Biology	1108	4.5	31	22.8		
	Nursing	447	1.8	39	28.7		
	Medicine	747	3.1	26	19.1		
	Subtotal	2,849	11.5				
Total		24,710	100	1,261	100	1,261	100
Study stage		n	%	Cumulative percentage			
Initial (cycles I to IV)		584	46.3	46.3			
Intermediate (cycles V to VIII)		340	27.0	73.3			
Final (cycle IX onwards)		337	26.7	100			
Total		1,261	100				

Source: Authors' own elaboration based on 2023 enrolment records and survey data.

Table 1 presents the distribution of university enrolment for 2024 and the composition of the study sample. The sample comprises 1,261 students, representing 5.1% of the total enrolment of 24,710 students. This proportion provides adequate representation of the university population. In terms of fields of knowledge, Social Sciences account for the largest proportion (50.3%), followed by Basic Sciences and Engineering (38.2%) and Biomedical Sciences (11.5%). This distribution is consistently reflected in the sample of 1,261 students, indicating a balanced sample aligned with the actual structure of institutional enrolment.

At faculty level, Education, Economics and Psychology are particularly prominent within the Social Sciences. In Basic Sciences and Engineering, Natural Sciences and Production and Services Engineering stand out. Within the Biomedical Sciences, Agronomy and Nursing are particularly well represented. This distribution reinforces the disciplinary diversity of the study. The distribution by stage of study also shows that most students are in the initial stage (46.3%), followed by the intermediate stage (27.0%) and the final stage (26.7%). This configuration makes it possible to capture differing perceptions across the academic trajectory. Overall, the composition of the sample provides a broad and representative view of the university context. It also highlights the importance of strengthening scientific literacy and communication from the earliest stages of university education in order to foster the progressive development of these competencies.

3. Results

The results of the psychometric analysis show the internal consistency indices, construct validity and item performance, enabling the robustness and relevance of the scale to be assessed within the university context under study. These findings provide insight into the structure of scientific communication competence and support the usefulness of the instrument for future research and educational initiatives aimed at strengthening this competence in higher education.

3.1. Reliability Analysis of the Scale for Assessing Scientific Communication

Assessing internal reliability is essential to ensure the coherence and validity of the instruments used in research. This psychometric property is estimated using internal consistency coefficients, among which Cronbach's alpha (α) and McDonald's omega (ω) are particularly notable for their statistical robustness.

Table 2

Reliability of the instrument for assessing scientific communication

Scales	Cronbach's alpha (α)	McDonald's omega (ω)
Scientific Communication	0.977	0.978

Table 2 shows the high internal consistency of the Scientific Communication scale. The reliability values are close to 1.00, indicating a high degree of coherence among the items. These results confirm that the instrument demonstrates excellent reliability and precision in measuring the theoretical construct. Measurement error is also substantially reduced, while the internal stability of the scale is ensured. Consequently, the high internal consistency supports the suitability of the questionnaire for the systematic and rigorous assessment of scientific communication competence in

university settings. This strengthens the validity of the inferences drawn from its application in higher education.

3.2. Scale Validity Assessment

The psychometric quality of an instrument rests on the strength of its content validity and construct validity. Both dimensions are complementary and essential when assessing complex competencies. Content validity ensures that the items are relevant, representative and consistent with the theoretical domain of the construct. Construct validity, in turn, makes it possible to empirically verify the underlying structure of the instrument and its correspondence with the proposed conceptual model. Exploratory and confirmatory factor analyses are used for this purpose. The integration of both approaches strengthens the structural validity of the instrument. This is particularly relevant when measuring multidimensional phenomena such as scientific communication in university settings, where cognitive, ethical, social and participatory dimensions converge.

Table 3

Mean (M) and standard deviation (SD) of the items in the Scientific Communication Questionnaire

Item	M	SD	N
2.1.1. Dissemination channels effectively reach the entire university community	3.13	1.23	1261
2.1.2. The university disseminates scientific knowledge through accessible media	3.37	1.11	1261
2.1.3. Scientific information is accessible to students at all levels	3.31	1.11	1261
2.1.4. Platforms or resources are available to facilitate open access to science	3.27	1.01	1261
2.2.5. Critical analysis of scientific information is encouraged	3.11	1.16	1261
2.2.6. Critical thinking is promoted through educational programmes.	3.15	1.21	1261
2.2.7. Questioning traditional approaches to science is encouraged	3.08	1.15	1261
2.2.8. Constructive criticism of the findings of scientific studies is encouraged	3.06	1.19	1261
2.3.9. Opportunities exist for student participation in science policy	2.94	1.11	1261
2.3.10. Students participate in decision-making on scientific and technological projects	3.01	1.01	1261
2.3.11. Students have opportunities to engage in scientific innovation	3.22	1.07	1261
2.3.12. Collaboration is encouraged to develop innovative solutions to social problems	3.06	1.16	1261
2.4.13. Students reflect on the ethics of scientific advances	3.28	1.19	1261
2.4.14. Opportunities exist to discuss ethical dilemmas in science and technology	3.15	1.09	1261
2.4.15. The university promotes scientific projects aimed at improving quality of life	3.36	1.07	1261
2.4.16. Reflection on the social impact of science is encouraged	3.06	1.23	1261
2.5.17. Students receive training to make decisions based on scientific evidence	3.29	1.10	1261
2.5.18. Access to scientific information is provided to support everyday decision-making	3.13	1.14	1261
2.5.19. The university promotes student participation in innovation	3.33	1.19	1261
2.5.20. Collaboration among students, teaching staff and researchers is encouraged	3.25	1.13	1261

The results presented in Table 3 indicate a moderately positive perception of scientific communication within the university context. Mean values range from 2.94 to 3.37. Students particularly highlight the availability of scientific information and access to content through a variety of resources. They also recognise certain institutional efforts aimed at social well-being and knowledge dissemination. However, these advances coexist with significant limitations, including the still limited development of critical thinking, active participation and ethical reflection on science. This situation points to the still fragmented incorporation of these dimensions into academic practices. Overall, the results suggest that, although basic conditions for access and dissemination are in place, challenges remain in consolidating comprehensive scientific communication. Such communication should foster the critical, participatory and socially responsible appropriation of knowledge in higher education.

Table 4

Construct validity of the Scientific Communication Questionnaire: results of the exploratory factor analysis (EFA)

Kaiser-Meyer-Olkin (KMO) and Bartlett's test		
Kaiser-Meyer-Olkin measure of sampling adequacy		0.777
Bartlett's test of sphericity	Approx. chi-square	43,894.415
	gl	190
	Sig.	0.000

Table 4 presents the results of the Exploratory Factor Analysis conducted on the questionnaire. The indicators provide evidence of adequate construct validity of the instrument. The KMO measure of sampling adequacy reaches an optimal value, confirming the suitability of the sample for factor analysis. In addition, Bartlett's test of sphericity is statistically significant. This result demonstrates the existence of substantive, non-random relationships among the items. Taken together, these indicators provide robust empirical support for the structural consistency of the questionnaire. They also confirm its capacity to coherently represent the theoretical factors underlying scientific communication competence in the university context.

Table 5

Communalities of the items in the Scientific Communication Questionnaire using principal component analysis (PCA)

Item	Initial Extraction	
2.1.1. Dissemination channels effectively reach the entire university community	0.884	0.683
2.1.2. The university disseminates scientific knowledge through accessible media	0.959	0.671
2.1.3. Scientific information is accessible to students at all levels	0.934	0.768
2.1.4. Platforms or resources are available to facilitate open access to science	0.913	0.623
2.2.5. Critical analysis of scientific information is encouraged	0.951	0.828
2.2.6. Critical thinking is promoted through educational programmes	0.925	0.826
2.2.7. Questioning traditional approaches to science is encouraged	0.936	0.803
2.2.8. Constructive criticism of the findings of scientific studies is encouraged	0.977	0.816
2.3.9. Opportunities exist for student participation in science policy	0.971	0.670
2.3.10. Students participate in decision-making on scientific and technological projects	0.981	0.720
2.3.11. Students have opportunities to engage in scientific innovation	0.966	0.720
2.3.12. Collaboration is encouraged to develop innovative solutions to social problems	0.954	0.706
2.4.13. Students reflect on the ethics of scientific advances	0.929	0.752
2.4.14. Opportunities exist to discuss ethical dilemmas in science and technology	0.948	0.685
2.4.15. The university promotes scientific projects aimed at improving quality of life	0.965	0.636
2.4.16. Reflection on the social impact of science is encouraged	0.952	0.747
2.5.17. Students receive training to make decisions based on scientific evidence	0.960	0.805
2.5.18. Access to scientific information is provided to support everyday decision-making	0.932	0.763
2.5.19. The university promotes student participation in innovation	0.970	0.744
2.5.20. Collaboration among students, teaching staff and researchers is encouraged	0.960	0.878

Table 5 shows the communalities obtained from the PCA, with extraction values ranging from 0.62 to 0.88 and exceeding the recommended minimum threshold of 0.50 in all cases. This confirms an adequate factorial representation of the items and ensures the relevance of each item in explaining the total variance of the model. Items with higher communalities show a strong correspondence with the theoretical factors of collaboration, critical thinking and scientific communication, while those with relatively lower values still make an acceptable contribution without compromising the stability of the factor model. Although PCA is not strictly a factor-analytic

technique, its use at this exploratory stage is justified because: (a) the high communalities indicate that unique and error variance is low, bringing the components closer to the latent factors; (b) the primary objective was dimensionality reduction and the identification of correlation patterns rather than the precise estimation of latent constructs; and (c) various studies in education and the social sciences have employed PCA as a preliminary step to Confirmatory Factor Analysis (CFA), showing that, with high loadings and a robust theoretical model, the resulting solutions are often equivalent (Hair et al., 2019). In any case, the final structure was validated using CFA (Tables 8 and 9), the standard method for confirming the dimensionality of a construct, thereby mitigating the inherent limitations of PCA and supporting the instrument's robust structural validity and conceptual coherence.

Table 6

Distribution of explained variance in the rotated component analysis (RCA) of the Scientific Communication Questionnaire

Total variance explained							
Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings
	Total	% Variance	Cumulative %	Total	% Variance	Cumulative %	Total
1	14.029	70.147	70.147	13.776	68.88	68.880	12.901
2	1.297	6.485	76.632	1.049	5.25	74.125	10.469
3	0.832	4.162	80.795				
4	0.708	3.538	84.333				
5	0.591	2.955	87.288				
6	0.508	2.538	89.826				
7	0.406	2.028	91.853				
8	0.381	1.907	93.760				
9	0.297	1.487	95.247				
10	0.254	1.270	96.517				
11	0.211	1.054	97.572				
12	0.146	0.732	98.304				
13	0.110	0.552	98.855				
14	0.065	0.326	99.181				
15	0.057	0.286	99.467				
16	0.041	0.206	99.673				
17	0.031	0.156	99.829				
18	0.019	0.097	99.926				
19	0.009	0.047	99.973				
20	14.029	70.147	70.147				

Table 6 presents the distribution of variance explained by the factor model. The first two components account for the largest proportion of the variance. The first explains 68.88% and the second 5.25%, representing a cumulative 74.13%. This level substantially exceeds the minimum threshold recommended for factor models in the social sciences. The progressive decline in eigenvalues from the third component onwards supports the decision to retain only the principal factors. It also confirms the stability and parsimony of the model. Overall, the results indicate a robust and well-defined factor structure. They also confirm the questionnaire's high explanatory capacity and construct validity.

Table 7*Oblimin rotation matrix of the Scientific Communication Questionnaire*

Item	Component	
	1	2
2.1.1. Dissemination channels effectively reach the entire university community	0.887	-0.715
2.1.2. The university disseminates scientific knowledge through accessible media	0.877	-0.598
2.1.3. Scientific information is accessible to students at all levels	0.865	-0.803
2.1.4. Platforms or resources are available to facilitate open access to science	0.855	-0.685
2.2.5. Critical analysis of scientific information is encouraged	0.852	-0.732
2.2.6. Critical thinking is encouraged through activities and programmes	0.848	-0.610
2.2.7. Questioning traditional approaches to science is encouraged	0.839	-0.557
2.2.8. Constructive criticism of the results of scientific research is encouraged	0.838	-0.743
2.3.9. Opportunities exist for student participation in science policy	0.837	-0.582
2.3.10. There are opportunities for student participation in science policy	0.814	-0.632
2.3.11. Students have opportunities to engage in scientific innovation	0.797	-0.559
2.3.12. Collaboration is encouraged to develop innovative solutions to social problems	0.795	-0.720
2.4.13. Students reflect on the ethics of scientific advances	0.788	-0.710
2.4.14. Opportunities exist to discuss ethical dilemmas in science and technology	0.769	-0.409
2.4.15. The university promotes scientific projects aimed at improving quality of life	0.739	-0.928
2.4.16. Reflection on the social impact of science is encouraged	0.570	-0.893
2.5.17. Students receive training to make decisions based on scientific evidence	0.784	-0.877
2.5.18. Access to scientific information is provided to support everyday decision-making	0.683	-0.854
2.5.19. The university promotes student participation in innovation	0.809	-0.852
2.5.20. Collaboration among students, teaching staff and researchers is encouraged	0.753	-0.769

The items presented in Table 7 provide a comprehensive representation of the five dimensions of the scientific communication model. These dimensions include knowledge dissemination, critical thinking, participation, ethics and social impact. Taken together, the indicators describe a university environment oriented towards democratising access to scientific knowledge. They also reflect the promotion of critical thinking and ethical reflection through the analysis and constructive critique of scientific information. In terms of participation, efforts are evident to involve students in scientific decisions and projects. This fosters collaborative innovation aimed at addressing social problems. Overall, the items reflect a comprehensive view of university scientific communication, oriented towards learning and the social responsibility of knowledge (Rigo y Donolo, 2019).

3.3. Confirmatory Factor Analysis (CFA) of the Scientific Communication Questionnaire

The CFA conducted on the questionnaire made it possible to verify the validity of its theoretical structure. The results confirmed that the empirical data fit the proposed model adequately. The internal coherence of its dimensions was also supported.

Table 8*Fit indices for the Scientific Communication Questionnaire*

χ^2/df	SRMR	RMSEA	CFI	TLI	PNFI
5.28	0.061	0.058	0.993	0.991	0.835

SRMR (Standardized Root Mean Square Residual), RMSEA (Root Mean Square Error of Approximation), CFI (Comparative Fit Index), TLI (Tucker-Lewis Index), PNFI (Parsimony Normed Fit Index)

Analysis of the fit indices indicates that, although the χ^2/df value falls within an acceptable range, the set of indicators shows an excellent overall model fit. The SRMR and RMSEA indices remain below the recommended threshold (Table 8). In turn, the CFI and TLI indices are well above the reference value. The PNFI parsimony index confirms an appropriate balance between model fit

and complexity. Taken together, these results provide strong validation of the instrument's factor structure and support its suitability for assessing scientific communication in university settings.

Table 9

Factor loadings for the scientific communication construct

Dimension	Item	B
1 (4 items): Dissemination of Scientific and Technological Knowledge (D1CC)	Item 1	0.810
	Item 2	0.812
	Item 3	0.818
	Item 4	0.674
2 (4 items): Promotion of Critical Understanding (D2CC)	Item 5	0.900
	Item 6	0.932
	Item 7	0.753
	Item 8	0.916
3 (4 items): Promotion of Civic Participation (D3CC)	Item 9	0.863
	Item 10	0.879
	Item 11	0.861
	Item 12	0.850
4 (4 items): Social and Ethical Implications (D4CC)	Item 13	0.883
	Item 14	0.839
	Item 15	0.778
	Item 16	0.871
5 (4 items): Informed Decision-Making (D5CC)	Item 17	0.892
	Item 18	0.882
	Item 19	0.813
	Item 20	0.871

The CFA results presented in Table 9 demonstrate the strong psychometric properties of the five-dimensional model. The standardised factor loadings are high, with most exceeding 0.80. This confirms the excellent reliability and internal consistency of each dimension. The results also support robust convergent validity, demonstrating that the items share a substantial proportion of variance with their corresponding factors. In particular, the critical understanding and informed decision-making dimensions show especially high loadings. Overall, the findings provide comprehensive validation of the proposed measurement model.

Figure 1. Path diagram of the Scientific Communication Questionnaire (SC)

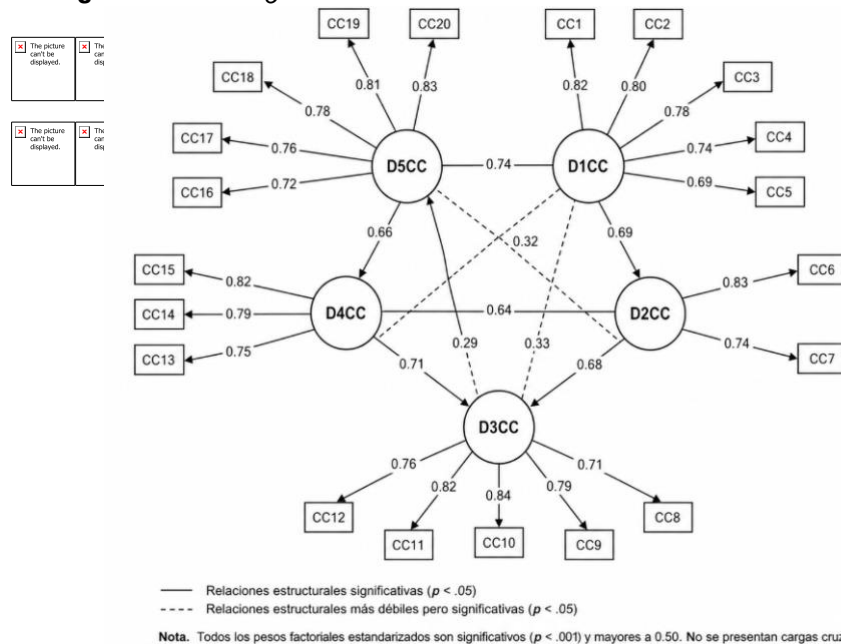


Figure 1 presents the path diagram of the CFA conducted on the questionnaire, in which five latent dimensions are identified and represented by their respective observed items. The standardised factor loadings, ranging from 0.674 to 0.942, indicate strong internal consistency and an adequate relationship between the indicators and their corresponding factors, while the correlations between dimensions reflect a high degree of structural cohesion, supporting the conceptualisation of the construct as a holistic and interrelated phenomenon. In this regard, although the EFA results do not delineate the five-dimensional structure with complete clarity, this structure is primarily supported by robust theoretical foundations that conceptualise scientific communication in higher education as a multidimensional construct comprising distinct processes — knowledge dissemination, critical thinking, participation, ethical reflection and social impact— that are nevertheless closely interconnected. From a methodological perspective, EFA is regarded as an exploratory stage aimed at identifying initial patterns; therefore, the presence of factorial overlap does not invalidate the proposed theoretical structure, particularly in complex constructs of a social and educational nature. Finally, the CFA results confirm the validity of the five-factor structure through high and coherent factor loadings and an adequate overall model fit, thereby consolidating the suitability of the model as a parsimonious, consistent and theoretically grounded representation of scientific communication in the university context.

4. Discussion

This study aimed to analyse the psychometric validity and reliability of the Scientific Communication Questionnaire among university students, addressing the need for standardised instruments that enable rigorous assessment of scientific communication competencies in the context of Peruvian public universities (Mikulic et al., 2016). The results showed high internal consistency indices (α and $\omega \approx 1.00$), confirming the instrument's high reliability and robustness for use in educational contexts. Likewise, the combined use of exploratory and confirmatory factor analysis provided robust evidence of construct validity, consolidating a model comprising five interrelated dimensions — dissemination, critical understanding, civic participation, ethical implications and informed decision-making— that together constitute a comprehensive and interdependent conception of scientific communication.

These findings are particularly relevant in a context in which scientific communication continues to be constrained by structural, symbolic and professional barriers that limit the visibility of knowledge and weaken links between science, society and the media, with a particularly significant impact on women (Sánchez-Holgado et al., 2026). In line with these results, various studies have identified fragmented science communication and limited institutional coordination (Barceló-Hidalgo y Dávila-Lorenzo, 2022), as well as persistent gaps in collaboration, diversity and the equitable circulation of knowledge, within a context marked by theoretical tensions and profound transformations in the media landscape (Parejo-Cuellar et al., 2023). This is compounded by shortcomings in the systematic assessment of impact and in specialised training in scientific communication, reinforcing the need for more inclusive, critical and bidirectional institutional strategies that strengthen the role of universities in scientific literacy and informed civic participation (Caferra et al., 2025; Arboledas-Lérida, 2026).

At the perceptual level, the mean scores, ranging from 2.94 to 3.37, reflect a moderately positive assessment of scientific communication within the university. Although progress is recognised in access to information and the use of audiovisual materials, weaknesses remain in fostering critical thinking, civic participation and ethical reflection. This trend is consistent with the findings of Lozano (2012) and Estrada-Araoz (2025), who identify the persistence of dissemination-based and unidirectional models. Such approaches contrast with bidirectional and participatory proposals aimed at the democratisation of knowledge (Ventura y Pozo, 2025).

The Confirmatory Factor Analysis confirmed the existence of five latent dimensions consistent with the classical literature, which conceptualises scientific communication as a comprehensive process ranging from knowledge production to its social appropriation (Council for Science, 2025). In particular, the instrument highlights the urgent need to strengthen the dimensions related to ethical implications, informed decision-making and civic participation. These dimensions are essential in

addressing current challenges associated with digitalisation, cultural diversity and the principles of open science (Lopezosa, 2023; Suazo-Galdames et al., 2024; UNESCO, 2021).

In the Peruvian context, the findings reaffirm the existence of structural and pedagogical limitations in university scientific communication, including a lack of institutionalisation, a weak participatory culture and the predominance of transmission-based approaches. These difficulties have previously been identified by Lozano et al. (2016), Massarani (2018) and Pacheco (2023). Nevertheless, strategic opportunities are also identified in the use of social media, young communicators and infographics as vehicles for the social appropriation of knowledge (Vilaplana-Camús, 2019; Fernández-Beltrán et al., 2024; Turpo-Gebera y Gonzales-Miñán, 2019). Building on these opportunities, innovative proposals are recommended, including the gamification of assessment, the creation of a student scientific communication observatory and training in digital and transmedia communication, with the aim of strengthening communication competencies through playful, collaborative and multimodal approaches. The study also acknowledges methodological limitations, including the size and representativeness of the sample, the exclusive use of online surveys and the inability to establish causal relationships, which restrict the interpretative scope of the findings.

In summary, the Scientific Communication Questionnaire proves to be a valid, reliable and relevant psychometric instrument for studying university communication practices in Peru. Its five dimensions reflect the multidimensional nature of the phenomenon and demonstrate that scientific communication extends beyond mere dissemination, constituting a bidirectional, inclusive and educational process (Vilaplana-Camús, 2019; Villegas-Tripiana, 2024). Consequently, there is a reinforced need to consolidate scientific communication as a structural dimension of Peruvian public universities, insofar as it contributes to the democratisation of knowledge and the development of a critically engaged citizenry (Fernández-Bermúdez et al., 2021).

5. Conclusions

The study confirms that scientific communication constitutes an essential competence in contemporary university education, integrating the production, dissemination and social appropriation of knowledge within digital, participatory and ethical environments. The Scientific Communication Questionnaire demonstrated high reliability (α and $\omega \approx 0.98$) and a coherent five-dimensional factor structure —dissemination, critical understanding, civic participation, ethical implications and informed decision-making—, establishing it as a valid instrument for assessing scientific communication competencies. Although students report moderately positive perceptions, weaknesses are evident in critical thinking, ethical reflection and active participation, reflecting the persistence of unidirectional approaches. In the Peruvian context, the results reveal both structural and pedagogical limitations and opportunities associated with the use of digital media and collaborative projects. In essence, the study emphasises the urgent need to incorporate scientific communication as a cross-cutting dimension of higher education, strengthening ethics, critical citizenship and the democratising role of universities in the knowledge society.

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