Design and psychometric validation of the research competency scale for university students in Peru

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Article Info

Article history:

Received May 11, 2025
Revised Oct 1, 2025
Accepted Oct 30, 2025

Keywords:

Epistemic competence
Epistemic knowledge
Higher education
Research competency
Scientific communication

ABSTRACT

Research competence is essential for the academic and professional development of university students. However, in the context of Lima, Peru, no specific, valid, and reliable instruments have been found to assess this competency comprehensively. This deficiency reveals a significant knowledge gap in the accurate assessment of research competencies in university students. Therefore, in the present research, a scale was constructed and validated to effectively assess research competence in university students. As methodology, the quantitative approach was used, following three processes: item construction, item functionality, and psychometric analysis. A sample of 216 students was used for the exploratory factor analysis (EFA), and 206 for the confirmatory factor analysis (CFA). The final version of the research competency scale for university students comprises 37 items distributed across five dimensions identified through EFA: epistemic knowledge (10 items), interpretation skills (5 items), methodological knowledge (9 items), scientific communication (6 items), and information management (7 items). CFA supported the adequacy of the model (root mean square error of approximation/RMSEA=0.064; comparative fit index/CFI=0.918; Tucker-Lewis Index/TLI=0.911), and the scale demonstrated high internal consistency. The validated scale reliably measures research competence and can improve teaching, assessment, and curriculum design.

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1. INTRODUCTION

Research training in professional higher education is an important factor; in this sense, Ruiz and Moya [1] point out that the university includes as part of its mission to ensure that students develop competencies that allow them to solve situations in their environment optimally. Therefore, this research seeks to conceive a scale that allows measuring the level acquired by university students on their research competencies and to recognize the gaps that may arise in these, where the university community has an important role to play to reduce them until they are eliminated. Research competencies in university students have become increasingly relevant in the global context, given their impact on academic and professional training. Previous study highlight the importance of research competencies in higher education as a key element of sustainability [2]. Several studies have addressed the implementation and challenges in teaching these competencies, as well as the design of task systems and activity models for their development [3], [4]. In addition, the interrelationship between complex thinking and education 4.0 in the acquisition of these competencies has been analyzed [5], as well as the student perception of their research training [6]. The need to strengthen research training is evident in the development of pedagogical strategies for learning [7], the use of virtual environments [8], and the design of specific evaluation instruments [9]. Likewise, formative research has been emphasized to strengthen inquiry competence in university students [10]. In the Peruvian context, recent studies have addressed the evaluation of research competencies in Amazonian university students [11], as well as their attitudes towards scientific research [12]. These findings show the relevance of continuing to develop strategies and tools to consolidate research competencies in Peruvian higher education, ensuring their alignment with current academic and labor demands.

There is evidence suggesting a significant theoretical gap in the international measurement of research competence among university students. This gap is evident in several key areas. Among these, it is noteworthy that various studies have developed different instruments and methods for measuring research skills, such as self-assessment tools and specific questionnaires. However, these instruments often focus on different aspects of research competence, leading to inconsistencies in measurement approaches [5], [9]. Institutional and contextual variations are also evident, as the measurement of research skills is influenced by national and institutional contexts. For example, the KoKoHs program in Germany highlights the challenges and results of modeling and measuring skills within a specific national framework, suggesting that international comparisons are difficult due to the diversity of educational contexts [13]. At the same time, there is a need for longitudinal and comprehensive tools to effectively measure research competencies. This includes addressing deficiencies in specific competency areas and ensuring that measurement tools align with curricular and professional requirements [14].

At the international level, the development of scales to measure research competencies faces various methodological and conceptual challenges. First, there is difficulty in reaching a consensus and operational definition of the construct of research competence, which directly impacts the wording of items and the delimitation of theoretical dimensions. In addition, studies show variability in the psychometric approach used (factor analysis, item response theory, and convergent validity), which complicates the standardization of quality criteria. Another recurring challenge is ensuring the cross-cultural validity and sensitivity of scales in different disciplinary or educational contexts, such as nursing, education, or public health. Limitations are also identified in the link between the scores obtained and actual performance in research tasks, which calls into question the predictive capacity of the instruments. Most research scales are validated in limited national contexts, hindering international generalization and comparison. This underscores the need for strong theoretical foundations, cross-cultural validation, and diverse samples to enhance their global relevance and methodological rigor [15]–[18].

2. LITERATURE REVIEW

2.1. Research competencies in higher education

Universities today must redefine the role of teachers as researchers while training students to develop research competencies essential for knowledge generation and problem-solving in professional practice. These competencies revolve around two key axes: i) inquiry, which involves problematization and knowledge generation; and ii) academic-scientific writing, which enhances argumentation and communication. Effective research requires identifying sources, analyzing ideas, and interpreting information—cognitive processes that foster critical thinking and investigative skills such as observation, discovery, and knowledge development.

Internationally, research skills in university students have been recognized as a fundamental component for academic, professional, and scientific development, especially in STEM and health sciences. Study by Adedokun *et al*. [19] have shown that research skills, together with research self-efficacy, are key predictors of professional aspirations in research, acting as mediators in students' retention in scientific careers. For their part, Feldon *et al*. [20] show that teaching experience combined with research significantly improves methodological skills, such as hypothesis formulation and rigorous experimental design. Likewise, Rodríguez *et al*. [21] highlight that active pedagogical approaches, such as interprofessional inquiry-based learning, strengthen creative thinking and the acquisition of complex research skills. Taken together, these findings reinforce the need to integrate research training from a practical, interdisciplinary, and reflective perspective to foster a sustainable scientific culture in higher education.

On the other hand, from emerging educational approaches, such as socio-training, research competencies are supported using complex thinking, creativity, and ethical problem-solving in collaborative contexts. In addition, with the use of technology, knowledge management is achieved, which empowers students to find innovative solutions that respond to academic challenges that occur in university classrooms [22], [23]. From the perspective of socioformation, research competence in university students acquires a deeply contextualized, ethical, and transdisciplinary orientation. This approach proposes to overcome the traditional views of research focused on the mere accumulation of knowledge, to focus on the resolution of real problems of the environment with relevant results that contribute to the improvement of living conditions. In this line, research is conceived as a complex formative process, based on the articulation of knowledge, skills, and attitudes that allow students to act with relevance in the face of social, environmental, and educational challenges. Socio-training incorporates complex thinking as an epistemological foundation, promoting an integrative and systemic understanding of phenomena and overcoming reductionist or fragmentary approaches.

Likewise, this approach emphasizes the development of the ethical life project as a transversal axis of research training, orienting students' actions towards a commitment to the common good, inclusion, social justice, and care for the environment. In addition, collaborative research logic is encouraged that favors the co-construction of knowledge, networking, and the active participation of the actors involved in the contexts studied. All this is articulated from competency-based training, where research becomes a significant experience of both personal and collective transformation, framed in processes of continuous improvement. In summary, socio-training provides a vision of research competence centered on ethics, complexity, collaboration, and transformative action, offering an alternative that is consistent with the current challenges of the knowledge society and sustainable development [22], [23].

Emphasize that strengthening research competencies is essential not only to generate new knowledge but also for students to face complex challenges and make informed decisions in their disciplines. These competencies form critical and participatory citizens, applying investigative thinking in everyday situations and contributing to social development. In addition, the adequate development of research competencies fosters critical thinking and innovation, essential elements for the comprehensive academic formation of students. In this context, universities play a key role in generating and applying knowledge that strengthens these competencies, promoting the capacity for innovation in an educational environment that is constantly growing and demands specialization [24]. Faced with the constant changes and challenges facing society, educational institutions must cultivate these competencies in students, enabling them to understand their environment and address complex problems. By strengthening these skills, they are prepared to make informed decisions and contribute to the development of their disciplines and society [25].

Likewise, these competencies are fundamental in university education since they allow students to apply scientific knowledge to identify, understand, and interpret phenomena in their environment by the scientific method. Their development requires that teaching integrates research in an interdisciplinary manner, under the guidance of the teacher and with practical application of knowledge. Nowadays, professionals need these competencies to respond in a critical and well-founded manner to social, economic, and technological problems. Therefore, universities must promote their transversal development in academic programs, providing resources for students to reflect, manage information, and propose evidence-based solutions [18].

In addition, universities face the challenge of incorporating research in a transversal and longitudinal manner in their processes to promote innovation and train highly competent professionals prepared for a globalized and competitive environment. However, current practice is far from this ideal. Although research is considered an essential function in universities, aimed at generating knowledge and technology to meet social demands and labor market requirements, the adoption of its techniques for problem-solving is still developed in limited. This situation is aggravated by low government investment in research, which in the case of Peru is the lowest in the region (0.1% of gross domestic product). Despite these restrictions, recent policies promoted by the Ministry of Education and National University Superintendency seek to strengthen research competencies, promoting a more robust and effective research culture. Therefore, it is a path that is still halfway, and it is expected that university students will contribute much more to their research [26]–[29]. The strength of research skills in university students is a priority so that they can play a leading role in the solution of current social, economic, and political problems. These competencies become especially relevant given the growing demands of the labor market, which requires professionals capable of facing complex challenges.

2.2. Dimensions of research competency

Among the studies reviewed is an article on the acquisition of research competencies during COVID-19 in university students in Lima, Peru [30]. In this work, the authors considered three dimensions to evaluate these competencies: analytical mastery, methodological mastery, and information processing. Another study is that of Rubio *et al.* [31] who consider five dimensions: general research knowledge, bibliographic research, information gathering techniques, information analysis, ethical treatment of information, and academic writing. For this part, Merma [32] establishes five dimensions: information search, technological mastery, methodological mastery, communication of results, and ability to work in a team in the field of research. Another study identifies a range of researcher skills, including cognitive, technological, methodological, research management, and teamwork abilities [33]. After analyzing the different scientific articles, five factors were selected for this study.

2.2.1. Epistemic knowledge

It is the competence that refers to the ability to sustain that the student has for the explanation, argumentation, or proposition of that knowledge of a field of study for the benefit of the progress of science through the acquisition of new knowledge based on the scientific method [34]–[36]. This dimension implies a reflective understanding of the foundations, limits, and scope of disciplinary knowledge. It also encompasses the capacity to critically analyze theoretical frameworks, justify methodological choices, and situate one's research within the broader scientific community. Epistemic knowledge enables students to transition from the mere application of knowledge to the active construction of it, engaging with scientific paradigms, questioning assumptions, and contributing meaningfully to the advancement of their field.

2.2.2. Interpretation skills

When researching, the student shows sufficient skills to interpret the research results rigorously, according to the research problem and objectives. This interpretation skill occurs at an advanced level of research competencies based on the student's capacity for critical analysis of qualitative and quantitative studies. It also implies organizing and evaluating data and presenting conclusions, with the ability to discuss the results obtained [31]. In another study, interpretive skills in scientific contexts are defined as students' ability to analyze empirical data, identify meaningful patterns, establish causal relationships, and draw substantiated conclusions that are consistent with the objectives of an investigation. These skills are considered essential for the development of scientific literacy, as they enable students not only to organize and represent information, but also to understand its meaning about specific scientific phenomena [37].

2.2.3. Methodological knowledge

It refers to the domain that the student must possess regarding the tools, techniques, and methods to collect information and respond to the research problem or object of study. As well as recognizing the designs of both qualitative and quantitative research. They also know how to assess the validity and reliability of the instruments to collect data. The student masters the phases of the research process that respond to a specific objective [38]. It also entails the ability to justify methodological choices, apply ethical standards, and ensure rigor and coherence throughout the research process.

2.2.4. Information management

From the perspective of text analytics and collaborative information management, information management as a dimension of research competence in students implies the ability to organize, analyze, and use unstructured data from diverse sources to generate new knowledge relevant to their disciplinary field. It is related to identifying patterns, key concepts, and significant relationships in large volumes of information, which is essential for research [39]. For this reason, the research training of students and, in particular, information management is not reduced to a technical task, but constitutes a strategic competence that articulates technologies, interdisciplinary collaboration, and systemic thinking to transform data into meaningful and applicable knowledge [40].

2.2.5. Scientific communication

Scientific communication, as a key dimension of research competence in university students, refers to the ability not only to express clearly, accurately, and accessibly the findings of research, but also to exercise a critical stance against misinformation and ideological manipulation of knowledge, especially in contexts dominated by post-truth, polarization and distrust of science. Thus, communicating scientifically requires training researchers capable of sustaining the legitimacy of evidence in hostile media environments, through ethical, rigorous strategies committed to informed public dialogue [41].

Thus, the research question is: how can a psychometric scale be constructed and validated to rigorously assess research competencies in university students within the Peruvian context? In addition, the objective of the study is to construct and validate a psychometric scale capable of rigorously assessing research competencies in university students in the Peruvian context. The hypothesis of the study is formulated as: the psychometric scale developed will demonstrate adequate levels of content and construct validity, as well as high internal consistency, thereby enabling a rigorous and reliable assessment of research competencies in Peruvian university students.

3. METHOD

The present study is developed under a quantitative approach; this type of research has as its central purpose to identify and detail the properties and characteristics inherent to concepts, phenomena, variables, or events in a specific context. A study was conducted for the development and validation of the instrument called "research competence assessment scale for university students". The validation was based on the analysis of evidence related to the content of the scale, and for this purpose, expert judgment was used as a criterion. In the estimation of the initial reliability, Cronbach's alpha coefficient was used to evaluate its internal consistency. The exploratory factor analysis (EFA) was also used to evaluate evidence related to internal structure to identify the latent variables or factors underlying a set of observable variables (items). In addition, to validate the structure of the theoretical dimensions of the scale, confirmatory factor analysis (CFA) was applied to estimate and validate the proposed theoretical model from the data obtained [42].

3.1. Population and sample

The study population consisted of students from several professional schools in Lima, Peru. Stratified probability sampling was used. In this sense, for the EFA, 3 professional schools were randomly considered: business sciences; health sciences; and political sciences, with a total of 492 students. Similarly, for the CFA, 2 professional schools were considered: humanities and engineering and architecture, with a total of 443 students. Although the stratified design ensured disciplinary representation, the sample's restriction to a single private university in Lima limits the generalizability of the findings to Peru's diverse higher education system. This focus may introduce sampling bias, as students from other institutions, regions, or academic areas could present different research competency profiles. Therefore, the results should be interpreted with caution regarding their external validity. To determine the sample size for the EFA and CFA, the following statistical formula was used:

$$n = \frac{Z^2 P*Q*N}{\varepsilon^2(N-1)+Z^2*P*Q}$$

Z=(1.96), value of the normal distribution, for a confidence level of (1–α)
p=(0.5), success rate
q=(0.5), failure rate (q=1–P)
ε=(0.05), tolerance to error
N=population size
n=sample size
The sample size for the EFA was 216 students from the 3 professional schools.

$$n = \frac{(1.96)^2(0.5)(0.5)(492)}{(0.05)^2(492-1)+(1.96)^2(0.5)(0.5)} = 215.968 = 216$$

The sample size for the CFA was 206 students from the 2 professional schools.

$$n = \frac{(1.96)^2(0.5)(0.5)(443)}{(0.05)^2(443-1)+(1.96)^2(0.5)(0.5)} = 205.9926 = 206$$

Finally, the sample by strata and the total sample for the exploratory and CFA are shown in Table 1.

Table 1. Sample of university students

Statistical analysis type	Professional schools	Subpopulation or population by stratum	Sample by stratum $=\frac{n}{N} \times sp$	Total sample
EFA	Business sciences	157	69	216
	Health sciences	186	82	
	Political science	149	65	
	Subtotal	492		
CFA	Humanities	298	139	206
	Engineering and architecture	145	67	
	Subtotal	443		

3.2. Instrument

The theoretical design of the initial items was based on a critical and systematic review of the specialized literature on research skills in higher education. In particular, the models proposed by several researchers [10], [30]–[32] were taken as the conceptual and structural basis, which address different approaches to epistemological and methodological knowledge, interpretive skills, information management, and scientific communication. Based on these theoretical references, key dimensions and operational descriptors were identified that guided the initial drafting of the items, ensuring their consistency with the defined constructs and their relevance to the Peruvian university context. This procedure allowed for theoretically informed and contextualized construction of the scale items.

The instrument developed aimed to assess five core dimensions of research competence: epistemic knowledge, interpretation skills, methodological knowledge, information management, and scientific communication of results. Initially, a total of 71 items were designed and distributed as: 18 items for the epistemic knowledge dimension, 10 for technological proficiency, 19 for methodological proficiency, 12 for information management, and 12 for the communication of scientific findings. The instrument employed a 5-point Likert scale with the following response options: 1 (strongly disagree), 2 (disagree), 3 (neither agree nor disagree), 4 (agree), and 5 (strongly agree). A rigorous validation and reliability process was subsequently conducted, including both exploratory and confirmatory factor analyses. As a result of this process, the final version of the questionnaire comprised 37 items distributed across the five clearly defined dimensions or factors.

3.3. Procedure

3.3.1. Phase 1: evidence based on scale content

The verification of content-based evidence is an important task within the validation process of measurement instruments, as it aims to verify the pertinence, relevance, and grammatical construction of the items concerning the theoretical dimensions, as well as the cultural and idiomatic characteristics of the target population [43]. The participation of expert judges with extensive knowledge in the domain of interest and/or the development of the scale was considered. For this purpose, the steps proposed by Pérez and Martínez [44] were followed, which are detailed as:

- Definition of objectives: the purpose consisted of evaluating the scale through expert judgment. Criteria such as pertinence, relevance, and grammatical construction were considered to evaluate the items of the scale, aligned with the theoretical foundations, the context, and the specific characteristics of the population under study.
- Selection of judges, criteria such as theoretical and methodological knowledge, professional experience, and academic background were considered. The seven judges were selected, five of whom were experts in the thematic field, and two specialized in methodology and participated voluntarily. These experts were provided with the following: informed consent and confidentiality forms, the variable operationalization matrix (which included the definition of dimensions, indicators, and items), the assessment scale, and the certificate of content validity, which includes the criteria used for the evaluation.
- Establishment of criteria for the evaluation of each of the items or reagents. The following criteria were established: i) it was evaluated whether the item corresponds to the theoretical concept formulated; ii) it was determined whether the item is appropriate to represent the specific component or dimension of the construct; and iii) the statement of the item is understood without any difficulty (concise, exact, and direct).
- Calculation of the concordance between judges: for this process, Aiken's content validity coefficient V was used as a method of analysis to determine the degree of consistency between them in the evaluation of the items.

3.3.2. Phase 2: evidence based on the construct of the scale

The central objective is to collect data associated with each of the items of the instrument for subsequent probabilistic grouping into factors or dimensions through the application of multivariate statistical techniques. For this purpose, the instrument was digitized and implemented in the Google Forms, which facilitated its distribution and efficient access through WhatsApp, Moodle, and/or email. The data obtained were processed and analyzed using Microsoft Excel and SPSS statistical software version 27.

- EFA

In the first stage, the data collected through the application of the instrument were subjected to an EFA to identify how the items are statistically grouped and to form dimensions through factor reduction. To initiate this process, the existence of a significant correlation between the items of the instrument was verified, which would allow the formation of dimensions or factors. At this stage, five structural hypotheses were proposed to verify that each dimension of the model—epistemic knowledge (H1), interpretive skills (H2), methodological knowledge (H3), scientific communication (H4), and information management (H5)—demonstrates significant construct validity within the factorial structure of the instrument.

This analysis included two key statistical tests: Bartlett's test of efficiency. This test evaluates whether the factors are correlated with each other. The null hypothesis (Ho) states that the items are independent, while the alternative hypothesis (Ha) suggests that there is a dependence between them, which would allow them to be grouped into one or more factors. A p-value of less than 5% indicates rejection of the null hypothesis, suggesting a high valuation between items [45]. Kaiser-Meyer-Olkin (KMO) test evaluates sampling adequacy by measuring the strength of partial correlations between items. Acceptable values for an EFA are greater than 0.7, indicating that the data are appropriate for factor analysis. These criteria are consistent with methodological recommendations for factor analysis in the social sciences, which emphasize the importance of both Bartlett's test and the KMO index in ensuring construct validity and sampling adequacy [45]–[47].

In the second stage, factors were extracted using the maximum likelihood (ML) method to reduce the number of factors by grouping the items that present greater similarity in their variations. The criterion used was the retention of those factors with eigenvalues greater than or equal to 1 [48]. To facilitate the interpretation of the results, the factor matrix was initially calculated, and subsequently, an orthogonal rotation was applied using the Varimax method, which optimizes factor loading. Items with loadings higher than 0.4 were selected for the final instrument. In addition, some authors suggest keeping the factors that group at least 3 items or whose factor loadings are equal to or greater than 0.3 [38].

– CFA

Once the aspects of the model were pre-specified, such as the factors or dimensions present in the data and their relationships with the indicators, based on the empirical evidence and theoretical background, the analysis was performed using AMOS software version 26. The ML estimation method was used, considering the following indices: χ^2/gl, root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), comparative fit index (CFI), Tucker-Lewis Index (TLI), adjusted global goodness of fit index (AGFI), goodness of fit index (GFI), and normed fit index (NFI). This analysis generated goodness-of-fit indices, both global and incremental, which allow for assessing the compatibility of the model with the empirical data [49].

After running the model, the first goodness-of-fit indices analyzed were the SRMR and the RMSEA. The SRMR index takes values in the range of 0 to 1 and is considered acceptable when it is less than 0.08 (<0.08). In contrast, the RMSEA index, although conceptually like the SRMR, is calculated differently and behaves differently, particularly when the sample size increases. An RMSEA value (less than 0.08)<0.08 is also recommended. Both indices assess how well the model fits the population, providing a key measure of validity.

The second group of indices analyzed corresponds to the global and incremental goodness-of-fit measures, which allow us to evaluate the quality of the proposed model. Thus, we have the GFI, which measures the proportion of total variance-covariance explained by the model. This index varies between 0 and 1, where a value greater than 0.90 indicates an adequate fit. On the other hand, the AGFI is an adjusted version of the GFI index that considers the number of parameters estimated in the model, with similar interpretation criteria: values greater than 0.90 indicate a good fit. Furthermore, the CFI compares the proposed model with a null model lacking factor structure.

Like the previous ones, the CFI index varies between 0 and 1, with values higher than 0.90 (>0.90), which indicates a satisfactory fit. For its part, the Tucker-Lewis Incremental Index (TLI) evaluates the fit of the model, considering its parsimony, penalizing those models with greater complexity. It ranges from 0 to 1, with values above 0.90 indicating a good fit. Finally, the NFI measures the best fit and compares the proposed model with a null model. Like the other incremental indices, it considers values above 0.90 (>0.90) as acceptable.

3.3.3. Phase 3: reliability analysis

The criteria established by psychometrics to assess the reliability of a measurement instrument are essential to ensure its consistency in measuring the variable of interest. Reliability refers to the ability of a measurement instrument to generate consistent and reproducible results across different groups and contexts. This is to assess the internal consistency of tests and ensure that the scores achieved primarily reflect the true variance relative to the observed variance [50].

At this stage, the reliability of the instrument was analyzed by calculating the internal consistency coefficient known as Cronbach's alpha, whose value varies between 0 and 1. Values closer to 1 indicate greater internal consistency. George-Reyes *et al.* [5] propose, as a general criterion, the following classification to evaluate the coefficient: higher than 0.90 is excellent, higher than 0.80 is good, higher than 0.70 is acceptable, higher than 0.60 is questionable, higher than 0.50 is poor, and lower than 0.50 is unacceptable.

4. RESULTS

4.1. Evidence of content validity

Content validity was assessed using expert judgment. A quantitative comparison of the differences between judges was performed using the Binomial Test. The calculation, based on the frequencies of the data (yes=1, no=0), made it possible to establish the probability of concordance and, from this, the content validity of the items. It was established that if $p<0.05$, the concordance is significant, and the item is assumed to have content validity. On the other hand, if $p>0.05$, the concordance is not significant, so it will be necessary to review the observations and make suggestions for improvement.

The validity of the questionnaire, composed of 71 questions, was calculated and reviewed by six experts. The data provided by these experts were recorded on a two-level scale (yes=1 and no=0). The value of the binomial test was calculated using the SPSS statistical package, version 27. To evaluate the content validity through expert judgment, the following hypotheses were put forward:

Null hypothesis (Ho): there is no agreement among the expert judges. The proportion of judges who rate “valid” or “to be improved” is equal to the proportion of judges who rate “not valid”. Alternate hypothesis (Ha): there is agreement among the expert judges.

$$P_x = \binom{n}{x} p^x q^{n-x}$$

P=proportion of expected cases in one of the categories
q=1-p: proportion of expected cases in the other category
n=number of elements

This analysis made it possible to determine whether there was a statistically significant level of agreement among the judges regarding the validity of the items. In this context, the null hypothesis (Ho) was proposed, which assumed a lack of agreement among the judges, as opposed to the alternative hypothesis (Ha), which proposed a significant level of agreement. The results obtained for each judge are presented in Table 2, where all exact significance values (bilateral) are less than 0.01, indicating a high level of agreement among the experts on the validity of the items evaluated. The results show that the value of the observed significance p=0.001; 0.003; 0.003: 0.002; 0.003; and 0.002, respectively, is less than the value of the theoretical significance α=0.05, which allows us to point out that the questionnaire is statistically significant. Therefore, the null hypothesis is rejected, and it is affirmed that the items are adequate.

Table 2. Content validity of the research competency assessment scale

Judges	Exact sig. (bilateral)	Valid no (per list)
Judge 1	0.001	71
Judge 2	0.003	71
Judge 3	0.003	71
Judge 4	0.002	71
Judge 5	0.003	71
Judge 6	0.002	71

4.2. Factorial construct validity

As a preliminary step, data processing was conducted. Normality was verified using the Kolmogorov–Smirnov test (p=0.200>0.05), confirming an approximate normal distribution. One missing case was removed, and outliers were identified through z-scores (values<–3 or >3). Consequently, two cases (105 and 198) in the epistemic knowledge dimension were excluded, resulting in 214 valid observations from the original 216. In the first analysis, Cronbach’s alpha coefficients obtained were higher than 0.7, indicating a high internal consistency among the scores recorded, as shown in Table 3.

Table 3. Reliability of the variable and dimensions

Variables and dimensions	Cronbach’s alpha
Research competence	0.979
Methodological knowledge	0.949
Epistemic knowledge	0.939
Information management	0.922
Scientific communication	0.937
Interpretive skills	0.830

To evaluate the relevance of applying the EFA, the KMO sampling adequacy index was calculated, obtaining a value close to 1. On the other hand, Barlett’s test of sphericity yielded a significance value (Sig.) of less than 5%, which shows a significant correlation between the items of the instrument and the degrees of freedom (gl) of around 741, indicating that the number of variables (items) and combinations is relatively high, which reinforces the validity of the test result. The detailed results are shown in Table 4.

Table 4. KMO index measure

Test		Statistic
KMO measure of sampling adequacy		0.946
Bartlett's test for sphericity	Approx. Chi-square	6334.608
	gl	741
	Sig.	0.000

4.3. EFA

The factor extraction analysis identified five factors with initial eigenvalues equal to or greater than 1 [48], which explained 54.026% of the total variance. Each factor grouped more than 3 items, with factor loadings greater than 0.4 [47]. Table 5 presents the grouping of the items in their respective new dimensions or factors.

Table 5. Rotated component matrix

Items	Component					Items	Component				
	1	2	3	4	5		1	2	3	4	5
Item 40	0.807					Item 48			0.780		
Item 42	0.754					Item 29		0.356	0.659		
Item 41	0.744					Item 01		0.406	0.603		
Item 45	0.705					Item 50			0.593		
Item 39	0.703		0.339			Item 30			0.552	0.399	
Item 38	0.616					Item 52			0.543	0.392	
Item 36	0.581					Item 54	0.443		0.499		
Item 32	0.573			0.348		Item 64				0.794	
Item 44	0.556		0.331			Item 65				0.792	
Item 10		0.730				Item 70				0.661	
Item 09		0.722				Item 66			0.436	0.547	
Item 08		0.670				Item 63				0.546	0.419
Item 03		0.648				Item 61			0.422	0.498	
Item 05		0.638				Item 68				0.441	
Item 11	0.353	0.637				Item 56					0.710
Item 04		0.616	0.410			Item 57					0.682
Item 02		0.590				Item 55	0.396				0.635
Item 13		0.582				Item 59					0.610
Item 06	0.305	0.570				Item 58			0.424		0.573
Item 49			0.807								

Extraction method: principal component analysis.
Rotation method: Varimax with Kaiser normalization.

4.4. CFA

The results from the EFA were confirmed through CFA, validating the model's structure and ensuring its internal consistency. In addition to the global indices, the individual factor loadings for each item were analyzed, with all loadings above 0.50, which is an acceptable range for exploratory scales. Likewise, the modification indices were reviewed, and correlations were identified between errors in items 1 and 2; 6 and 10; 12 and 13; 17 and 18; 25 and 30; 34 and 35; 36 and 37, which was theoretically justifiable due to their similar wording. Adjustments were made to improve fit, including the removal of item 32 (factor 3) and item 27 (factor 4), resulting in 37 items, as shown in Table 6. As a result, the final model was structured into five factors and 37 items. Figure 1 is a path diagram of the CFA model, created using AMOS software.

Figure 1, elaborated using AMOS, illustrates the relationships between the five latent factor (F1–F5) and their respective observed variables (items), including standardized factor loadings and error terms. The model demonstrates how each group of items clusters around its corresponding factor, as well as the correlations among the latent constructs, providing evidence of the internal structure of the instrument. According to the absolute and comparative fit indicators, it is concluded that the confirmatory factorial model is adequate since it meets the seven criteria established for goodness of fit, as in Table 7. In addition, the Chi-square goodness-of-fit test was significant (X2=1110.680; gl=612; p=0.00), which supports the adequacy of the model. In general terms, the analysis of the data using the CFA allows the conclusion that the proposed model fits satisfactorily to the empirical data collected during the application of the questionnaire.

4.5. Reliability

The results of the reliability calculations, performed in the Jamovi software, using Cronbach's alpha test and McDonald's omega coefficient (ω), are presented in Table 8. From these results, it is concluded that, both individually and globally, the items evaluated in each factor or dimension of the variable exhibit a high degree of internal consistency, meeting the established reliability criteria.

Table 6. Final validated version of the scale

Dimensions	Items
Methodological knowledge (F1)	I know the elements of the validation portfolio of data collection instruments.
	I identify the research designs in the qualitative route.
	I identify research designs in the quantitative route.
	I apply theoretical methods such as analysis–synthesis, induction–deduction, and generalization–abstraction.
	I know how to perform the validation and reliability of data collection instruments.
	I select the study population and sample based on inclusion and exclusion criteria.
	I establish the necessary elements in the operationalization matrix of variables and/or a priori categories.
	I write the objectives in a congruent way with the research questions.
	I identify and use data collection techniques and instruments in quantitative and qualitative research.
Epistemic knowledge (F2)	I construct methodological knowledge based on the review of reliable sources.
	I construct theoretical knowledge based on the exhaustive review of reliable sources.
	I identify the theoretical methods that underpin and guide the study.
	I distinguish the different approaches to scientific research.
	I identify the scope of my research (exploratory, descriptive, correlational, explanatory, and transformative).
	I produce new scientific knowledge.
	I differentiate the type of research I conduct.
	I identify the appropriate paradigm to develop my research project.
	I make critical judgments about existing theories to integrate them into the theoretical bases of my research.
	I have mastered the topic and use the scientific method.
Information management (F3)	I efficiently find reliable and relevant information for my research.
	I easily identify the object of study or research problem.
	I adequately organize the information obtained from quantitative and qualitative data.
	I properly organize bibliographic information using reference managers or digital tools.
	I know and use quantitative and qualitative data analysis software.
	I use scientific databases appropriately to extract relevant information.
	I evaluate the relevance and quality of the sources I use, following well-defined academic criteria.
Scientific communication (F4)	I rigorously follow the formal structure and academic standards when writing research reports.
	I communicate research results orally with clarity.
	I communicate research results in writing effectively.
	I use technical language appropriate for the target audience when writing the research report.
	I use definitions and concepts appropriately.
	I prepare the research report specifying each part of the process.
Interpretation skills (F5)	I draw coherent conclusions based on the analysis of the qualitative and quantitative data obtained.
	I interpret the results of my research according to the objectives set at the beginning.
	I analyze research data using techniques suited to the applied methodology.
	I contextualize the results of my research considering the problem and the reality studied.
	I critically compare the results obtained with previous relevant studies in the same field.

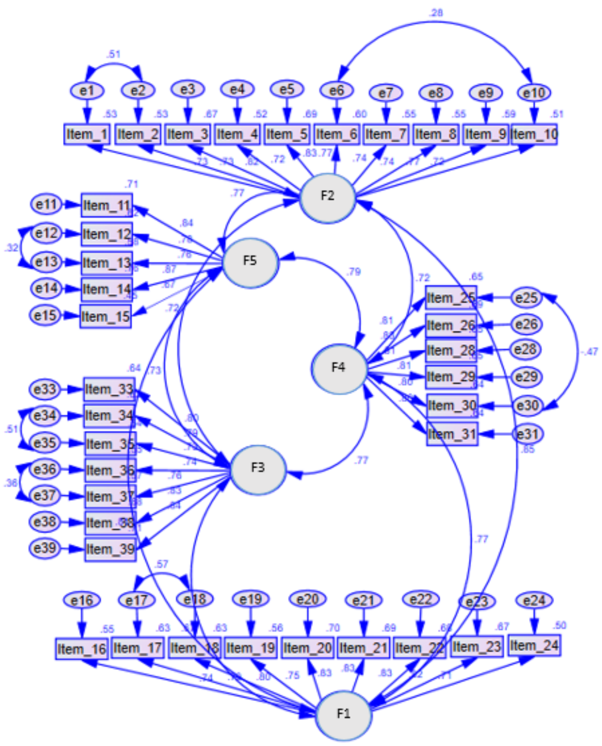

Figure 1. Final scale model

Table 7. Goodness-of-fit indicators of CFA

Absolute adjustment index	Expected	AMOS initial model	AMOS final model
GFI	0.90-1	0.802	0.910
AGFI	0.90-1	0.864	0.936
SRMR	Closest to zero	0.038	0.035
RMSEA	<0.05–0.08	0.080	0.064
CFI	Expected		
	0.90-1	0.866	0.918
TLI	0.90-1	0.856	0.911
NFI	0.90-1	0.885	0.936

Table 8. Results of reliability analysis

Dimensions and variables	Number of items	Cronbach's alpha	Ω McDonald's
Epistemic knowledge	10	0.931	0.932
Interpretation skills	5	0.890	0.896
Methodological knowledge	9	0.937	0.938
Scientific communication	6	0.914	0.915
Information management	7	0.922	0.923
Research competence	37	0.974	0.974

5. DISCUSSION

The content validation process of the scale showed a solid adequacy to expert criteria, which was evidenced by the significant values in the binomial test ($p<0.05$), confirming the relevance and pertinence of the items to measure research competencies. This result supports the conceptual validity of the instrument and reinforces the importance of a rigorous approach in the selection and evaluation of the items, following the guidelines established in similar psychometric studies [43].

The EFA identified five factors with eigenvalues greater than 1, which explained 54.026 % of the total variance. Subsequently, the CFA corroborated the structure, obtaining satisfactory fit indices, such as the GFI (0.910) and the RMSEA (0.064). These results not only validate the internal structure of the instrument but also highlight the ability of the scale to reflect theoretical constructs in a coherent manner, aligned with several methodologies [46], [47], [49].

The internal consistency of the items, evaluated by Cronbach's alpha (α) and McDonald's ω coefficient, presented values above 0.90 in all factors, indicating excellent reliability. This result reinforces the robustness of the instrument to evaluate research competencies in university students by the reliability standards [50], [51]. This strong internal consistency suggests that the items within each dimension are conceptually aligned and measure the intended constructs consistently across different student samples. The debugging of the initial items, which reduced the scale from 71 to 39, optimized its structure, maintaining its validity and reliability. This adjustment is made based on the relevance of the factor loadings, greater than 0.4 (>0.4), which strengthens the precision of the instrument and its applicability in educational contexts. This approach is consistent with recommended practices in the development of psychometric scales [47].

A recent study directly related to epistemic knowledge underlines the importance of comprehensive training in epistemic competence. This approach encompasses multiple interrelated aspects, such as knowledge construction and conceptual change, epistemological beliefs, conceptual understanding, knowledge creation, and personal epistemology, also incorporating the role of epistemic emotions in the learning process, all grounded in science education. These elements, taken together, reinforce the need for a holistic approach that promotes the development of research competence in higher education.

For its part, a recent study has consolidated methodological knowledge as a key competence in higher education [52], emphasizing that its development requires not only the understanding of research approaches and techniques but also the ability to select, apply, and adapt methodologies according to the nature of the object of study. This approach stresses the importance of integrating teaching strategies that favor advanced methodological literacy, allowing students not only to acquire theoretical knowledge about research methods but also to apply them critically and reflexively in the generation of knowledge.

In this sense, strengthening methodological knowledge involves training in the design of studies, the formulation of pertinent research questions, the appropriate selection of data collection and analysis techniques, as well as the rigorous interpretation of results. This requires training that goes beyond the traditional teaching of methods and promotes learning experiences based on the resolution of real problems, the use of specialized software, and the evaluation of the validity and reliability of the methodological strategies employed. From a pedagogical perspective, it is proposed that the teaching of this competency be based on active and experiential learning, incorporating activities such as the simulation of research processes, the analysis of previous studies, and the development of research projects with a reflective and critical approach. It also highlights the need to foster in students an epistemologically conscious attitude that allows them to question the underlying assumptions in different methodologies, identify biases in research, and build knowledge with rigor and argumentative soundness.

The dimension of interpretation skills in research competence implies the ability to analyze, understand, and process complex information in different contexts. The three studies provide evidence of the factors that influence its development. The first study, conducted at the Department of Interpreting at the University of Geneva, highlights the importance of a blended learning environment based on deliberate practice. In this approach, conference interpreting students are trained to become adaptive experts, able to self-regulate their learning and perform professionally. Through activities anchored in real contexts, a collaborative approach, and tutor support, students develop autonomy, metacognitive skills, and self-regulation, which strengthens their interpreting skills [53].

The second study examines the relationship between general cognitive skills and simultaneous sign language interpreting proficiency. The findings suggest that interpreting proficiency is influenced by a combination of cognitive abilities such as processing speed, working memory, mental flexibility, and cognitive control, as well as personality traits such as risk orientation and emotion-cognition integration. These differences between highly competent interpreters and those with lower abilities indicate that both cognitive abilities and personality factors can predict the level of interpretive skill and its evolution over time [54].

The third study demonstrates that the use of pedagogical scaffolding, through smart systems, improves students' immediate performance in data interpretation tasks by guiding them in the procedural aspects of the research activity. However, it is also evident that certain components of interpretation remain challenging, suggesting that these skills involve complex cognitive processes that require practice, continuous feedback, and targeted instructional support to fully consolidate [37]. Taken together, these studies highlight the importance of a comprehensive approach to the development of interpretive skills, combining pedagogical strategies based on deliberate practice with the recognition of cognitive and personality factors that influence effective interpretation.

The scientific communication dimension refers to the ability of students to express, argue, and disseminate scientific knowledge effectively. It has recently been established as a key competence of students [55]. Several studies have analyzed the strategies and conditions that favor its development. The first study explored the approaches employed by university students to improve their scientific communication skills. It identified that the use of interactive resources, teacher guidance, and access to scientific literature significantly contribute to performance on written tasks. These findings underscore the importance of providing explicit guidance and opportunities for interaction with experts to strengthen these skills [56]. The two studies focused on a science communication skills measurement instrument adapted to the sociocultural context of Indonesia, suggesting that future research incorporates learning models that integrate social issues to enhance these competencies [50]. Meanwhile, a new study examined the impact of using higher-order thinking-based virtual laboratories on improving scientific communication. It was found that students who used this methodology significantly outperformed those who employed conventional virtual labs, evidencing the effectiveness of interactive approaches in developing these skills [57].

Finally, another study analyzed the implementation of the scientific communication program, designed to strengthen higher-order learning skills. Students who participated in the program demonstrated better performance in the application of knowledge, learning skills, and quality of academic products compared to those who did not receive this training [58]. Taken together, these studies highlight the relevance of interactive methodologies, the validation of specific instruments, and the integration of structured didactic strategies to enhance students' scientific communication. The information management dimension refers to the student's ability to search, select, organize, analyze, and communicate information effectively within the academic and scientific environment. This competence is essential for the construction of knowledge and the development of research skills.

In this regard, a study presents a system of tasks designed to develop information management as a research skill in university students. It is emphasized that this skill involves the construction and reconstruction of knowledge through social interaction and the use of innovative strategies. The research concludes that training in information management should be integrated into various subjects since it allows students to process and communicate data effectively, thus contributing to their academic and professional development [4].

Another study addresses information management in the context of the data life cycle, highlighting the importance of its systematic use for decision-making and the generation of new knowledge. It highlights the need for structured approaches that enable students to understand how to efficiently collect, store, analyze, and reuse information [59]. These studies emphasize that information management is a key skill for academic and professional success. Its development requires pedagogical strategies that encourage the critical processing of information, the application of research methodologies, and the use of technological tools for data organization and analysis.

Although this scale has been validated in the context of a Peruvian university, its framework could be useful for other educational situations with comparable characteristics in Latin America. Peru's cultural diversity, especially regarding the presence of indigenous languages, regional approaches to higher education, and systemic inequalities, provides a significant backdrop for developing locally adapted tools. Furthermore, these findings contribute to the international discussion on research training in higher education by providing evidence from a middle-income country facing significant challenges in educational equity. Future research could apply the scale in different cultural contexts and test its cross-cultural validity.

6. CONCLUSION

This study developed and validated a 37-item, 5-dimension scale to assess research competencies in Peruvian university students. Exploratory and confirmatory factor analyses confirmed its strong psychometric properties, with high internal consistency (α and $\omega>0.9$). The instrument demonstrates solid content and construct validity, offering a reliable tool for evaluating research competencies in higher education.

Although the study offers valuable insights, it presents limitations related to its single-institution sample and quantitative design, which restrict generalizability and depth of interpretation. Future studies should include multiple universities, mixed methods, and longitudinal designs to evaluate the instrument's stability and broaden its applicability. The scale is valid and reliable for measuring students' research skills and may serve as a diagnostic and formative tool in subjects such as research methodology or thesis design. Its regular use can monitor progress, identify gaps, and guide improvements in teaching strategies.

The validated scale has broad applicability for educational and institutional policy. Its systematic use can inform decision-making processes in curriculum design, accreditation, and quality assurance, providing evidence-based indicators for strengthening research education. At the national level, the instrument could guide public policies aimed at fostering scientific competence among university students and promoting innovation-oriented learning. Likewise, other institutions may adapt and apply the scale to evaluate, compare, and enhance their own research training processes, thus contributing to a regional culture of research excellence. In a context where research drives university transformation, this validated scale becomes a strategic tool for assessing and developing research competencies, supporting curricular innovation, and promoting a more relevant, equitable, and knowledge-driven higher education system in Latin America.

FUNDING INFORMATION

The authors state that no funding is involved.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

This study was registered with the Research Group of the Graduate Program in Education at USIL under the code EDUSIL-2025-L4-ODS4-OR-012.

DATA AVAILABILITY

The data supporting this study is available upon request from the corresponding author.

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