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Design and Validation of the Scientific-Research Skills Questionnaire for Basic Education Teachers

Gilber Chura-Quispe [1*], Bianca Daisa Laura-De-La-Cruz [1], Patricia Rosa Maria Nué Caballero[2], Edith Cristina Salamanca Chura[3] and Héctor Octavio Guido Torres Orihuela[4]

[1] Escuela de Posgrado Newman, Av. Bolognesi 987, Tacna 23001, Perú;
[2] Universidad Privada de Tacna, Av. Jorge Basadre s/n Pocollay, Tacna 23003, Perú;
[3] Universidad Nacional Jorge Basadre Grohmann, Av. Miraflores s/n, Tacna 23000, Perú;
[4] Universidad Nacional de San Agustín, Av. Independencia s/n, Arequipa 04001, Perú;

Corresponding author*: e-mail: gilber.chura@epnewman.edu.pe.

ABSTRACT: One teacher skill that has allowed for progress and development in pedagogy is that of scientific research, but there is very little attention to its measurement in basic education. The aim of the study was to design and validate a questionnaire of teachers' scientific-research skills and to compare them according to socio-demographic variables. The design was psychometric and descriptive-comparative with the participation of 736 Peruvian teachers. The results indicate that the instrument has evidence of content validity with a concordance > 0.7 among the 9 judges. The exploratory factor analysis (EFA) exposed 25 items and 3 dimensions that explained 81.1% of the total variance (KMO > 0.7, Bartlett < 0.05) and was confirmed by adequate fit indices (X2/df = 4.648, p < 0.001, SRMR=0.036, RMSEA=0.099, TLI, CFI and GFI >0.95). The values obtained for convergent validity (AVE > 0.5), discriminant validity (√AVE > r) and internal consistency (αordinal and ωordinal > 0.7) exceeded the minimum expected values. In addition, it was found that there are moderate and significant differences in the skills of problematisation and research theorisation, research contrastation and scientific communication according to teaching levels in favour of secondary school teachers and in academic training with higher scores in teachers with a doctorate degree (p < 0.05; $\hat{\varepsilon}$ > 0.25). In conclusion, the questionnaire has adequate evidence of validity and reliability, and there are differences in teachers' abilities according to teaching and training levels.

Keywords: Scientific-research skills, educational research, validity, reliability, basic education.

I. INTRODUCTION

Research is a set of activities carried out by specialists in the various branches of knowledge. In the education sector, the main researcher is the teacher; his or her role is not only focused on pedagogical activities, but also on contributing to educational knowledge. Being a research teacher requires scientific and technical skills, but the lack of commitment to the epistemology of education means that teachers only meet the requirements of teacher promotion [1]. These limitations are evident from professional training with difficulties in accessing information, superficial reading, limited reasoned judgement and little innovation in their ideas [2, 3]. In addition to this, there are other factors evidenced in pedagogical praxis such as the lack of reading scientific articles [4], continuity of their training, time, comfort zone, difficulty in transferring results [5], family burden, absence of active collaborators, little institutional support and lack of research culture [1] and academic overload [6].

There are a variety of factors involved in the problems and obstacles to production and performance [6] that can generate dissociation between research and pedagogical processes [7]. The development of research skills involves the generation and implementation of research and innovation projects in their disciplinary field [8]. In this way, teachers are able to solve obstacles or problems arising from student behaviour or the classroom environment [9]. However, the significance of these findings can go beyond the classroom or educational institution, specifically to dissemination and communication of studies [10].

Advances in educational research have been constantly evolving in accordance with the needs of knowledge of teaching and learning processes. These changes occurred at the level of paradigms and approaches; initially, positivist or quantitative research predominated, but advances in the mid-twentieth century allowed increasing attention to action-research studies, ethnographic, socio-critical or constructivist designs [11, 12], which allow a deep understanding of educational phenomena. Therefore, teachers in the 21st century must be able to draw on both approaches to propose new alternative solutions to problems related to learning. Teaching performance and research [13] address educational issues such as educational administration, continuous teacher training and efficiency in the critical analysis of their teaching practice [14].

Developing scientific research skills is becoming increasingly important in teaching and learning processes. They contribute to the improvement of critical thinking, problem solving and reflective practice, but their strengthening requires teachers to have previous experience [15]. In this sense, continuous training, participation in collaborative educational projects, as well as involvement in academic communities, educational networks or scientific events are relevant. The development of such skills promotes a research culture and enhances teachers' professional development [16, 17]. The combination of pedagogical and scientific activities can favour the updated knowledge of teachers to reformulate teaching methods [18], the creation of relevant learning environments, the questioning of events and processes that arise in the classroom, allowing them to conduct research, identify problems and propose alternative solutions [19, 20].

In today's basic education, the new challenges of the 'Knowledge Society' invite teachers to play a fundamental role in the training of students capable of questioning and solving society's problems. Teachers who are motivated and committed to research are capable of transmitting this same spirit to their students [6, 21], making them key players in having a positive or negative impact in the classroom [22]. Scientific research is the fundamental basis for educational development and represents a way to improve not only the conditions of teaching and learning processes, but also administrative, labour relations and society [23]. Having teachers skilled in research would generate a continuous reflection on their classrooms, but this requires tools that diagnose the research strengths and weaknesses of teachers.

The literature review identifies that researchers have conducted design and validation studies of scientific-research skills under different names such as research competences, scientific skills or research skills. Research has designed instruments to assess the research competences of postgraduate students based on their written production that evaluate the introduction, methodology, results, final report and collaborative work [24]. Some studies focused on assessing e-learning thesis writing skills in a multidisciplinary way [25] and others directly addressed the research skills of undergraduate students with rubrics [24, 26] or questionnaires [27, 28] that are organised between 3 and 6 factors assessing aspects such as knowledge of the scientific method, interpretation and evaluation of data, use of technologies, management, organisation, application and communication of knowledge.

In other more specific scenarios, instruments have been designed for disciplines such as engineering, which prioritises factors such as processing, management and development of scientific research [29]; health sciences, with attention to the link between academia and work in their profession [30-32]; and library science, with emphasis on information processing [33]. In the field of teaching careers, there are studies that have developed instruments on the perception of educational research in a polytomous [34] or dichotomous, although not validated, form [35]. In addition, there are instruments that analyse the impact of educational research on teaching practice [36], as well as on the scientific practices of basic education teachers [37]. While some scales choose to assess cognitive and affective attitudes towards educational research [38].

Approaches in the construction of instruments are important, however, one aspect not yet explored is the construction of an instrument based on the processes developed within educational research [39]. Constructing a relevant instrument could help in teacher recruitment, professional competence development and evaluation of didactic methods at qualitative, quantitative or mixed levels [40]. Its contribution would not only contribute at a practical level, but also at a theoretical level, mainly in descriptive comparative studies between teachers' skills [14, 41, 42], in order to identify professional development needs [43] for the contribution to the improvement of the instructional-educational process [44].

The reasons presented allow us to express the lack of existing knowledge in the field of educational research, which is why this study aims to design and validate a questionnaire on scientific-research skills of basic education teachers and, in addition, to compare these skills according to the socio-demographic variables of sex, age, type of educational management, years of experience, level of teaching and academic training in Peruvian teachers.

II. LITERATURE REVIEW

1. SCIENTIFIC-RESEARCH SKILLS IN EDUCATION

Scientific-research skills are a set of actions based on the planning, execution, evaluation and communication of results in response to scientific problems [45]. They are also understood as the domain of actions linked to the scientific method that problematise, theorise and verify reality [39]. It involves mastery of the basic phases of scientific activities and is associated with the ability to provide a creative response to scientific problems [41] and is acquired through research practice [46]. In education, the structure of scientific-research competence has a higher degree of scope in teachers who have carried out scientific research work in their professional experience [41].

Research in pedagogy is associated with two positions: a) the positivist perception, based on studies with the scientific method and b) the interpretive, with contextualised actions aimed at understanding educational phenomena [47, 48]. Educational research addresses problems situated in the school community that includes the participation of parents, students and teachers [49]. It influences the management of educational processes, professional development, teaching methodologies and evaluation [4] in search of a holistic view of educational processes, focusing on teachers, students, curriculum and educational management [6].

2. STRUCTURE OF THE SCIENTIFIC-RESEARCH SKILLS MODEL

The model was based on the theoretical contributions of Chirinos-Ramos [39] and Román and collaborators [50] from which the proposed factors were extracted:

Problematisation is the ability to identify contradictions between pedagogical theory and practice based on observation and literature review [39]. In addition, the teacher is able to identify gaps in knowledge in order to propose new theoretical models or pedagogical interventions [11, 34]. Strategies to identify problems can generate changes in behaviour and outcomes in the teaching and learning process [51]. The measurable indicators in this factor are (1) observation, (2) description, (3) comparison, (4) identification of contradictions and (5) problem statement in educational reality [50].

Theorising is the ability to analyse, reflect and take a scientific and ethical stance on theoretical foundations in education [39]. It is associated with epistemic capacity that enables knowledge about the nature and sources of knowledge, evidence-based reasoning and contextual understanding within a discipline [52]. Developing theoretical understanding skills can condition the quality of research [53]. The indicators assessed in this construct are (1) analysis and synthesis of scientific theories, (2) statement of objectives, hypotheses, ideas or situations, (3) determination of the object of research, (4) justification and (5) modelling of scientific solutions [50].

Contrasting is the ability to verify the results obtained, evaluating achievements and difficulties from an objective and scientific stance using data collection methods and instruments [39]. The indicators assessed in this construct are (a) selection of methods, (b) development of instruments, (c) tabulation and graphical representation of results, (d) interpretation of data and (e) comparison of results obtained [50]. There are different methods used in education such as qualitative (action research, case studies, ethnographies, etc.), review (narrative reviews, systematic reviews, bibliometrics or meta-analysis) and quantitative (non-experimental, experimental, predictive models, etc.) [54, 55].

Scientific communication is the transmission of research advances to the community through interaction in scientific events or publication of results in journals. Communication takes place in written or oral form [50]. This procedure is carried out under the support of technology that incorporates contributions and a better capacity to respond to changes in knowledge [56]. This practice is carried out from all stages of professional teacher training [57]. The indicators assessed are (e) scientific publication, (b) scientific language, (c) knowledge of text types, (d) interaction in events and (e) oral communication [50].

III. MATERIAL AND METHOD

1. RESEARCH DESIGN AND DATA COLLECTION

The research design is composed of two stages, the first one based on the instrumental design based on the creation and validation of new instruments in a given scenario [58] and the second stage was a descriptive-comparative design in which the emerging factors of the instrument were compared according to socio-demographic data (gender, age, type of educational institution, level of education and academic background) [48].

First, a review of the most recent publications on the creation and validation of instruments on scientific and research skills or competences was carried out; publications between 2015 and 2022 were considered with the keywords “Research competence” OR “Investigative competence” OR “Research skills” OR “scientific ability” OR “scientific expertise” AND “validation” in the Web of Science and Scopus databases. Then, the selection process of the main constructs and theories used was carried out. Based on the analysis of the literature, the theoretical contributions of Chirinos-Ramos [39] were taken as a basis, who uses the dialectic relationship of knowledge-ability to propose that the scientific-research skills of teachers are: problematising the educational reality, theorising the educational reality and testing the educational reality. The contribution of Román and collaborators [50], who propose research problematisation, scientific theorisation and research contrasting, also stands out. To this, we can add the proposal of Llorente & Revuelta [59], who highlight the relevance of scientific communication. Based on these three proposals, the model for the initial instrument was constructed with 26 items distributed in 4 factors called problematisation (5 items), theorisation (6 items), research contrastation (9 items) and scientific communication (6 items). The evaluation scale is a 5-level scale (1 = not at all, 2 = little, 3 = enough, 4 = quite a lot and 5 = a lot).

The opinions of 9 university lecturers specialising in educational research were then sought. The evaluations were made based on the criteria of clarity, sufficiency, relevance and coherence of each of the items, and based on the suggestions, the wording of items 3, 11, 21 and 26 was modified because they lacked clarity. The judges gave their assessment on a scale of 1 to 5. The concordance was evaluated with the Content Validity Coefficient of Hernández Nieto. Subsequently, 10 basic education teachers participated and gave a qualitative and critical assessment of each item and indicated whether they were understandable or not, so items 22, 23 and 24 were modified. The model of the corrected instrument is shown in Figure 1.

The instruments were then applied to Peruvian teachers. First, the Tacna Education Management Unit and the Regional Education Directorate of Moquegua were asked for permission to collect data in the institutions of the jurisdiction. Then, the research objectives, information on data confidentiality and questionnaire items were transcribed into a Google Form, and informed consent was requested for their anonymous and voluntary participation in the study. With the support of the principals of the different educational institutions, the link was disseminated via Whatsapp and Email to basic education teachers between December 2021 and February 2022.

The research involved 736 intentionally selected teachers with inclusion criteria: active teachers who teach in regular basic education and who agreed to participate in the study after informed consent. The sample size was estimated in two stages: in the first stage for the exploratory factor analysis (EFA), the item-subject criterion was used, with at least 10 participants per item and the recommendation of Anthoine and collaborators [60], who proposes considering at least 200 subjects in the EFA [61]; 362 basic education teachers from the Moquegua region participated in this stage. In the second stage, regarding the confirmatory factor analysis (CFA), the criterion of at least 100 subjects was taken as a basis [60]; 374 teachers from the Tacna region participated in this stage. The majority were female (73.37 %) compared to male (26.63 %); the teachers teach at the pre-school (20.52 %), primary (39.27 %) and secondary (40.22 %) levels of basic education. The most frequent age range was between 41 and 60 years (67.39 %), most of them belong to the public sector (76.49 %) and have a pedagogical degree or bachelor degree (74.19 %) as described in table 1.

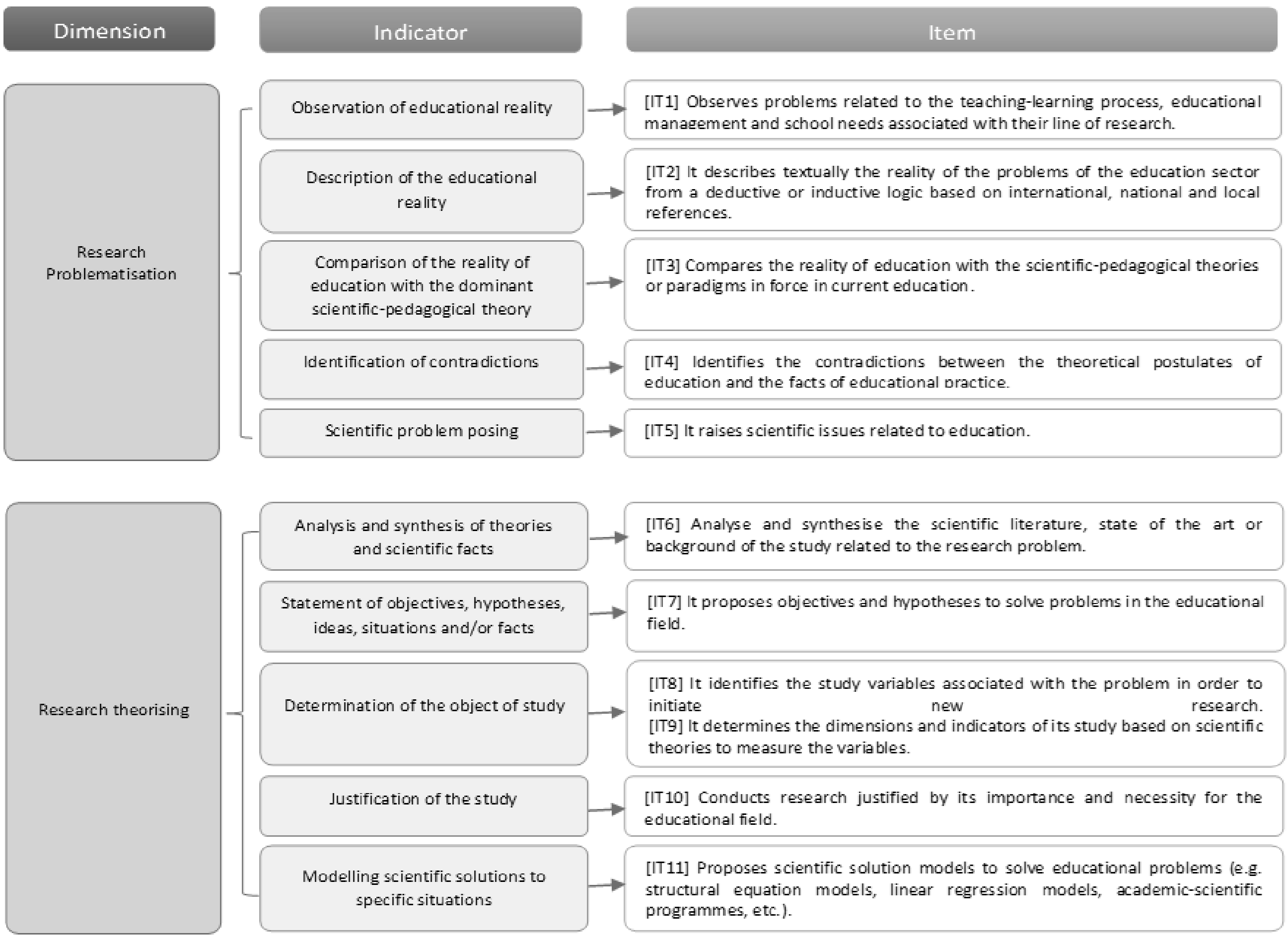
With the group of teachers from Moquegua, we proceeded to analyse the items and construct validity by means of exploratory factor analysis (EFA). Once the results were obtained, with the information from the Tacna teachers, the emerging model was checked with the confirmatory factor analysis (CFA), as well as the convergent and discriminant validity and the internal consistency measures. Comparisons were also made of the teachers' scientific research skills based on socio-demographic data. The findings are presented in illustrative tables and figures in the results section.

Table 1. Socio-demographic data

Variable	Categories	Frequencies	Percentages
Sex	Female	540	73.37
	Male	196	26.63
Age1	21-30	66	8.97
	31-40	143	19.43
	41-50	256	34.78
	51-60	240	32.61
	61-70	31	4.21
Experience1	1-5	78	10.60
	6-10	92	12.50

	11-15	115	15.63
	16-20	98	13.32
	21-25	138	18.75
	26-30	113	15.35
	31 years or older	102	13.86
Type of educational management	Private	173	23.51
	Public	563	76.49
	Pre-school	151	20.52
Level of education	Elementary	289	39.27
	Secondary	296	40.22
Academic training	Pedagogical	335	45.52
	Baccalaureate	64	8.70
	Bachelor's degree	211	28.67
	Master's degree	120	16.30
	Doctor's degree	6	0.82
Region	Moquegua	362	49.18
	Tacna	374	50.82

Note. 1Based on years



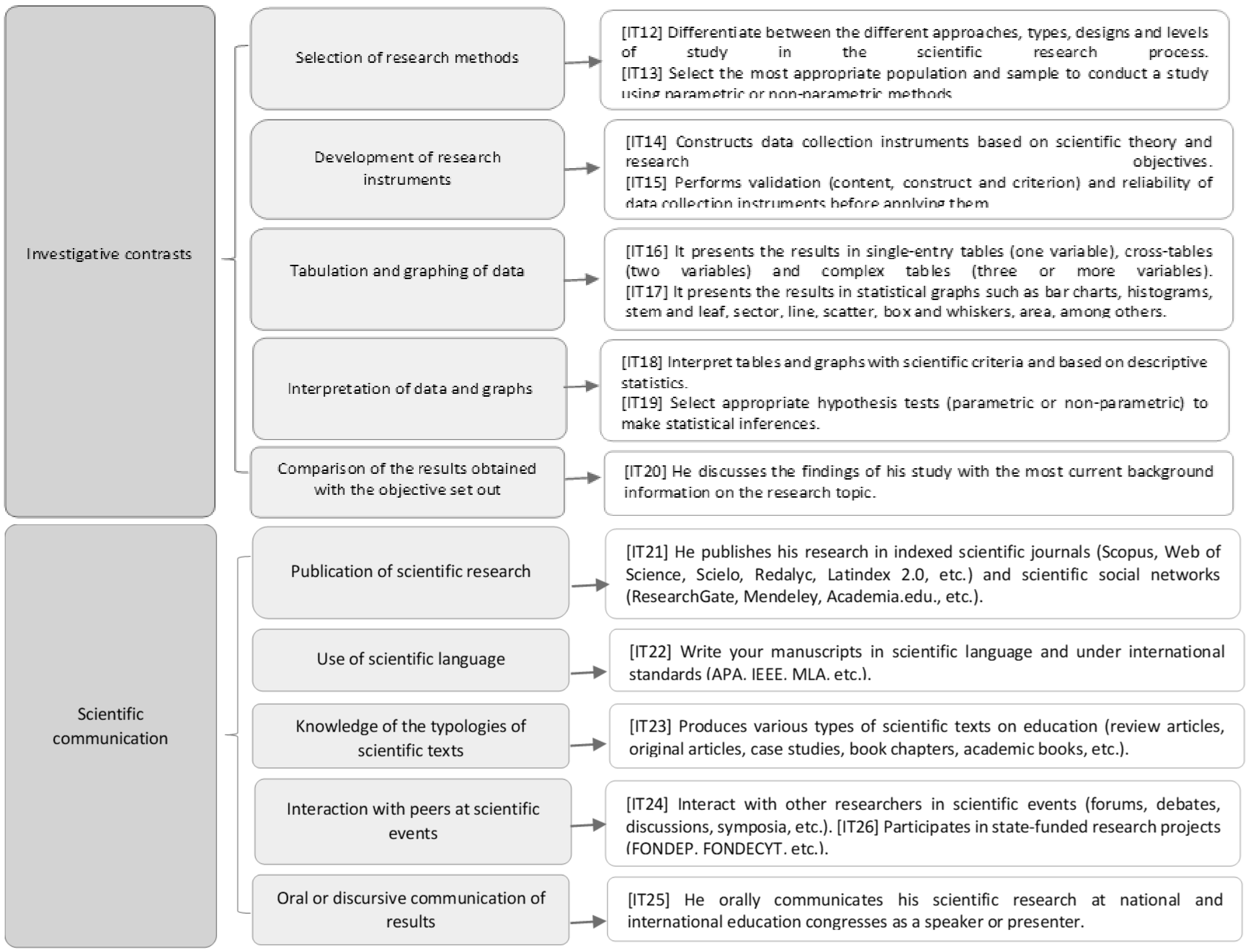


FIGURE 1. Proposed questionnaire of scientific-research skills in education (Q-SRSE)

2. DATA ANALYSIS

Firstly, in the content validity stage, the concordance between the 9 experts was verified with the Hernández-Nieto Content Validity Coefficient assuming an acceptable concordance > 0.7 [62]. Next, descriptive statistics such as mean, standard deviation, skewness and kurtosis (+/- 1.5), corrected homogeneity index (CHI > 0.3) and communalities (h2 > 0.4) were evaluated for each item [63, 64].

Secondly, exploratory factor analysis (EFA) was carried out in order to verify the empirical grouping behaviour of the items with the programme Factor Analysis 10.10.02 [65]. The assumptions of sample suitability for the analysis were checked with the KMO test (Kaiser Meyer Olkin) with an expected value higher than 0.5 and Bartlett's test with a score lower than 0.05 [61]. The polychoric relationship matrix was identified due to the ordinal nature of the items, given that they have Likert scales from 1 to 5 [66, 67], thus, Oblimin Direct oblique rotation was assumed due to the high relationships (r > 0.7) and the Robust diagonally weighted least squares (RDWLS) method, which is relevant for categorical data [68]. To determine the number of factors of the construct, three criteria were compared: (a) parallel analysis method, (b) Kaiser's rule with eigenvalues > 1 and (c) number of factors of the theoretical model [69, 70]. Explained variance with expected values above 60 % [71], root mean square error of approximation and goodness-of-fit index were assessed for the three models [72]. Then, the estimation of factor loadings and their confidence intervals was verified, which should be > 0.3 and gather at least 3 items [73, 74].

Third, the model was confirmed using the confirmatory factor analysis (CFA) technique. For this, the software R Studio 2024.04.1 was used with the Lavaan package [75] and semPlot [76] for categorical data. Therefore, the Weighted Least Squares Mean and Variance adjusted estimator (WLSMV) was used which is based on polychoric correlations and does not require meeting multivariate normality assumptions [68, 77]. The fit indices identified were Chi-square/degrees of freedom (X2/gl) with values that should range between 2 and 5, p-value < 0.05, comparative fit index (> 0.90), goodness-of-fit index (> 0.90), Tucker Lewis index (> 0.90) and root mean square error of approximation (< 0.08) and standardised root mean square residual (< 0.05) [78, 79]. Also, factor loadings were checked to ensure that they were relevant, i.e. greater than 0.7 [80].

Fourth, convergent validity was assessed with the average variance extracted (AVE) and a value higher than 0.7 was expected. In discriminant validity, the root of the AVE was assumed and was expected to be higher than the relationships between the factors [81]. Then, the internal consistency analysis of ordinal alpha (αordinal) and ordinal omega (ωordinal) was checked with expected values greater than > 0.7 [82].

Finally, a comparison was made between the scientific-research skills according to the socio-demographic variables. To compare the variable sex and management, the Mann Whitney U statistic was used for two independent samples (p < 0.05), while for the variables age, years of experience, level of education and academic training, the Kruskall Wallis H statistic was used (p < 0.05) due to the absence of normality of the data tested with the Anderson-Darling test. Furthermore, effect size was identified with Glass' biserial rank (rbis > 0.10 = small, > 0.30 = medium and > 0.50 = large) and the Epsilon coefficient ($\hat{\varepsilon}$ > 0.04 = minimum necessary, > 0.25 = moderate and > 64 = strong) [83, 84].

3. ETICAL ASPECTS

The study has considered the ethical aspects corresponding to the treatment of data and handling of information provided by the participants. Citations and references were used to maintain copyright and the corresponding permissions were obtained to carry out the research in the Tacna region with N° 551-2021/AGP-UGELT-DRET/GOB.REG.TACNA and in Moquegua with N° 1252-2021-GRM/DRE-MOQUEGUA/DGP. Permission was also requested from the principals of each educational institution who were provided with information about the study. Informed consent was also requested from the teachers participating in the research on the first page before filling out the form.

IV. RESULTS

1. CONTENT VALIDITY AND ITEM ANALYSIS

Table 2 shows the agreement among the 9 judges based on the sufficiency, clarity, coherence and relevance of the items; the values exceeded the expected in all cases (CVCtc > 0.95). That is, there is high agreement among the judges in affirming that the items represent the domain of the evaluated content [62]. As for the item analysis, a mean between 1.79 and 3.38 was obtained; with variation between ±1.00 and ±1.13, indicating a slight tendency towards low values. The skewness (g1) and kurtosis (g2) were positive with a tail to the right and leptokurtic with low values (< 1) [63]. Likewise, the corrected homogeneity index of (CHI > 0.3) and the communalities (h2 > 0.4) of all the items were adequate, indicating that there is a relevant relationship with the general scale, as well as a representativeness of the items in the initial factors [64]. Therefore, the items present the expected adequacy for analysis.

Table 2. Item descriptions and inter-judge concordance

Item	CVCtc	ME	SD	g1	g2	CHI	h2
IT1	1.00	3.38	1.03	-0.34	-0.42	0.74	0.75
IT2	0.99	3.17	1.05	-0.15	-0.52	0.78	0.84
IT3	0.99	3.26	1.04	-0.26	-0.43	0.79	0.85
IT4	1.00	3.20	1.06	-0.11	-0.63	0.77	0.83
IT5	0.98	3.04	1.10	0.08	-0.69	0.79	0.82
IT6	1.00	2.90	1.10	0.04	-0.72	0.84	0.79
IT7	0.99	3.11	1.09	-0.14	-0.66	0.85	0.82
IT8	1.00	3.04	1.10	-0.09	-0.71	0.88	0.86
IT9	0.98	2.95	1.07	-0.03	-0.64	0.90	0.87
IT10	1.00	2.95	1.11	0.02	-0.73	0.87	0.81

IT11	0.98	2.70	1.12	0.20	-0.80	0.85	0.76
IT12	1.00	2.83	1.06	-0.11	-0.71	0.87	0.80
IT13	1.00	2.69	1.08	0.09	-0.78	0.89	0.85
IT14	1.00	2.69	1.11	0.04	-0.89	0.88	0.90
IT15	1.00	2.67	1.12	0.07	-0.86	0.89	0.88
IT16	1.00	2.60	1.10	0.08	-0.91	0.90	0.89
IT17	1.00	2.59	1.12	0.19	-0.82	0.86	0.87
IT18	0.98	2.72	1.13	0.09	-0.79	0.86	0.85
IT19	1.00	2.54	1.08	0.18	-0.77	0.89	0.88
IT20	1.00	2.55	1.10	0.19	-0.82	0.89	0.86
IT21	0.98	1.85	0.97	0.94	0.16	0.69	0.80
IT22	0.99	2.01	1.04	0.70	-0.45	0.78	0.80
IT23	1.00	1.92	1.00	0.85	-0.05	0.74	0.84
IT24	1.00	2.02	1.06	0.78	-0.22	0.74	0.82
IT25	0.99	1.88	1.05	1.01	0.15	0.73	0.84
IT26	0.99	1.79	1.00	1.08	0.29	0.66	0.72

Note. g1: skewness, g2: kurtosis, CHI: corrected homogeneity index, h2: communalities, CVCtc: coefficient of total content validity

2. CONSTRUCT VALIDITY: EXPLORATORY FACTOR ANALYSIS

Table 3 shows that the prior assumptions of Bartlett's < 0.05 and KMO > 0.5 present adequate scores, i.e., the item-sample correlations are relevant for conducting a factor analysis [61]. Initially, we checked the fit indices of models 1, 2 and 3, which explained more than 60% of the variance of the construct [71]; that is, in all models, the factors capture a significant portion of the variability of the data. In the indices, the RMSEA was only relevant in model 3 (RMSEA ≤ 0.08), in the SRMR (≤ 0.05) and GFI (> 0.90) all three were adequate. Only in the TLI, the model with 2 and 3 had adequate scores (> 0.90). In contrast, in the BIC, greater parsimony is evident in model 2 [72]. However, the rotation in the EFA was carried out on the basis of the third model (4 factors), which is based on the initial theory, because it has better fits than the other two models.

Table 3. Preliminary assumptions and EFA indices according to extraction models

Models	Factors	σexplained	RMSEA	IC 90%	RMSR	GFI	TLI	BIC
Model 1	2	0.770	0.134	0.129-0.140	0.046	0.960	0.838	439
Model 2	3	0.808	0.097	0.092-0.104	0.028	0.975	0.914	362
Model 3	4	0.908	0.075	0.069-0.082	0.022	0.981	0.948	643
Bartlett's statistic			4046.8 (df = 325; p = 0.000010)					
KMO				KMO = 0.978				

Note. Model 1: with KMO criteria, Model 2: with parallel analysis, Model 3: based on initial theory

Table 4 presents the results of the rotation of model 3 (with 4 factors). Items 8, 9, 10 and 11 were grouped in F1 with factor loadings higher than the minimum expected value ($\lambda > 0.3$), however, they were also grouped in F2 with better scores ($\lambda > 0.4$) and based on the analysis of the substantive theory and statistical criteria were linked to the latter [73, 74]. The same happened with item 7, which presented adequate scores in F2 and F3, but with a higher value in F3. In this sense, it can be concluded that the model actually has only 3 factors, so the items were rotated again assuming the three-dimensional grouping.

Table 4. Exploratory factor analysis with the four-factor model

Items	λF1	λF2	λF3	λF4	λIC95 %
IT1			0.946		(0.832 - 1.107)
IT2			0.882		(0.463 - 0.964)
IT3			0.932		(0.869 - 1.014)
IT4			0.958		(0.909 - 1.076)
IT5			0.710		(0.409 - 0.846)
IT6			0.389		(0.223 - 0.499)
IT7		0.341	0.372		(0.223 - 0.518)

IT8	0.309	0.497			(0.259 - 0.644)
IT9	0.313	0.448			(0.230 - 0.546)
IT10	0.316	0.457			(0.303 - 0.591)
IT11	0.307	0.445			(0.248 - 0.579)
IT12		0.721			(0.419 - 0.859)
IT13		0.843			(0.615 - 0.972)
IT14		0.982			(0.901 - 1.049)
IT15		0.925			(0.810 - 1.004)
IT16		0.908			(0.836 - 1.058)
IT17		0.956			(0.883 - 1.030)
IT18		0.932			(0.790 - 1.009)
IT19		0.907			(0.844 - 0.998)
IT20		0.850			(0.579 - 0.942)
IT21				0.954	(0.824 - 1.079)
IT22				0.691	(0.514 - 0.830)
IT23				0.897	(0.774 - 0.992)
IT24				0.845	(0.477 - 0.944)
IT25				0.937	(0.825 - 1.066)
IT26				0.794	(0.502 - 0.925)

Rotation was then performed assuming 3 factors. The findings indicate that the factor loadings are adequate ($\lambda > 0.3$). However, item 11 obtained confidence intervals below the expected value ($\lambda = 0.421$; λ IC 95% = 0.212 - 0.598), therefore, this item was removed and the rotation was performed again under the name 'Emergent Model'. Table 5 presents the results of this final rotation with 25 items. The final grouping of the items indicates that F1 is composed of 9 items (12, 13, 14, 15, 15, 16, 17, 18, 19 and 20) and is named as "Problematising and Theorising Research" (PTI). F2 is composed of 10 items (1, 2, 3, 4, 5, 6, 7, 8, 9 and 10) and is assigned the name "Contrastive Inquiry" (CIN). Finally, F3 was composed of 6 items (21, 22, 23, 24, 25 and 26) and is nominalised as "Scientific communication" (SCC). Moreover, the values of orion and αordinal exceed the value of 0.7, so the model presents adequate evidence.

Table 5. Model with 3 factors without item 11

Items	λPTI	λCIN	λCCI	λIC95%
IT1		0.838		(0.698 - 0.992)
IT2		0.902		(0.434 - 0.985)
IT3		0.905		(0.705 - 1.025)
IT4		0.895		(0.473 - 1.013)
IT5		0.838		(0.455 - 0.972)
IT6		0.677		(0.555 - 0.792)
IT7		0.678		(0.600 - 0.796)
IT8		0.606		(0.526 - 0.740)
IT9		0.578		(0.522 - 0.673)
IT10		0.509		(0.404 - 0.624)
IT12	0.688			(0.502 - 0.824)
IT13	0.811			(0.713 - 0.917)
IT14	0.939			(0.918 - 0.988)
IT15	0.884			(0.838 - 0.941)
IT16	0.870			(0.842 - 0.928)
IT17	0.917			(0.881 - 1.019)
IT18	0.895			(0.848 - 0.986)
IT19	0.873			(0.843 - 0.948)
IT20	0.822			(0.754 - 0.891)
IT21			0.946	(0.832 - 1.052)
IT22			0.704	(0.534 - 0.825)
IT23			0.882	(0.788 - 0.985)

IT24			0.849	(0.681 - 0.949)
IT25			0.912	(0.807 - 1.041)
IT26			0.784	(0.544 - 0.899)
Variance	8.955	7.033	5.200	
Orion	0.986	0.972	0.967	
αordinal	0.993	0.986	0.983	
Model emergent*	σexplicada = 0.811, RMSEA = 0.095, RMSEA IC 90% = 0.089-0.102, SRMR = 0.027, GFI = 0.974			

Note. PTI: problematización y teorización investigativa/problematization and investigative theorization, CIN: contrastación investigativa/investigative contrastation, CCI: comunicación científica/scientific communication, *AFE without item 11 and with 3 factors

3. CONSTRUCT VALIDITY: CONFIRMATORY FACTOR ANALYSIS

In Figure 2, the results of the confirmatory factor analysis reaffirm the 3-factor model. The factor loadings on each latent variable are relevant ($\lambda > 0.7$) [80]. In the CCI they range between 0.82 and 0.95, in PTI between 0.86 and 0.98, while in CIN between 0.93 and 0.97. Likewise, the fit indices express relevant scores at X2/df < 5, p < 0.05, SRMR < 0.05, CFI and TLI > 0.95 [78, 79]. Only the root means square error of approximation presented a value above the established threshold (RMSEA > 0.8), but in general the indices are relevant. In conclusion, the scientific-research skills questionnaire fluctuates adequately with the emerging model of 25 items distributed in 3 factors.

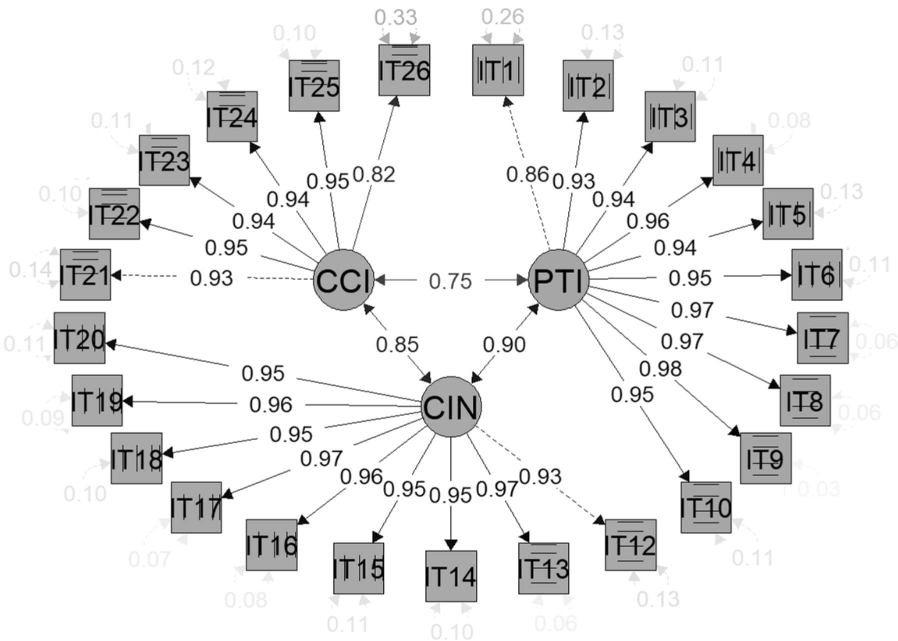


FIGURE 2. Factor loadings of the Q-SRSE-25 model

Note. 1) X2/df = 4.648, p < 0.001, SRMR = 0.036, RMSEA = 0.099 (IC95% = 0.094-0.105), CFI = 0.99, GFI = 0.99, TLI = 0.99; 2) PTI: problematización y teorización investigativa/ problematization and research theorization, CIN: contrastación investigativa/ research contrastation, CCI: comunicación científica/ scientific communication

4. CONVERGENT, DISCRIMINANT VALIDITY AND RELIABILITY

The convergent validity findings indicate an appropriate score above the expected value (AVE > 0.5) on each construct (PTI, CIN and CCI). In discriminant validity, the scores were also above the ratios ($\sqrt{AVE} > r$) [81], indicating that each factor has a distinct identity from the other (Table 6). In the case of the internal consistency indices, the values found in the αordinal and ωordinal show scores that exceed 0.7, therefore, it is possible to affirm that there is adequate reliability in each construct [82].

Table 6. Convergent, discriminant and internal consistency validity

Factors	PTI	CIN	CCI	AVE	√AVE	αordinal	ωordinal
PTI	0.946			0.894	0.946	0.99	0.99
CIN	0.90	0.954		0.911	0.954	0.97	0.98
CCI	0.75	0.85	0.923	0.852	0.923	0.95	0.96

Note. AVE: average variance extracted, √AVE: discriminant validity

5. COMPARISON OF TEACHERS' SCIENTIFIC-RESEARCH SKILLS ACCORDING TO SOCIO-DEMOGRAPHIC DATA

The comparison of the results based on the socio-demographic variables shows that there is no difference between the PTI, CIN and CCI skills of the teachers according to gender, age or years of experience ($p > 0.05$). However, according to the type of management, there is a higher score in PTI skills in the private sector than in the public sector, but with a small difference ($p < 0.05$; rbis > 0.10), while no such differences were found in CIN and CCI. As for the levels of education and academic training, there are significant and moderate differences in PTI ($p = 0.05$; $\hat{\varepsilon} > 0.25$), CIN ($p < 0.05$; $\hat{\varepsilon} > 0.25$) and CCI ($p < 0.05$; $\hat{\varepsilon} > 0.25$) [83], only in the difference of CCI according to the levels of education the difference was small ($\hat{\varepsilon} > 0.04$). The best scores were obtained by teachers at secondary level, followed by pre-primary and primary. In terms of academic training, teachers with doctorates had the highest scores, followed by those with master's degrees, bachelor's degrees, bachelor's degrees and teaching degrees.

Table 7. Comparative scientific-research skills of teachers according to variables

Variable	PTI ME(SD)	PTI Z/H (p)	PTI rbis/ε̂	CIN ME(SD)	CIN Z/H (p)	CIN rbis/ε̂	CCI ME(SD)	CCI Z/H (p)	CCI rbis/ε̂
Sex									
Female	29.90(9.68)	-1.062	0.039	22.81(9.03)	-1.114	0.041	11.02(5.27)	-1.775	0.065
Male	30.51(10.91)	(0.288)		23.85(9.79)	(0.265)		11.81(5.58)	(0.076)	
Management									
Private	32.82(9.68)	-4.080	0.150	24.27(8.66)	-1.895	0.069	11.26(5.20)	-0.034	0.000
Public	29.21(9.98)	(0.000)		22.73(9.39)	(0.058)		11.22(5.41)	(0.973)	
Age									
21-30	29.89(8.86)			22.42(8.29)			10.77(4.83)		
31-40	31.16(10.61)	6.680		24.26(9.40)	7.709		11.87(5.77)	8.273	
41-50	29.29(9.61)	(0.154)	0.009	22.16(8.88)	(0.103)	0.010	10.79(5.17)	(0.082)	0.011
51-60	30.62(9.86)			23.75(9.41)			11.59(5.34)		
61-70	27.45(13.30)			21.65(11.39)			10.10(5.86)		
Experience									
1-5	31.27(9.06)			24.03(8.75)			11.59(5.24)		
6-10	31.36(8.39)			24.51(8.25)			11.99(5.48)		
11-15	30.16(9.40)	7.021		23.45(9.23)	7.015		11.74(5.63)	12.253	
16-20	28.83(10.58)	(0.312)	0.010	22.28(8.92)	(0.319)	0.010	10.48(4.63)	(0.057)	0.017
21-25	28.83(10.72)			21.79(9.14)			10.25(5.16)		
26-30	30.03(10.40)			22.80(9.87)			11.40(5.36)		
31 or +	30.75(10.74)			23.55(10.11)			11.55(5.81)		
Level									
Pre-school	29.12(9.13)	24.458		22.28(8.72)	25.156		10.77(5.34)	17.838	
Elementary	28.35(10.78)	(0.000)	0.033	21.43(9.30)	(0.000)	0.034	10.45(4.96)	(0.000)	0.024
Secondary	32.21(9.30)			25.13(9.08)			12.22(5.59)		
Academic training									
Pedagogical	28.04(9.70)	34.751	0.047	21.61(9.02)	29.293	0.040	10.45(5.04)	22.411	0.030
Baccalaureate	29.36(9.29)	(0.000)		22.00(8.64)	(0.000)		10.86(4.89)	(0.000)	

Bachelor's degree	31.48(9.08)	23.75(8.22)	11.43(5.12)
Master's degree	32.94(11.42)	25.95(10.56)	12.82(6.09)
Doctor's degree	42.83(8.26)	36.67(9.22)	19.67(7.09)

Note. Z/H = Z for Mann Whitney U tests and H for Kruskall Wallis; effect size rs = biserial rank (for two groups) and $\hat{\varepsilon}$ = Epsilon (for more than two groups).

V. DISCUSSION

The development of scientific-research skills of basic education teachers is an increasingly relevant need for the continuous improvement of their professional practice. Therefore, it is necessary to have tools that identify these skills. Therefore, this study aimed to design and validate a Questionnaire of Scientific-Research Skills (C-HCIE-25) in Education, as well as to compare these skills according to the sociodemographic data of basic education teachers. In this sense, after an exhaustive review of the literature, the study was designed with four factors, which finally culminated in three: Problematisation and investigative theorisation, Investigative contrastation and Scientific communication. The instrument was subjected to expert validity, item analysis, construct validity and reliability, demonstrating relevant scores with a solid theoretical underpinning.

The final instrument is made up of 25 items divided into 3 dimensions supported by a theoretical framework based on research processes in the educational field: the first factor "Problematisation and investigative theorization" (PTI) refers to the observation, description and comparison of the educational reality with what is proposed by theory, as well as the appropriate handling of the bibliography to assume theoretical positions [39]; in such a way that the teacher can identify the contradictions or problems that represent the gaps in knowledge [32]. Thus, he or she sets objectives, justifies the research or carries out pedagogical modelling with up-to-date information based on scientific articles that support and direct the research projects [5, 31, 50]. The second factor "Investigative contrast" (CIN) consists of the permanent verification of the processes and findings of educational proposals that address specific problems [39]. This skill articulates theory and practice in a systematic way, through the methodological domain [41, 50] such as the elaboration of instruments, presentation of tables and figures of qualitative or quantitative research results that allow verifying whether the findings are in line with the stated objectives. The third factor 'Scientific communication' (CCI) refers to the publications and scientific dissemination of the research carried out by the teaching staff in academic events or journals [50]. Disseminating research is a practice usually carried out by undergraduate and postgraduate professionals [57].

Some similar research also explored the phenomenon in university students up to the content [24, 85] and construct validity stages [27-29] or focused on university teaching in health [30, 32] or library science [33]. These studies had significant contributions in the multidisciplinary framework, however, the C-HCIE-25 provides a relevant contribution in the framework of research on basic education teachers, dedicated to the training of infants, primary and secondary education. The closest contributions addressed the constructs in value-oriented factors, competence and research implication [5], in other cases, they focused on the impact of research on teaching practice through factors such as diagnosis, improvement actions and opportunities at the perceptual level [36, 37]. The C-HCIE-25 opens a scenario oriented to assess the scientific-research skills of school teachers considering an approach focused on the experience acquired in the different stages of research, from problematisation to the communication of results.

The second objective of the study was to compare the scientific-research skills (theorising, contrasting and communication) of the teachers considering the criteria of socio-demographic data. Differences were found according to the degree of training and level of education at which they teach. The first finding is consistent with the literature [5, 41], which stresses the importance not only of training in academic degrees, but also of self-training and continuous training. In this sense, the university stage plays an indispensable role in training professionals who associate their pedagogical practice with research actions [13, 14, 23, 42]. A solid training in scientific-research skills can have an impact on the ability to identify educational problems [19] that can be addressed with critical and reflective thinking [15] to propose more efficient and up-to-date methodological strategies for the benefit of education [18, 20]. Regarding the second finding, there is little literature showing that secondary school teachers have developed a favourable advantage in scientific-research skills compared to pre-school or primary school teachers. However, these differences seem to be associated with the distribution of time and roles of teachers in Peruvian education [86]. The functions of pre-school and primary school teachers are focused on comprehensive learning that encompasses personalised pedagogical work, with a greater allocation of time to the development of educational materials from various disciplines in order to establish the educational foundations of the learner. At secondary level, teachers, on the contrary, are focused on promoting written or oral argumentation, critical thinking, statistics, science and the scientific method: essential aspects for research [87]. Therefore, they are in need of solid training to turn the classroom into a scenario in which they encourage their students to investigate [22].

In addition, the type of management (private or public) only showed relevant differences in the problematisation and research theorisation, with the private sector being more highly valued. Private management invests in continuous training for its teachers with the aim of strengthening their skills [23] and adopting an educational perception of the private institution. These trainings are generally aimed at strengthening pedagogical strategies, but they also keep teachers up to date with new educational trends, which allow them to differentiate between theory and practice and to identify educational problems, as well as to offer them a greater number of methodological alternatives that allow for the solution of learning problems. In the public sector, less attention is paid to training; most teachers are more focused on meeting the evaluation criteria of the teacher promotion scale than on other aspects such as research training or updating pedagogical knowledge [1].

Peru's National Education Project 2036, in its tenth strategic orientation, emphasises that the education system should promote enquiry and scientific thinking to strengthen research [88]. In this sense, educational management has the task of strengthening research strategies and promoting enquiry activities in schools through pedagogical projects. In the teacher evaluation framework, performance 32 of the Good Teaching Performance Framework states that basic education teachers must develop research and pedagogical innovation projects to improve the quality of service [89]. However, the performance evaluations of teachers during the school cycle do not seem to consider participation in educational projects as mandatory. Consequently, there is no instrument to assess the scientific-research skills of teachers at the national level.

As for the contributions of this article, it comprises a series of theoretical, methodological and practical implications within the framework of scientific-research research.

On the one hand, the theoretical implications of our study favour the theoretical increase of scientific-research skills in basic education teachers [50]. The presence of three factors expresses a new construct for its evaluation (problematisation and theorisation, research contrastation and scientific communication) in a little-studied scenario such as the education career. The role of teachers in the classroom is associated with research processes [7]. Problematisation and theorisation are concerned with the teacher's ability to identify real situations and compare them with existing theory. Teachers will have developed this skill only if they have up-to-date literature and close observation of their students' learning during classes [39]. The research contrast is focused on the methodological mastery of teachers to determine whether they achieved the objectives proposed in their projects [41]. This exercise is linked to the evaluative function exercised by teachers in their classrooms. Scientific communication stems from the socialisation of their successful experiences with other teachers, a common practice within institutions. However, teachers are also required to participate in academic events, where the scope of their proposals is national and international.

Methodologically, the C-HCIE-25 enables the development of future studies with a quantitative design aimed at describing, relating or explaining the scientific-research skills variable with others of educational interest within the framework of teacher training. Furthermore, its construction makes it possible to carry out other psychometric, adaptation or validation studies in contexts with realities different from the Peruvian scenario. The instrument is not an immovable construct; it is still under continuous debate and discussion with further research.

On a practical level, our study provides a tool that favours the diagnosis of teachers' skills in different basic education institutions, which can be used by managers or education administration authorities. Based on this, new alternative solutions could be proposed through practical workshops for the continuous improvement of the three skills (problematisation and theorisation, contrasting and communication). Establishing strategic alliances between regional education directorates or local education management units with universities, graduate schools and continuing education institutions through scholarships would promote further research training. Likewise, proposing collaborative research strategies in schools between secondary, pre-school and primary school teachers strengthens the development and implementation of pedagogical projects.

It is also important that the educational innovation competitions organised by the Ministry of Education through FONDEP [90] be made more extensive and with greater impact on their participation as part of teachers' duties. This would increase the number of teachers committed to overcoming problems in their educational institutions. Research, innovation and education are three essential pillars for change in 21st century society.

VI. CONCLUSION

Although the research presents favourable conditions in terms of its application, it is not without limitations. Firstly, the study was carried out with a sample from two regions in southern Peru characterised by high scores in educational competitiveness; however, it is desirable to carry out studies in central and northern regions where educational conditions are different, as well as in other countries. Comparisons between basic education teachers have been verified according to socio-demographic variables such as gender, type of management, teaching level, age range, years of experience and training, but it would have been convenient to investigate the factorial invariance of the instrument, as well as to consider other variables for comparison. The sample selection was by convenience, due to the conditions of disclosure of the questionnaire and voluntariness of the participants, so the findings should be taken with caution.

Future studies should consider the identified limitations. First, it is suggested to carry out studies on teachers from different regions and countries in order to carry out adaptations or psychometric studies that allow the evaluation of the internal structure. Second, it is important to consider probability sampling techniques that provide a guarantee of population representativeness. Third, it is pertinent to carry out studies that evaluate the factorial invariance of the 3-factor model considering the variables studied or other variables such as employment status, socioeconomic status or type of vocational training institution. Fourth, the study presented was cross-sectional, so it is advisable to carry out longitudinal studies that analyse the behaviour of the skills over time with or without interventions and that can establish scales in line with the educational reality.

To conclude, the questionnaire of scientific research skills of basic education teachers is composed of three factors: (F1) research problematization and theorization (PTI), (F2) research contrastation (CIN) and (F3) scientific communication (CCI). The instrument has adequate evidence of content, construct, convergent and discriminant validity, as well as adequate reliability indices, so it can be used for research purposes. The study shows that teachers with better academic backgrounds, i.e. higher academic degrees and those who teach at higher levels (e.g. secondary education), have better developed scientific research skills. Also, teachers working in the private sector are better able to detect problems in the educational setting compared to those working in the public sector. However, it is still a challenge to continue deepening this line of research in order to obtain more empirical evidence to enable positive change in schools.

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Author contribution

Gilber Chura-Quispe: Project development, data collection, statistical analysis, drafting and final revision, Bianca Daisa Laura-De-La-Cruz: Information gathering, methodology, writing, layout and final revision, Patricia Rosa María Nué Caballero: Data collection, methodology, drafting and final revision, Edith Cristina Salamanca Chura: Methodology, drafting and final review, Héctor Octavio Guido Torres Orihuela: Methodology, drafting and final review.

Conflict of interest

The authors declare no conflict of interest.

Data Availability Statement

Data are available from the authors upon request.

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