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Effect of research culture on university scientific output: evidence from a structural model in southern Peru

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The objective of the study was to analyze the predictive relationship between research culture and scientific output at the National University of Moquegua (UNAM), Peru, during the year 2023. The research is basic in nature, with a quantitative approach, explanatory level, and non-experimental design. The survey technique was applied to a stratified sample of 151 employees, consisting of 60 teachers and 91 recent students. Structural equation models (SEM) with the MLR estimator were used for data analysis. The structural model for the teaching stratum presented optimal fit indices (X^2/gl = 0.005; CFI = 1.000; SRMR = 0.002), indicating that research culture significantly predicts scientific output (β = 0.734, p = 0.013), explaining 53.9% of its variance (R^2 = 0.539). In the student stratum, robust fit indices were obtained (X^2/gl = 1.81; CFI = 0.996; SRMR = 0.014), where research culture emerged as a critical predictor (β = 0.983, p = 0.001) explaining 96.6% of the variance (R^2 = 0.966). It is concluded that a highly developed research culture is substantially associated with high levels of scientific production. In other words, the greater the research culture, the greater the scientific production, indicating that it is essential to strengthen research groups and seedbeds in order to raise the scientific standing of the university.

KEYWORDS
Peru, research culture, scientific production, scientific research, university community

1 Introduction

University professors and students acquire research training, closely linked to the creation of academic and scientific work, the ability to conduct research, and the promotion of research culture. This is because universities are global institutions that create re-search, and that is the reason for their existence (Khosrowjerdi and Bornmann, 2021; Agudelo, 2004; Álvarez et al., 2020).

The research culture promotion program exerts a positive influence, contributing to the strengthening of research competencies in teachers (Yangali Vicente et al., 2020). Producing forward-looking scientific knowledge is crucial both for the expansion of human under-standing and for the preservation of sustainable societies in the modern period. According to UNESCO (2021), the three main ways in which new information is generated and disseminated are through research, scholarly publications, and academic associations. In addition to promoting technological advancement and innovation, research and scientific advancement help societal efforts around the world to achieve the Sustainable Development Goals (UNESCO, 2019).

Scientific and technological progress is incomplete without production, which in turn drives national knowledge and innovation. The term refers to the steps taken to generate fresh data for use in studies and publications within the academic and scientific communities. The advancement of society and the economy is greatly benefited by scientific production, but it also has a major influence on the formulation and sustainability of policy (CONCYTEC, 2021).

Local scientific production in Peru has shown steady growth across multiple fields over the past 5 years (CONCYTEC, 2021). However, significant obstacles remain to achieving higher quality production, institutional coordination, and resource equity (Sotomayor, 2018). It is also essential to understand that skills and attitudes are essential components that students must develop to foster the generation of ideas, reflections, and diverse options in the research field (Díaz Espinoza and Cardoza Sernaqué, 2021).

There has been a notable increase in the publication of all types of articles, including scientific articles and reviews, according to journals included in indexed storage systems such as Scopus, Web of Science, Scielo, Latindex, and Redalic. Scopus (2021) and Web of Science Group (2021) state that academic institutions are the main sources of the generation of new scientific knowledge. As stated by Millones et al. (2021) and Kuh and Whitt (1988) cite what they call the norms, practices, and beliefs that sup-port and promote research as a whole as "research culture." This has social implications as it changes the type and quantity of research. Institutional practices have a significant impact on the dissemination of knowledge and scientific and artistic creations, according to recent studies (Brew, 2001; Gonzáles, 2018).

One possible reason for the scarcity of academic articles is that many educators and students simply lack the necessary research skills, cultural background, or training. Academic research and its contents are not exhibited or published in peer-reviewed journals. Improving scientific production and culture among educators and students is crucial for launching a career as a researcher and integrating into the field of study. Finally, in light of the aforementioned problems, it is pertinent to conduct this research, the purpose of which was to determine the relationship between research culture and scientific production at UNAM in 2023.

A research culture actively seeks and contributes to the creation of new information to address community concerns. University degree programs and the education system as a whole are impacted by research and the practice of doing that develops in higher education institutions (Gonzáles, 2018). López et al. (2006) argue that when it comes to research, research development, or teaching, there is a certain culture that permeates everything from organizations to beliefs, attitudes, processes, and techniques. Navas et al. (2016) detailed that higher education institutions have a research culture that has been prevalent lately, the treatment given to this culture has had great popularity, much has been discussed regarding its relevance in the circumstances and the requirement to generate a research culture, so the corresponding research of the teacher and the university entity cannot be unlinked because nothing is detailed according to any field of knowledge without a scientific basis or research work.

The research culture encompasses fundamental values, beliefs and concepts shared by individuals such as teachers, coordinators and authorities, which establish a distinctive way of conducting research in a specific context (Martins, 2005), on the other hand (Vargas, 2005) defines research culture as a way of perceiving, understanding, and valuing science and knowledge. Its mission is to transform the academic system and university teaching, starting from a critical and reflective approach to knowledge. According to Mendivel (2020), research culture entails the acquisition and application of research skills such as reading, writing, critical thinking, teamwork, and communication, among others, which are superficially addressed at the university level (Camayo, 2021). Research culture is linked to the production of scientific and academic research by higher education teachers and students. They must have research training, research skills, and promote and participate in activities aimed at strengthening the research culture (Khosrowjerdi and Bornmann, 2021). Olvido (2020) indicates that research culture is conceived as an investment, a process, and a regulation, given that it is based on evidence, is dynamic, and differs from the structure of the academic institution (Criado, 2020).

Regarding scientific production, we can indicate that if the results of the study are not published, they do not constitute scientific production; instead, they are merely biblio-graphical production. Scientific work, which is more than a simple repository of records, is the concrete component of knowledge development. Furthermore, it aims to take into account the author's complete corpus of academic and scientific publications (Martelo et al., 2018; Barrutia et al., 2019). Castro-Rodríguez (2017) examined the elements that impact the creative production of UNMSM students. Personal and academic circumstances, in my opinion, explain most of these characteristics. As part of a permanent commitment to learning, the author promotes his or her work through study. Both processes are ongoing and pro-vide writers with official avenues for disseminating information, particularly for having scholarly articles appear in journal indexes. University students in most fields do not typically conduct substantial independent research (Arellano, 2017; Bracho, 2012).

At the regional level, the production of scientific work by university students is quite limited. This assertion is supported by Castro-Rodríguez (2017), who presented a comprehensive collection of statistical data. He also states: "According to the student, the information provided to them about the publication of the study is insufficient, and when they receive it, it is unsatisfactory." In Colombia, the percentage is 11%, while in Chile it is 10%, and the same is true in Peru. Through the editing of scientific publications and participation in seminars and scientific activities, instructors should appreciate and recognize the scientific creation produced at the student level. Likewise, it is detailed as the conglomeration of knowledge through which it is manifested through scientific research in a specific specialty (Castro-Rodríguez, 2017; Barja et al., 2020).

The value of undergraduate research by emphasizing the claim that various academic publications, such as these, essays, study guides, journals and monographs, constitute students' scientific productivity. For the vast majority of academic institutions, the thesis serves as an introduction to the scientific process for novice researchers. University students should be the driving force behind innovation in research, especially in scientific creation. Universities should promote continuous research and publication of scientific publications that improve the level of scientific production of both students and faculty (Castro-Rodríguez, 2017). Therefore, Castro-Rodríguez's (2017) statement that monographs, articles, theses, study teams, the generation of scientific journals at the student level and the emphasis on the (degree) thesis are the student's first approaches to scientific research is valid and accurate because this approach is crucial to instill in the student an affection for research, in a continuous and fruitful way (Batallas and

Garzozi, 2021; Montoya, 2021). Providing students with technological skills is beneficial for their academic and professional growth, based on the strengthening of their research capacities (Kino-Saravia et al., 2023).

Universities have a vital impact on research and the advancement of knowledge in all fields. There are 143 universities in Peru, 51 of which are public and 92 are private, according to CONCYTEC (2021). Peruvian universities, especially those in the social sciences, lack a strong research culture, in part because professors in these fields do not conduct enough innovative studies. In contrast, academic researchers at the PUCP, UNMSM, and UNP have generated significantly more scientific and technological output over the past 3 years. An article written by Universidad Peruana Cayetano Heredia (2021) by the UPC Academic Repository.

For the fourth consecutive year, the National University of Moquegua stands out in scientific production, ranking nineteenth among ninety-six licensed universities in Peru in the 2023 Bieetech Ranking. The ranking takes a fair count of publications per thousand students as a measure of scientific production, with the objective of recognizing and rewarding outstanding academic programs regardless of their size (UNAM, 2024).

The study was conducted in compliance with ethical principles for research, with authorization from the authorities of the National University of Moquegua. Prior to data collection, informed consent was obtained from each teacher and student, who were duly informed about the voluntary nature of the study, ensuring anonymity and confidentiality.

Therefore, the following general question is formulated: What relationship exists be-tween the research culture and scientific production of the National University of Moquegua, 2023? And the specific questions, What relationship exists between institutional responsibility with research and scientific production? And What relationship exists between responsibility with research activity and scientific production? The general hypothesis of the research: There is a direct relationship between re-search culture and scientific production of the National University of Moquegua, 2023, HE1 there is a direct relationship between institutional responsibility with research and scientific production, HE2, There is a direct relationship between responsibility with re-search activity and scientific production.

2 Method

The research was basic in nature, with a quantitative approach at the explanatory level and a non-experimental cross-sectional design, as described by Hernández-Sampieri et al. (2014) and Arias et al. (2022), they state that this type of studies aims to identify the causes of events and phenomena, whether of a physical or social nature, with the purpose of explaining why a phenomenon occurs, questionnaires were used for data collection, whose analysis made it possible to achieve the expected results.

The analysis unit included 245 participants, including teachers and students from the 9th and 10th cycles of studies at the National University of Moquegua. The two validated instruments were applied to a sample of 60 teachers and 91 students, for a total of 151 respondents.

The minimum sample size was determined *a priori* using Soper's (2023) calculator, considering an effect size of 0.30, a power of 0.80, and a confidence level of 0.95 for the constructs evaluated. The analysis indicated that the sample size achieved ($n = 151$) exceeds the minimum requirement to ensure the validity of the estimates. The analysis indicates that the minimum sample size requirement is met. Furthermore, considering the model, priority was given to the use of the robust maximum likelihood (MLR) estimate to ensure the validity of the fit indices.

A stratified probability sampling method was applied based on official University records. In Table 1 the study achieved a response rate of 61.2% among active faculty ($n = 60$) and 61.9% among senior students ($n = 91$). A wave analysis (comparison of means) confirmed the absence of non-response bias ($p > 0.05$), thereby ensuring the representativeness of the sample and the external validity of the results.

The data were organized and processed using SPSS and Jamovi 2.3.28 statistical software. A multiple linear regression analysis was performed to evaluate the predictive capacity of the dimensions of research culture in scientific production, and a structural equation model was used, considering the X^2/gl, CFI, TLI, RMSEA, and SRMR fit indices.

2.1 Goodness-of-fit indices

Table 2 presents the primary criteria used to evaluate the goodness-of-fit for the explanatory structural equation models. Each index has an established threshold that serves as a benchmark for interpretation. The X^2/gl (CMIN/DF) ratio should be less than 3.0 to indicate an optimal fit, as low values suggest minimal discrepancies between the theoretical model and the empirical data. Similarly, the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) should exceed 0.90 to demonstrate a satisfactory fit. Regarding error indices, both the Standardized Root Mean Square Residual (SRMR) and the Root Mean Square Error of Approximation (RMSEA) should ideally remain below 0.08, although values up to 0.09 are considered acceptable in exploratory contexts. These indices collectively ensure the statistical validity and reliability of the model structure.

TABLE 1 Detailed sampling process.

Phase	Description	Teachers	Students
Target population (*N*)	Total active members in selected departments	98	147
Initial contact	invitations sent via institutional email	98	147
Gross response	Total surveys received	65	103
Exclusion criteria	Incomplete data or straight-lining patterns	5	12
Final sample (*n*)	Valid cases used for SEM analysis	60	91
Response rate	(Final sample/Invitations) × 100	61.2%	61.9%

TABLE 2 Fit index criterion for the explanatory model.

Statistic	Indices	Range or values	Interpretation
Chi-square ratio/degrees of freedom	X^2/gl	<3.0	Optimal
Comparative goodness-of-fit index	CFI	>0.90	Optimal
Tucker–Lewis's index	TLI	>0.90	Optimal
Root means square residual	SRMR	<0.09	Acceptable
Root means square residual approximation	RMSEA	<0.09	Acceptable

TABLE 3 Confirmatory factor analysis of the investigative culture scale.

AFC	X^2/gl	CFI	TLI	RMSEA	SRMR
Indices	2.41	0.96	0.96	0.09	0.09

TABLE 4 Confirmatory factor analysis of the scientific output scale.

AFC	X^2/gl	CFI	TLI	RMSEA	SRMR
Indices	2.41	0.96	0.96	0.09	0.09

Table 3 displays the fit indices for the Confirmatory Factor Analysis (CFA), providing evidence of a robust internal structure for the research culture scale. The results fulfill the requirements of X^2/gl < 3.0, CFI and TLI > 0.90$, and RMSEA/SRMR ≤0.09 Furthermore, all factor loadings exceeded 0.60 (Escobedo et al., 2016). The MLR (Robust Maximum Likelihood) estimator was used because of its ability to provide unbiased estimates and robust standard errors under non-normal distributions, common on Likert scales.

Table 4 reveals the fit indices for the CFA of the Scientific Production Scale, which also demonstrate an adequate internal structure. The model achieved a X^2/gl < 3.0, CFI and TLI > 0.90, and error indices (RMSEA/SRMR) within acceptable limits (≤ 0.09). Factor loadings were consistently above 0.60, supporting the construct validity of the instrument (Escobedo et al., 2016). As in the previous scale, the MLR estimator was used because it guarantees the validity of global adjustment rates in models of structural equations with moderate sample sizes.

2.2 Result of factor loads

Table 5 presents the results of the independent variable investigative culture with its dimensions institutional responsibility for research (RII 1 to RII 7) Responsibilities with regard to research activity (RAI 8 to RAI 17), where factor loadings vary from 0.73 to 0.89; and the results of the dependent variable scientific production with its dimensions research activity (AIN 18 to AIN 27) and research methods (MEI 28 to MEI 33), where factor loadings vary from 0.76 to 0.92. In all cases, the indicators are above 0.70, which means that the questions meet validity and reliability criteria.

2.3 Model validity and reliability results

Another condition is that the validity and reliability of the measurement model for the variables that make up the structural model must be demonstrated.

In Table 6, the results of Cronbach's alpha reliability and composite reliability (rho) are statistics where all variables show indicators above 0.908, which is strong and high. Likewise, the statistical test mean extracted variance (AVE) is greater than 0.50 in all variables, with the minimum acceptable value being 0.50. These results allow us to affirm that these instruments are reliable and valid and that the structural model works.

Table 7 displays the discriminant validity analysis for the four dimensions identified in this study: institutional responsibilities (RII), responsibilities with research activity (RAI), scientific activity (AIN), and research methods (MEI). The results indicate that the square root of the average variance extracted (AVE) for each construct is higher than the inter-construct correlations, demonstrating that each dimension captures unique variance. Furthermore, all HTMT values were below the 0.85 threshold, confirming the empirical distinction between the dimensions of research culture and scientific production, even in light of the strong association observed in the structural model (Fornell and Larcker, 1981). The discriminant validity of the relationship between investigative culture and scientific production is 0.742, therefore meeting the threshold of 0.85.

3 Results

3.1 Descriptive analysis of research culture and scientific output

The descriptive results of the research culture variable in Figure 1 reveal that the majority of faculty members (66.7%) perceive the dimension "Institutional Responsibilities for Research" as having a medium level, while 20.0% perceive it as having a low level and only 13.3% perceive it as having a high level. For the dimension "Research Responsibilities," the majority (66.7%) perceive it as having a high level, 20.0% perceive it as having a medium level, and 13.3% perceive it as having a low level. Considering the variable "Research Culture," 60.0% of respondents perceive it as having a high level, 33.3% perceive it as having a medium level, and 6.7% perceive it as having a low level. In other words, there is

TABLE 5 Result of factorial loads of variables and dimensions.

Variables	Dimensions	Items	Factor loadings
Research culture	Institutional responsibilities with regard to research	RII 1	0.74
		RII 2	0.73
		RII 3	0.74
		RII 4	0.71
		RII 5	0.70
		RII 6	0.81
		RII 7	0.71
	Responsibilities with regard to research activity	RAI 8	0.77
		RAI 9	0.84
		RAI 10	0.88
		RAI 11	0.77
		RAI 12	0.84
		RAI 13	0.89
		RAI 14	0.71
		RAI 15	0.77
		RAI 16	0.82
		RAI 17	0.88
Scientific production	Scientific activity	AIN18	0.81
		AIN 19	0.80
		AIN 20	0.71
		AIN 21	0.81
		AIN 22	0.87
		AIN 23	0.89
		AIN 24	0.77
		AIN 25	0.81
		AIN 26	0.81
		AIN 27	0.76
	Research methods	MEI 28	0.92
		MEI 29	0.81
		MEI 30	0.82
		MEI 31	0.85
		MEI 32	0.90
		MEI 33	0.76

TABLE 6 Statistical results of reliability and construct validity.

Variables	Cronbach's alpha	Composite reliability (rho_a)	Average Variance Extracted (AVE)
Research culture	0.918	0.921	0.52
Institutional responsibilities with regard to research	0.908	0.914	0.50
Responsibilities with regard to research activity	0.948	0.950	0.61
Scientific production	0.964	0.965	0.70
Scientific activity	0.946	0.948	0.62
Research methods	0.938	0.939	0.71

evidence of a strong commitment to research activity, although institutional responsibilities could be further strengthened to improve the research culture as a whole.

Figure 2 reveals that a significant majority (73.6%) of respondents in the "Institutional Responsibilities for Research" dimension perceive a medium level, while 18.7% perceive a high level, and only 7.7%

TABLE 7 Discriminant validity: Fornell–Larcker criterion and HTMT ratio.

Constructs/dimensions	(1) RII	(2) RAI	(3) AIN	(4) MEI
(1) Institutional responsibilities (RII)	0.707	0.684	0.512	0.489
(2) Responsibilities with research activity (RAI)	0.612	0.781	0.724	0.650
(3) Scientific activity (AIN)	0.480	0.655	0.787	0.812
(4) Research methods (MEI)	0.420	0.590	0.740	0.842

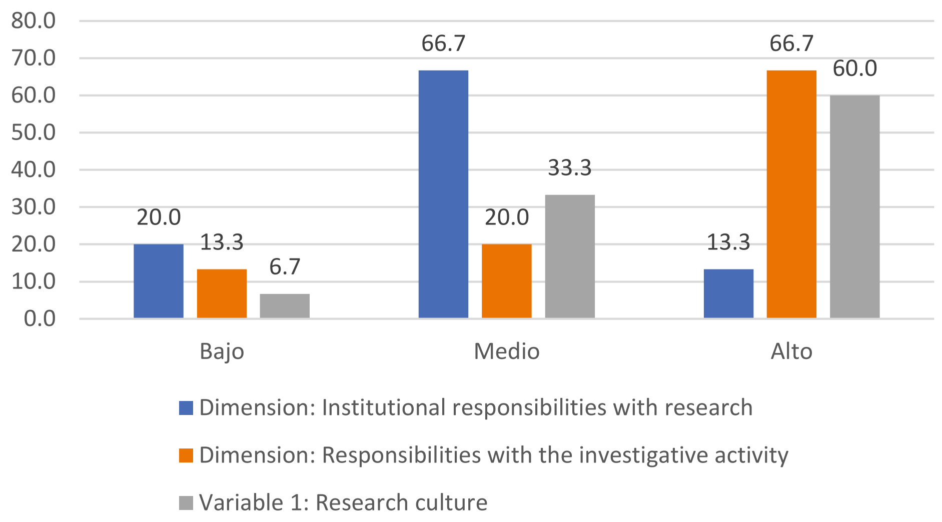

FIGURE 1
Research culture of teachers.

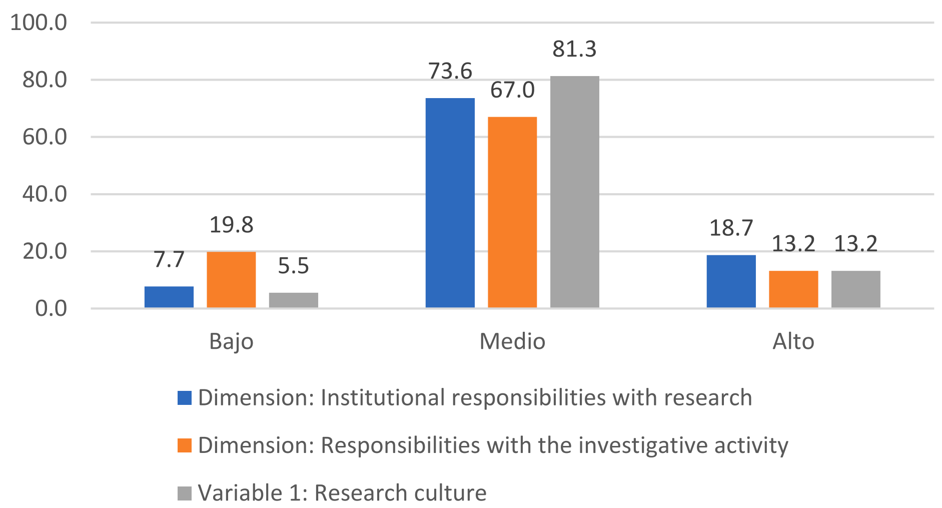

FIGURE 2
Student research culture.

perceive a low level. In the "Research Activity Responsibilities" dimension, 67.0% of participants perceive a medium level, 13.2% perceive a high level, and 19.8% perceive a low level. In the "Research Culture" variable, the majority of respondents (81.3%) perceive a medium level, 13.2% perceive a high level, and only 5.5% perceive a low level. In other words, it is evident that respondents have a moderate commitment and responsibility toward research culture, suggesting that there is room to strengthen research development toward higher levels.

In Figure 3, the descriptive results of the scientific production variable reveal that a large majority of teachers (73.3%) perceive a high level of performance in the "Research Activity" dimension, indicating a notable performance in conducting research-related activities. However, in the "Research Methods" dimension, the majority (45.5%) perceive a medium level, followed by 28.5% at a low level, suggesting a need to improve knowledge and application of research methods. Regarding the "Scientific Production" variable, more than

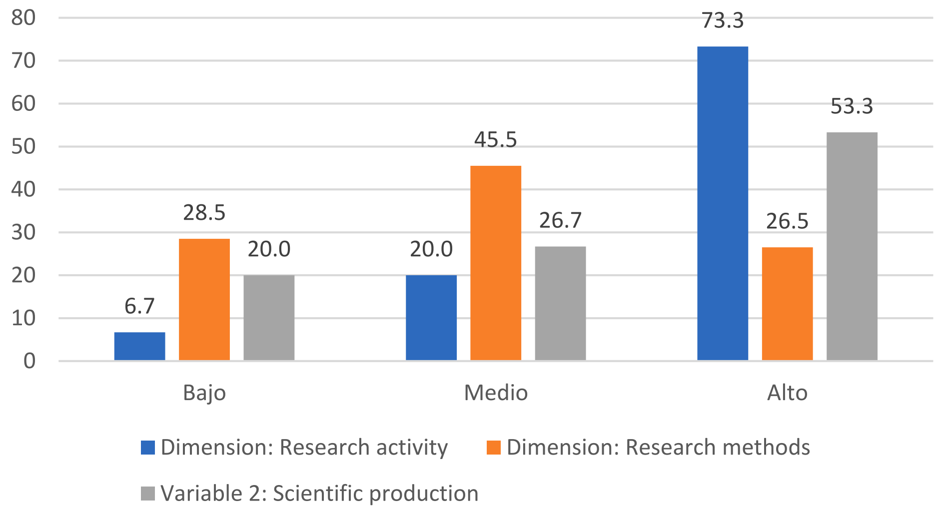

FIGURE 3
Scientific production of teachers.

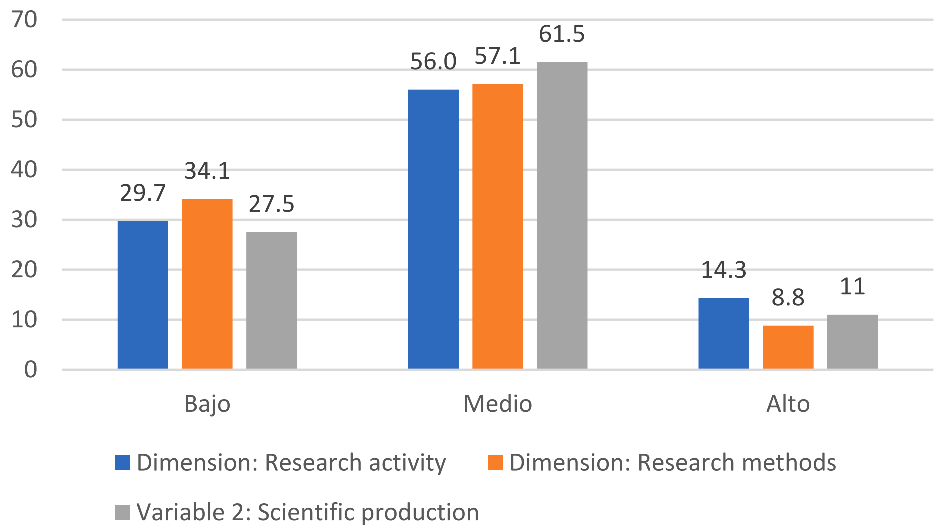

FIGURE 4
Scientific production of students.

half (53.3%) perceive a high level, 26.7% perceive a medium level, and 20.0% a low level. That is, although scientific production presents positive results in terms of research activity, it is necessary to strengthen research methods to achieve a more comprehensive development in scientific research.

Figure 4 reveals that in the "Research Activity" dimension, the majority of respondents (56.0%) perceive it at a medium level, while 29.7% consider it at a low level and only 14.3% reach a high level. In the "Research Methods" dimension, the majority (57.1%) perceive it at a medium level, but there is a considerable proportion (34.1%) at a low level and only 8.8% at a high level. In general, for the "Scientific Production" variable, the majority (61.5%) perceive it at a medium level, with 27.5% at a low level and only 11.0% at a high level. That is, the results suggest that, although there is a moderate performance in scientific production, it is essential to work on strengthening research activity and, mainly, on research methods to raise the quality and effectiveness of scientific production.

3.2 Evaluation of the general explanatory model

The findings indicate a substantial predictive association between research culture and scientific output. For the teaching stratum (Beta = 0.734, $p = 0.013$), research culture accounts for a significant portion of the variance in output. The findings in the teaching stratum show that the proposed structural model is an excellent fit for explaining the influence of research culture on scientific output. According to the indicators shown in Table 8, the X^2/gl value of 0.005 reflects a minimal level of discrepancy between the observed data and the theoretical model. The CFI, TLI, and NNFI indices exceed the value of 1.000, indicating an optimal and robust fit. Similarly, the RMSEA (0.000) and SRMR (0.002) values confirm that the model has virtually no approximation error and adequately represents the structure of relationships between variables. These results allow us to affirm that the proposed model is highly relevant and valid for analyzing teachers' research behavior.

TABLE 8 Proposed structural model of the explanatory model for the teaching stratum.

Model	X^2/gl	CFI	TLI	NNFI	RMSEA	SRMR
Model 1	0.005	1,000	1.019	1.019	0.000	0.002

TABLE 9 Parameter estimation.

Dep	Pred	Dear	HE	95% confidence intervals		β	z	p
				Lower	Upper			
PCI	CIN	1.93	0.776	0.408	3.45	0.734	2.49	0.013

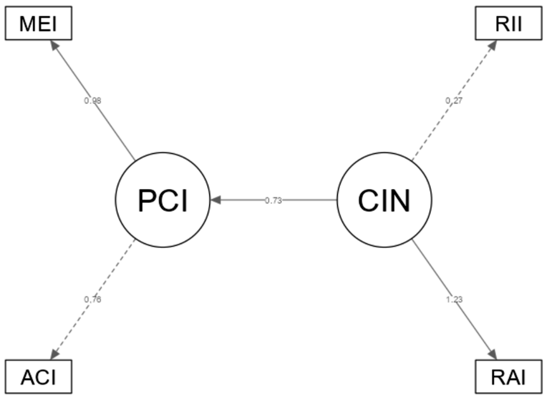

FIGURE 5
Proposed structural model of the explanatory model for the teaching stratum. PCI, research culture; REI, institutional responsibility dimension for research; RAI, responsibility dimension for research activity; PCI, scientific production; ACI, research activity dimension; MEI, research methods dimension.

The estimate presented in Table 9 shows that research culture has a significant and positive influence on scientific output. The standardized coefficient ($\beta = 0.734$) indicates a strong effect, while the confidence interval (0.408–3.45) confirms the stability and robustness of this relationship. Furthermore, the z-value (2.49) and the significance level ($p = 0.013$) allow us to reject the null hypothesis and maintain that this relationship is not the result of chance. This implies that the more developed the research culture, the greater the probability that teachers will increase their scientific output. In summary, research culture is a key factor in academic performance and the generation of scientific knowledge within the institution.

Figure 5 shows the structure of relationships linking the different dimensions of research with scientific output. In this model, research culture is positioned as the central axis, from which components such as institutional responsibility, responsibility in research activity, research activities, and research methods are derived. These dimensions act as mediators or facilitators that strengthen the influence of research culture on scientific results. The model supports the idea that the development of a strong research culture not only improves individual capabilities but also promotes an institutional environment conducive to productive research.

3.2.1 Decision making

Tables 8, 9 and Figure 5 show the fit indices of the proposed explanatory model based on structural equations, where research culture is considered to explain scientific output. In the teaching stratum, optimal X^2/gl 0.05 values are shown. Bonett Non-normed Fit Index (NNFI) > 0.90; RMSEA = <0.08 (Escobedo et al., 2016). The MLR estimator was used for this analysis because multivariate normality is present despite the small sample size.

The findings in the student stratum show that the proposed structural model is an adequate fit for explaining how research culture influences student scientific output. The indicators presented in Table 10, with an X^2/gl value of 1.81, indicate an acceptable level of fit between the theoretical model and the observed data, suggesting that the model structure reasonably well reflects the relationships between the variables. The CFI (0.996), TLI (0.976), and NNFI (0.976) indices are above the threshold of 0.90, confirming that the model presents a robust and consistent fit. Although the RMSEA value (0.09) is slightly higher than the recommended criterion (<0.08), this is offset by a fairly low SRMR (0.014), indicating that the model maintains an acceptable approximation error within methodological standards. In conclusion, we can affirm that the model is relevant and functional for analyzing students' research behavior.

The estimate presented in Table 11 shows that research culture has a significant and very strong effect on students' scientific output. The standardized coefficient ($\beta = 0.983$) shows a high impact, indicating that research culture is a key predictor of scientific performance in this group. Furthermore, the confidence interval (1.06–4.30) confirms that this association is stable and reliable, while the z-value (3.24) and the significance level ($p = 0.001$) allow us to confidently reject the null hypothesis. We can say that students who actively participate in research activities or who receive adequate training in research. In other words, research culture, understood as the set of attitudes, practices, and values surrounding research, plays an important role in professional training.

Figure 6 shows the structural model and the relationships between the different dimensions that make up research culture and its effect on scientific output. In this model, research culture is positioned as the central variable that articulates key components such as institutional responsibility, responsibility in research activity, research activities, and research methods. These dimensions function as elements that strengthen or facilitate students' research skills. In other words, the model supports the idea that solid research training not only increases motivation but also directly impacts students' research capacity.

3.2.2 Decision making

Tables 10, 11 and Figure 6 show the fit indices of the proposed explanatory model based on structural equations, where research culture is considered to explain scientific output. In the student stratum, optimal values of X^2/gl 1.81 are shown. Bonett Non-normed Fit Index

TABLE 10 Proposed structural model of the explanatory model for the student stratum.

Model	X^2/gl	CFI	TLI	NNFI	RMSEA	SRMR
Model 1	1.81	0.996	0.976	0.976	0.09	0.014

TABLE 11 Parameter estimation.

Dep	Pred	Dear	HE	95% confidence intervals		β	z	p
				Lower	Upper			
PCI	CIN	2.68	0.827	1.06	4.30	0.983	3.24	0.001

(NNFI) > 0.90; RMSEA = <0.08 (Escobedo et al., 2016). The MLR estimator was used for this analysis because multivariate normality is present despite the small sample size.

In Table 12, for teachers ($R^2 = 0.539$): the model explains 53.9% of the variance. The 46.1% unexplained variance suggests that other external factors (such as administrative workload, financial incentives, or institutional budget) also impact scientific output. For students ($R^2 = 0.966$): the model explains nearly the entire variance. This indicates that, in the student context, research culture is the almost absolute critical predictor of their initial scientific output.

In Table 13, the results yielded VIF values ranging from 1.54 to 2.08, staying well below the recommended threshold of 3.0. These findings confirm the absence of multicollinearity, ensuring that the estimated parameters specifically the high predictive power ($R^2 = 0.966$) in the student stratum are stable and statistically reliable.

4 Discussion

The robust association found between research culture and scientific output (β teachers = 0.734; β students = 0.983) is grounded in the theory of planned behavior and the construct of research self-efficacy. According to this perspective, research culture is not merely an environment but a system of beliefs and subjective norms that shape the intention to produce knowledge. For faculty, a consolidated culture acts as a catalyst that transforms institutional commitment into articles and patents. For students, this culture represents where academic socialization defines nearly their entire initial scientific behavior, explaining the high explained variance R^2 of 96.6%.

The overall purpose of this research was to determine how research culture and scientific output are related. In the case of teachers, the structural model of the analysis showed optimal fit indices (X^2/gl = 0.005; CFI = 1.000; TLI = 1.019; NNFI = 1.019; SRMR = 0.002), which shows that the research culture has a favorable influence on their scientific production. In the student stratum, the fit indices were also adequate (X^2/gl = 1.81; CFI = 0.996; TLI = 0.976; NNFI = 0.976; SRMR = 0.014), suggesting that the research culture has a moderate impact on their scientific output. These results coincide with those reported by Silva (2024), who obtained a model with moderate and acceptable fit (X^2/gl = 3.075; CFI = 0.972; TLI = 0.942; NNFI = 0.948; SRMR = 0.038) and demonstrated the influence of teachers' research skills on students' research skills at UNAM. Similarly, Fuster and Menacho (2023) obtained acceptable indices (NFI = 0.836; GFI = 0.928; AGFI = 0.642; RMR = 0.007), indicating a significant effect of research skills on problem solving.

To respond to the general objective, Spearman's Rho coefficient was applied, obtaining a value of 0.691 with statistical significance ($p = 0.000 < 0.05$). This confirms a moderate positive relationship between research culture and scientific output. This finding is consistent with the study by Camayo (2021), who reported a correlation of 0.787 ($p < 0.01$) between both variables in performing arts teachers at a private university in Lima. Similar results were found by Mendivel (2020) at the National University of Engineering, demonstrating the direct relationship between research culture and scientific production; and by Cornejo (2020), who confirmed a significant correlation in students at USE Lima using Chi-square ($p < 0.05$). Bracho (2012) also found a strong link between research culture and knowledge acquisition ($r = 0.89$), while Nagamine (2015) reaffirms this relationship.

Regarding the first specific objective, a weak but significant correlation was found (rho = 0.174; $p = 0.032$), indicating that institutional responsibility in research has a slight positive relationship with scientific output. Although the effect is low, it confirms that greater institutional responsibility tends to improve scientific results. This finding partially differs from Cornejo (2020), who found no significant relationship ($p = 0.134 > 0.05$). However, studies such as those by Batallas and Garzozi (2021) and Delgado et al. (2021) highlight that a strong research culture favors creativity and the development of research skills. Complementarily, Catacora (2016) points out that knowledge management by directors strongly influences the scientific output of faculty. Regarding the second specific objective, Spearman's coefficient showed a very strong positive correlation (rho = 0.845; $p = 0.000$), which shows that responsibility for research activity has a significant impact on scientific output at UNAM. Similar findings are observed in Suyo et al. (2020), who reported a high correlation ($r = 0.788$).

Similarly, Cornejo (2020) found a significant relationship ($p = 0.046 < 0.05$) between these variables. Mena (2018) highlights that factors such as competitive funding and professional recognition favor research, while Espinoza (2021) demonstrated through multiple regression that these elements explain 38% of scientific production in universities in Tacna. Finally, Suyo et al. (2020) corroborated that research skills are positively related to scientific output, and Santos et al. (2014) pointed out that the production of articles, books, and other academic works directly reflects university research activity.

When contrasting these results with other Peruvian universities of similar rank (public regional universities in the process of consolidating research): UNAM vs. UNCP (Huancayo): The results are consistent with Camayo (2021), who reported a correlation of 0.787 in similar contexts, suggesting that in regional Peruvian universities, organizational culture is the primary predictor of scientific output.

UNAM vs. Universidad Nacional de Ingeniería (UNI): Mendivel (2020) found a similar direct relationship, though with a lower explained variance for faculty, indicating that at UNAM, dependence on institutional culture is more critical due to its current stage of academic growth. Fit Comparison: The fit indices obtained in this study (X^2/gl = 1.81 for students) are superior to those reported by Silva (2024) for the same institution (X^2/gl = 3.075), validating the robustness of the dimensions evaluated in this model.

Based on the fact that the faculty model leaves 46.1% of variance unexplained, specific actions are suggested: Strengthening methods (MEI), given that both faculty (45.5%) and students (57.1%) perceive a medium level of research methods, UNAM should implement advanced training programs in data analysis and scientific writing. Incentive Management, the unexplained variance in faculty suggests that UNAM should review external factors such as teaching load reduction for research and financial incentives, which could enhance the effect of the current culture. Standardization of Student Culture, since culture is the almost total predictor for students (96.6%), creating institutional research seedbeds (Seemillers) is the most effective way to raise the quality of their initial scientific output.

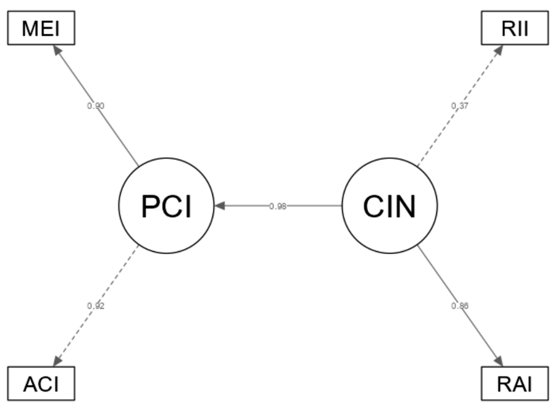

FIGURE 6
Proposed structural model of the explanatory model for the student stratum. PCI, research culture; REI, institutional responsibility dimension for research; RAI, responsibility dimension for research activity; PCI, scientific production; ACI, research activity dimension; MEI, research methods dimension.

5 Conclusion

It is concluded that research culture is a significant and robust predictor of scientific output among UNAM faculty. The structural model shows optimal adjustment indices and explains 53.9% of the variance in academic output. This confirms the effect of research culture on the scientific performance of faculty members. In other words, in the teaching stratum, the strengthening of research-oriented practices, values, and attitudes has a direct impact on scientific output.

In the student stratum of the UNAM, the research culture shows a high predictive capacity for initial scientific production. The model presents a quality statistical fit and an explained variance of (96.6%), which positions academic culture as the determining factor in the development of research skills. This indicates that the skills and abilities acquired in professional training are key to the training of future researchers.

A direct, positive, and significant relationship between research culture and scientific output in the UNAM university community has been confirmed. These findings indicate that systematically strengthening research culture improves scientific output indicators. In other words, the stronger the research culture, the greater the scientific output, contributing to the institution's academic standing.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

JJ: Conceptualization, Formal analysis, Methodology, Writing – original draft. LF: Formal analysis, Investigation, Methodology, Writing – original draft. JF: Software, Supervision, Validation, Writing – original draft. JL: Investigation, Methodology, Validation, Writing – review & editing. MR: Conceptualization, Data curation, Project administration, Writing – review & editing.

TABLE 12 Explained variance (R^2).

Model	Beta coefficient (β)	Explained variance R^2	Unexplained variance
Teachers	0.734	0.539 (53.9%)	46.1%
Students	0.983	0.966 (96.6%)	3.4%

TABLE 13 Multicollinearity diagnostics: variance inflation factor (VIF).

Variable	Dimension	VIF
Research culture	Institutional responsibilities (RII)	1.54
	Responsibilities with research activity (RAI)	2.08
Scientific production	Scientific activity (AIN)	1.96
	Research methods (MEI)	1.79

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Supplementary material

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