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Teaching collaboration in networks: analysis in public schools in Bogotá, Colombia across modalities and levels

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Abstract

This study analyzes the manner in which the positive perception of the "Program to promote and support innovative teachers" serves as a mediator in the relationship between participation in professional networks and collaborative cohesion. In addition, the text examines how this phenomenon varies according to the educational modality in question (i.e., primary education versus technical secondary education) within the context of public institutions in Bogotá. The sample consisted of 197 elementary, primary, and technical secondary school teachers selected from a cross-sectional quantitative perspective using a structured survey to measure network participation, program perception, and collaborative cohesion. Moderate mediation analysis and non-parametric tests were conducted to identify differences by educational modality. The results indicate that the positive perception of the mentoring programme significantly mediates the relationship between participation in teacher networks and collaborative cohesion. The aforementioned effect is more pronounced and direct in technical upper secondary education, where autonomy and reciprocity prevail. Conversely, in primary education, the effect is indirect and contingent on structuring and external accompaniment. A statistically significant discrepancy exists between the various modalities, which is indicative of the impact of institutional factors. In summary, the present study demonstrates the significance of programmatic perception as a mediator in teacher collaboration and underscores the necessity for diversified support policies according to educational modality. The findings provide criteria for adapting support programs in Latin American education systems and analogous international contexts.

Keywords: Professional learning communities, teacher networks, collaboration, educational innovation

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Introduction

Teacher collaboration has been consolidated as a fundamental axis for educational innovation and the improvement of school quality at the international level. In the domain of primary and secondary basic education, collaboration assumes a strategic work dimension, particularly among educators who are members of professional networks. This strategic collaboration facilitates the exchange of knowledge, the collective construction of solutions to educational challenges, and the strengthening of learning communities. It has been demonstrated that institutional support for collaborative processes is a significant factor in the promotion of innovative and sustainable pedagogical practices. (García-Martínez et al., 2021; Liu & Huang, 2025; Ventista et al., 2024).

Nonetheless, empirical evidence from Bogotá, Colombia, demonstrates that teacher collaboration engenders significant tensions and is not homogeneous. The present article offers preliminary results from a doctoral project that is developing evaluative research on the *"Program to promote and support innovative teachers"* implemented in Bogotá. The main objective is to *analyse the conditions that shape the collaboration between primary and secondary school teachers who participate in pedagogical networks, in the context of the support received through the programme, oriented towards processes of educational innovation*. This approach facilitates comprehension of the progress, challenges, and opportunities encountered by teachers in Bogotá in the consolidation of collaborative and innovative practices. It also enables identification of factors that facilitate or hinder collaboration and assessment of the impact of the strategies promoted by the program on the transformation of educational practices and the strengthening of the primary and secondary educational system.

The following sections provide the background information regarding the program, as well as the levels and types of education in which teacher collaboration occurs. Subsequent to this introduction, the theoretical framework for approaching teacher collaboration is presented, along with the methodology, the procedures used, and the results.

Contextualisation

Program description

Colombia's education system is characterized by a collaborative effort among various governmental entities, educational institutions, and stakeholders. This collaborative effort is aimed at ensuring the effective implementation of educational policies and the development of teacher capacity. Bogotá, as the capital city, functions as a central hub for these initiatives, with agencies responsible for educational governance and innovation.

The "Program to promote and support innovative teachers" operates through the Secretariat of Education of Bogotá (SED) and the Institute for Educational Research and

Pedagogical Development (IDEP). The SED is responsible for the oversight of the city's educational system, including its administration, planning, and regulation. The responsibility of IDEP is advance educational research, and to create teacher support and training for innovation in education. In this context, the program's main function is to establish and strengthen networks among teachers, research groups, and innovation teacher's groups to facilitate collaborative practices and the exchange of pedagogical strategies in Bogotá's schools.

By connecting various teacher communities and supporting the deployment of innovative teaching methods, the program seeks to enhance instructional practices and contribute to improved educational outcomes. This initiative fits within broader efforts to institutionalize innovation and professional growth as central components of the education system's modernization process.

Levels and modalities of education in Colombia

In order to analyze the collaborative work of teachers, it is essential to understand the structure of levels and modalities of the Colombian education system. Each stage and modality present a set of challenges and opportunities that necessitate distinct forms of collaboration.

The Colombian educational system is structured into three distinct stages, each characterized by specific levels of academic instruction and learning objectives: pre-school (for children aged 3 to 5), primary education (five grades, approximately between 6 and 10 years old) and secondary, which is divided into basic secondary (four grades, from 11 to 14 years old) and *technical upper secondary education* (two final grades, generally from 15 to 17 years old). Upon completion of secondary education, students obtain a baccalaureate degree, which can be either academic or technical, depending on the modality pursued.

In the context of the Colombian education system, basic secondary education is organized into two distinct modalities: academic and technical. The academic stream is oriented towards the development of competencies in science, humanities, arts, and foreign languages. The objective of this preparatory education is to equip students with the necessary skills and knowledge to successfully transition to higher education.

The technical modality is characterized by a dual approach to education, integrating general education with specialized training for the workforce and the productive sectors. This approach is designed to equip students with the necessary skills and credentials to pursue higher education and secure employment in technical occupations upon completion of secondary education.

Within the technical modality, three principal submodalities stand out, each with specific educational objectives and curriculum emphases: general technical education, commercial technical education, and normalista or pedagogical emphasis programs.

General technical education focuses on developing scientific and technical competencies tailored to various industrial and productive fields. Students receive both

theoretical instruction and hands-on training aimed at preparing them for emerging technologies and industry practices. Typical areas of specialization include manufacturing, information technology, and environmental management. This modality emphasizes applied knowledge and practical skills, which enable graduates to enter directly into technical roles within the labor market or pursue further education in technical disciplines.

Commercial technical education centers on preparing students for roles in commerce, finance, administration, and related service sectors. This modality strives to balance theoretical understanding with real-world applications in commercial contexts.

Normalista or pedagogical emphasis programs prepare students for careers in education, especially as future teachers of basic education levels. These programs emphasize pedagogical theory, and didactics. Alongside core academic subjects, students acquire specific skills related to teaching methodologies and child and adolescent development.

Each technical submodality corresponds to different vocational profiles and institutional contexts, influencing collaborative practices among teachers and the implementation of innovation processes.

Theoretical references

Teacher collaboration is defined as a structured, intentional and sustained process of professional interaction between peers. This process is aimed at collectively generating pedagogical solutions, jointly developing teaching resources, and sharing reflections on educational practice, and this concept extends beyond mere cooperation or the fulfilment of shared tasks. It involves building a professional culture based on interdependence, mutual learning, and the ongoing enhancement of teaching practices, also teacher collaboration is grounded in autonomy and mutual trust, and is understood as teamwork based on shared responsibility and purposeful relationships oriented towards common goals. (Ahn, 2016; Mora-Ruano et al., 2019)

This approach posits that professional development and teacher collaboration necessitate not only individual willingness but also institutional conditions that facilitate frequent and meaningful knowledge sharing, in addition to the provision of necessary support to achieve sustained school improvement. Precisely, teacher collaboration concept constitutes an element of the theoretical model of professional learning communities (hereafter PLCs) where collaborative work is supported by shared values, norms, and goals, as well as by structures that foster interdependence. (de Jong et al., 2022; Shauly & Avargil, 2023)

It seems that this definition, based on recent literature and the guidelines of the original instrument, integrates structural, pedagogical, and relational dimensions. The structural dimension includes the frequency and quality of the exchange of materials and experiences. The pedagogical dimension includes the co-design of assessments, joint

planning, and classroom innovation. The relational dimension includes trust, co-responsibility, and a sense of professional community.

Teacher collaboration in addressing emergent challenges underscores the critical role of sustained interaction and the systematic identification of common challenges. These components are widely recognized as foundational to the effective operation of Professional Learning Communities (PLCs) (Ahn, 2016; Karsenty et al., 2024; Shaully & Avargil, 2023) and serve as an analytical framework for examining collaborative processes.

Methodology

The present study employs a cross-sectional, quantitative methodological design. The data were collected through the implementation of a structured survey composed of 50 questions on a Likert scale. This survey comprised a total of 213 items and required approximately 20 minutes to complete. The survey was administered to a purposively selected sample of teachers from public educational institutions in Bogotá, Colombia. These teachers are engaged in collaborative work networks and have participated in "*The program to promote and support innovative teachers*". The sample included teachers from various educational levels (pre-school, primary, and secondary) and from different institutional modalities (academic and technical), which facilitated analysis of teacher collaboration in terms of these variables.

Objectives and hypotheses

Objective: Analyze the conditions that influence collaboration between primary and secondary school teachers participating in pedagogical networks within the framework of support provided by the Program to Promote and Support Innovative Teachers, which is focused on fostering educational innovation processes.

Hypothesis: The positive perception of the *Program to promote and support innovative teachers* significantly mediates the relationship between participation in teacher networks and collaborative work, with differential effects according to educational modality.

Research question: How does the perception of the *Program to promote and support innovative teachers* significantly mediate the relationship between participation in teacher networks and collaborative work, and how does this effect vary by educational modality?

Participants

A total of 380 teachers were invited to participate in the survey, of which 197 participated. Regarding gender distribution, 62% of the subjects were female, 31.15% were male, and 0.79% were classified as "other." The age range of the subjects was from 32 to 57 years old.

In regard to their educational attainment, the majority of the participants, specifically 80%, have obtained a Bachelor's degree. This degree is designed to prepare individuals for careers in education, offering a comprehensive foundation in various pedagogical domains. It is comparable to the Bachelor of Education degree in other educational systems. 17.39% are professionals in specific disciplines and 1.98% are trained as teacher educators, which implies secondary education with an emphasis on pedagogy and qualifies them to teach in pre-school and primary education.

In addition, 93.68% of teachers have specialised or master's degrees, and 28.85% have reached doctoral level. In terms of employment, 86.11% have a permanent contract and 13.89% have a temporary contract. 85.31% of teachers have been employed for more than three years. 85.31% have been employed for more than seven years, while 4.76% have been employed for between one and two years, another 4.76% for between three and four years, and 5.16% for between five and six years.

Moreover, the vast majority of the participants, specifically 93.68%, possess either a specialization or a master's degree, while a significant proportion, amounting to 28.85%, hold a doctoral degree. Regarding their employment relationship, 86.11% have a permanent contract and 13.89% have a temporary contract. 85.31% of the participants have been working for more than 7 years; 4.76% between 1 to 2 years; 4.76% between 3 to 4 years; 5.16% between 5 to 6 years.

Description of the instrument

The survey utilized in the present study comprises 50 Likert-type questions, amounting to a total of 213 items. It is estimated that the respondents will require approximately 20 minutes to complete the survey. The instrument's design is the result of a process of fusion and adaptation of two international references. The first of these references is the questionnaire "Participation in digital professional networks and innovation in teaching practices" developed by the Chilean Ministry of Education's Education Research and Development Fund (FONIDE), (Salinas et al., 2011), and on the other, an open questionnaire from the Organisation for Economic Co-operation and Development (OECD), (Vincent-Lacrin, 2023) aimed at supporting the understanding and monitoring of educational innovation, as well as identifying drivers and differences according to school levels in different contexts.

The adaptation process facilitated the identification and validation of 17 key dimensions for the study of teacher innovation and collaboration in the Colombian context. Specifically, the "teacher collaboration" dimension analysed in this article corresponds to the section of the instrument that fully incorporates the items from the FONIDE-Chile survey.

Procedures

The preliminary stage of the implementation of the instruments involved the establishment of protocols for the utilization and implementation of the selected instruments. In regard to the program perception survey, the authors were contacted via email to request permission for its utilization, and they granted approval.

With regard to the OECD survey, the formats stipulated in the manual of tools and methods designed for its application and the Frascati 2015 manual were completed and submitted. (OECD, 2015; OECD/Eurostat, 2018; Vincent-Lacrin, 2023) The OECD questionnaire was translated from 47panish into 47panish and reviewed by two experts in the field of education, native 47panish speakers (one European, one Colombian) with an advanced level of English.

In regard to the distribution and application of the survey, a formal request was submitted to the government institutions responsible for implementing the program. The program coordinators were informed that all participants were part of WhatsApp groups, which was regarded as the primary means of communication. Consequently, with prior consent and permission from the groups, the survey was disseminated.

The survey was implemented using Question Pro software. To ensure a high response rate, a mass mailing strategy was employed, whereby postings were disseminated across various groups. This was complemented by the deployment of personalized reminder messages via WhatsApp over a period of three weeks. Furthermore, a raffle was organized to incentivize participation. The survey was disseminated via WhatsApp and email, and 197 teachers provided responses.

The participants were granted the option to disengage from the data collection process at any time. In the online version, participants were provided with detailed information about the purpose of the research, the conditions for conducting the research and obtaining informed consent to participate. Furthermore, the subjects were informed that their participation was voluntary, and that all data collected would be treated confidentially.

The statistical processing of the data was executed in a series of interconnected stages, with the objective of organizing and analyzing the information. First, the non-parametric Kruskal-Wallis test was employed to compare differences between independent groups on ordinal variables. This test is suitable for likert-type scales and does not require assumptions of normality. This analysis enabled the identification of substantial discrepancies in the medians of the groups studied.

Subsequently, Principal Component Analysis (PCA) with Varimax rotation was employed. PCA is a multivariate technique that reduces dimensionality and groups variables into orthogonal components. This facilitates the interpretation of latent patterns and the identification of relevant thematic dimensions. The selection of components was based on statistical criteria, including the Kaiser criterion (eigenvalues greater than 1) and a factor loading threshold of 0.4 for the inclusion of variables in each

dimension. Finally, the utilization of boxplots was instrumental in the visualization of the distribution, dispersion, and the presence of outliers in each dimension. This procedure facilitated a comparative analysis of central tendencies and an assessment of the heterogeneity of the data across the various groups that were subjected to analysis.

As indicated by the statistical process previously delineated, a total of 17 dimensions pertaining to innovation and collaboration were identified. The present article focuses on the results of the *“Teacher Collaboration Dimension”* which in turn includes two variables of analysis. 1) teacher collaboration according to the educational level to which the teacher belongs and 2) teacher collaboration according to the mode of education.

Results

The statistical findings related to the *“Teacher collaboration dimension”* are presented below in order of priority. This analysis evaluates several key variables, including the frequency of interactions among teachers who encounter similar challenges, the dissemination and discussion of innovative experiences, the willingness of teachers to share knowledge with their peers, participation in mutual support groups, and the proactive search for information aimed at fostering educational innovation. These variables collectively provide a comprehensive overview of the extent and nature of collaborative practices within the teaching community, highlighting both strengths and areas for further development in promoting effective professional learning environments.

Interpretation respects the educational modality variable:

The Kruskal-Wallis test was selected on the basis of its proven efficacy in handling non-normal data distributions and its optimality for the purpose of comparing medians across multiple independent groups. In order to ensure a comparison between groups, non-parametric statistical techniques were employed. Employing this method ensures that potential deviations from normality present in teachers' responses are accounted for, thereby strengthening the validity of the statistical conclusions.

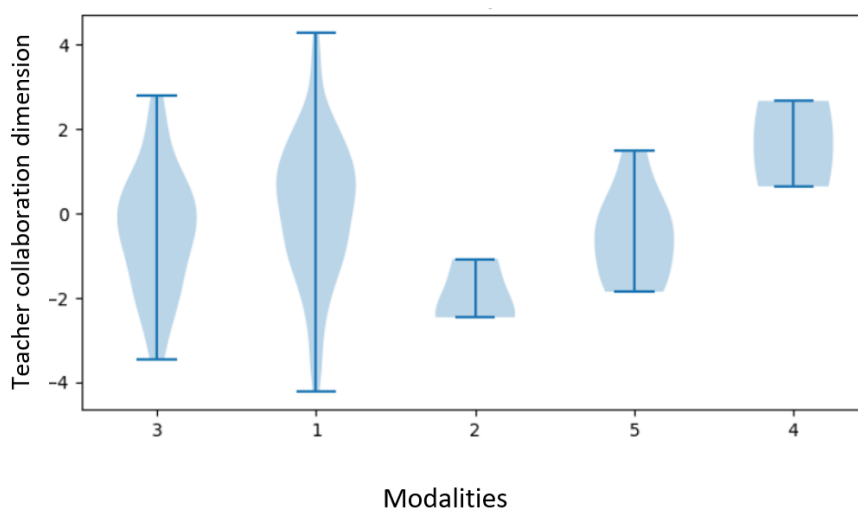
Regarding educational modalities, the Kruskal-Wallis test shows significant differences ($H = 12.645$, $p = 0.0131$) between the groups. In this section, the utilization of boxplots is employed to visually illustrate the differences that have been identified through the implementation of the Kruskal-Wallis test. This graphical approach facilitates more accessible interpretation of the data's distribution, thereby enabling the identification of patterns, such as median differences and the range of responses, across the educational modalities under study.

To facilitate a comprehensive understanding of the distribution of perceptions regarding collaborative learning across different educational modalities, this boxplot offers a graphical summary of the data, allowing for an immediate comparison of key statistical features among the groups analyzed.

The boxplot is a graphical representation of the median, interquartile range (IQR), and potential outliers for each educational modality. It is a useful tool for understanding the central tendency and variability of responses, as it provides a visual representation of the distribution of data. The utilization of a boxplot facilitates the discernment of the distribution of values. This graphical representation enables the identification of not only the modalities that exhibit higher or lower valuations of collaborative learning but also the degree of consistency or heterogeneity within each group. It is important to interpret the position and spread differences observed in each box plot, as overlapping interquartile ranges may indicate that apparent differences in medians are not always statistically robust in pairwise comparisons. Consequently, this visual interpretation should be regarded in conjunction with the corresponding p-values to prevent an overestimation of group differences.

Figure 1

Distribution of Dimension teacher collaboration by modalities variable (n=194)



The following table summarizes the educational modalities examined in the study, along with their corresponding numerical designations:

Table 1

Educational modalities

Modality Number	Educational Modality
1	Preschool and primary education
2	Secondary education with technical modality, emphasis commercial
3	Secondary education with academic modality
4	Secondary education with technical modality
5	Other

The boxplot reveals that modality 4 (secondary education with technical emphasis) is characterized by a notably concentrated distribution of positive values and a high median. This finding suggests a strong and consistent appreciation for collaborative learning among its participants. In contrast, modality 1 (Primary education) demonstrates a much wider and more heterogeneous spread, indicating substantial variability in perceptions within this group. Modalities 2 and 5 tend to cluster around negative values, while modality 3 (Secondary education with academical emphasis) occupies an intermediate position, with a relatively balanced distribution.

Interpretation respects the educational level variable:

To facilitate an examination of how collaborative learning is valued across educational levels, a box plot was created to visually illustrate the distribution of responses for each category of the education level variable.

The utilization of boxplots for the presentation of valuations pertaining to collaborative learning across various educational levels serves a dual purpose. Firstly, it serves to underscore the similarities and differences that characterise these levels. Secondly, it reinforces the value of visual tools in complementing numerical statistics. This approach facilitates the identification of subtle trends, such as homogeneity or the presence of outliers, that may not be immediately apparent from statistical tables alone. The ensuing graph summary is of particular value, as it facilitates immediate and intuitive comparison of the central tendency, dispersion, and presence of outliers within each group.

The boxplot indicates that the medians and interquartile ranges are remarkably similar across all educational levels. This finding indicates a consistent central tendency and variability in the valuation of collaborative learning regardless of the level. Furthermore, the distribution of outliers appears homogeneous, suggesting that extreme values - whether particularly high or low- are not concentrated in any specific educational group, but rather are distributed throughout the sample.

Figure 2

Distribution of Dimension teacher collaboration by level variable (n=194)

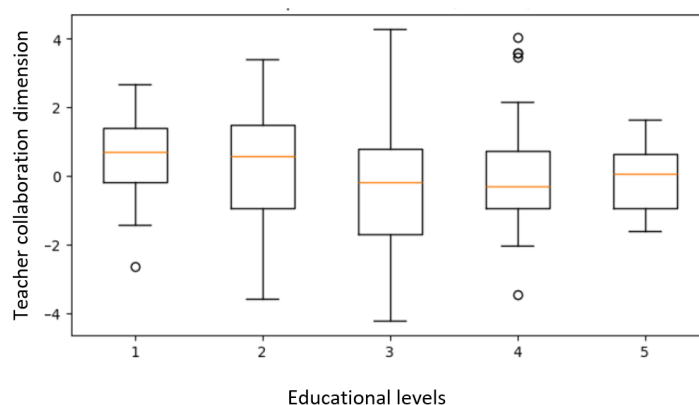


Table 2*Educational levels*

	Educational levels
1	Preschool
2	Primary
3	Secondary education
4	Upper secondary education – Academical
5	Upper secondary education - Technical

This visual representation provides a complementary analysis of the statistical findings. Specifically, Spearman's correlation reveals a weak yet statistically significant negative relationship between educational level and the valuation of collaborative learning. ($\rho = -0.157$, $p = 0.0291$). The Kruskal-Wallis test does not demonstrate the presence of statistically significant differences between the categorized educational levels ($H = 9.088$, $p = 0.0589$). This finding indicates that the observed trend is gradual and does not result in the formation of sharp distinctions between groups.

Table 3

valor		
0	rho	-0.156728
1	p_rho	0.029082
2	KW_H	9.087659
3	KW_p	0.058945
4	n	194

The variables that are most influenced by this trend are the frequency of meetings among teachers facing similar challenges and participation in mutual support groups. These variables tend to decrease as the educational level increases. In contrast, Interest in acquiring knowledge regarding innovative experiences and the pursuit of information to promote educational innovation remain consistent across all levels.

The graph reveals patterns that are consistent with the presence of similar medians across all levels (approximately between -0.5 and +1). Additionally, there is a comparable interquartile range and a relatively homogeneous distribution of outliers.

Table 4*Description by level*

Level	Median	IQR Range	Values Atypical	Trend
1	~+1	Broad	Moderates	Slightly positive
2	~+0.5	Moderate	Few	Neutral
3	~-0.5	Compact	Some superiors	Slightly negative
4	~-0.5	Moderate	Several	Slightly negative
5	~+0.5	Compact	Few	Neutral

The observed trend ($p = -0.157$) indicates a negative correlation between the appreciation of collaborative learning among teachers and their educational level, suggesting a slight decrease in appreciation with increasing educational level. Taken together, these findings suggest that while specific methodologies or levels of education may exhibit slight variations in perceptions of collaborative learning, overall trends remain relatively stable. The limited range of variation between groups suggests the potential influence of institutional or systemic factors that broadly shape collaborative practices, rather than sharply dividing them by modality or level.

Discussion

The discussion section of the article aims to interpret and contextualize the statistical results obtained for the "Teacher collaboration dimension" within the broader framework of collaborative research and practice. The analysis emphasizes the multifaceted nature of collaboration by highlighting the relationships that define it. These results align with previous literature regarding collaboration approaches, especially in interdisciplinary contexts.

Furthermore, the results of the study suggest that collaborative efforts may be viable for measurement and evaluation through the application of data-driven instruments. These instruments possess the capacity to facilitate the analysis of research trends, the mapping of partnerships, and the establishment of institutional benchmarks.

The divergency in collaborative teaching practices between technical upper secondary education and primary education can be elucidated through the framework of professional learning communities (PLCs) theory. PLCs are defined as groups of educators who, through systematic interaction, reflection, and shared learning, endeavor to enhance their teaching practices and improve student outcomes.

Within the context of the primary education system, there is a prevalent perception that teacher collaboration is confronted with significant structural and cultural challenges. It appears that curricular heterogeneity, diversity of interests, and a lack of consolidated support structures may present certain challenges to the consolidation of autonomous professional communities. (Burgin, 2022; Stoll et al., 2019)

In this context, the involvement of facilitators, external accompaniment, and the implementation of protocols or mentoring could play a crucial role in fostering collaboration and addressing potential asymmetries. The literature suggests that the PLC could be considered a guided learning space. In such cases, it seems that trust-building and the generation of a shared vision might require more structured and sustained interventions. (de Rivas et al., 2025; Karsenty et al., 2024; Liu & Huang, 2025)

The teachers' pursuit of information for the purpose of innovation is indicative of proactivity and active learning, both of which are considered essential principles of Professional Learning Communities (PLCs). In academic secondary education, it seems that the integration of digital resources and shared knowledge has the potential to enable

a balance between mutual support and effective information management. In social contexts characterized by limited access to economical resources, the function of institutional programs as facilitators assumes paramount importance, serving as a conduit for the integration of external knowledge with local experiences. (AlAjmi, 2022; Ortega et al., 2023; Pennell & Firestone, 1996)

In technical upper secondary education, collaboration is often seen in interdisciplinary projects and shared objectives. The goal of these collaborative efforts is to foster autonomous and cohesive communities. The development of effective collaboration may be influenced by a variety of factors, including prior experience, the presence of internal facilitators, and the clarity of common goals. These factors contribute to the establishment of smooth and sustainable collaboration. As demonstrated by (Fletcher et al., 2024; Karsenty et al., 2024; Liu & Huang, 2025), elements such as trust, reciprocity, distributed leadership, and flexible organizational structures play a central role in their functioning. (de Jong et al., 2022; Karsenty et al., 2024; Shauly & Avargil, 2023)

In the context of technical upper secondary education, the presence of professional cohesion and collective problem-solving is indicative of intentional relationships and group autonomy. In contrast, within the context of primary education, the importance of institutional mediation in the creation of effective collaborative spaces is underscored by the presence of contextual heterogeneity. (Mora-Ruano et al., 2019)

As indicated by the principle of collective learning, which is fundamental to professional learning communities (PLCs), exposure to the innovative experiences of other teachers is a crucial aspect of these communities. In the context of professional learning communities (PLCs), the exchange of knowledge among colleagues and the active engagement in learning activities have been demonstrated to improve pedagogical practices and enhance student outcomes. (de Jong et al., 2022; de Rivas et al., 2025).

In contexts characterized by high curricular diversity, such as primary education, this exchange functions as a compensatory mechanism that enables the adaptation of approaches and practices. It underscores the significance of institutional support in the systematization and dissemination of successful cases, thereby fostering a culture of innovation and a sense of professional belonging.

The analysis of reciprocity in the sharing of knowledge and experiences facilitates the identification of the degree of maturity of teacher collaboration. In technical upper secondary education, reciprocity and participation in interdisciplinary projects reflect the ideal of co-responsibility and autonomy that characterise mature PLCs (de Rivas et al., 2025; Karsenty et al., 2024; Kolléck, 2019) The asymmetry observed in primary education, with knowledge reception prevailing over sharing, underscores the necessity of developing supportive structures and mentoring to balance this exchange.

Participation in mutual support groups is a concrete manifestation of the support structures required by PLCs. In the context of technical upper secondary education, self-managed groups exemplify autonomy and ownership in collaborative processes.

Conversely, the reliance on external support in primary schools underscores the necessity for progressive autonomization strategies, as highlighted in research on teacher professional development. (Castro-Cáceres & Lillo, 2024; Liu & Huang, 2025)

These modal contrasts are also reflected in the sustainability of collaborative practices. Collaboration is a key component of both technical upper secondary education and primary education. In the former, it is sustained and evolves from professional autonomy and distributed leadership. In the latter, the continuity of PLC is more dependent on the provision of resources, protected time for collaboration, and systematic support from school management or external agents. (Ourania et al.; Liu and Huang; Mora et al.).

The literature emphasizes the necessity of adapting professional development and coaching strategies to the specific characteristics of each modality. This adaptation is important to avoid homogeneous approaches that fail to consider the organizational and cultural particularities of teaching teams. (de Rivas et al., 2025; Ortega et al., 2023)

In summary, the theory of professional learning communities offers a way to understand the differences in teacher collaboration as the result of the interaction between structural, cultural, and leadership factors. Autonomy, trust, and clarity of goals might favor the consolidation of PLCs in technical upper secondary education. In elementary and primary education, it might be a good idea to consider ways to strengthen support structures and collective construction processes. This could contribute to the development of sustainable and effective professional communities.

Therefore, the study may be suggesting that program mediation could be a contributing factor to the observed differences in collaborative cohesion across educational modalities. The study addresses the primary research question by demonstrating that the perception of the program mediates the relationship between participation and cohesion through distinct modal pathways. Specifically, it finds that there is a direct and autonomous route in technical education, and an indirect and structured route in basic education. The efficacy of this mediation is contingent upon the program's capacity to adapt to the distinctive institutional and contextual realities. This adaptive capacity enables the program to foster meaningful collaboration and sustainable cohesion, tailored to the specific needs and dynamics of each modality.

Conclusions and limitations of the research

In conclusion, the findings of this study provide key elements for education policy and teacher education in complex urban contexts. The results underline the importance of designing differentiated accompaniment and professional development strategies that recognise the particularities of each educational modality and respond to the specific challenges of teachers in basic/primary and *technical upper secondary education*. For public policy, this implies prioritising the reduction of administrative burdens, ensuring protected time for collaborative work and promoting flexible structures that favour both the autonomy of teaching networks and access to mentoring and external support in

more heterogeneous contexts. Thus, it highlights the need for policies that not only encourage collaboration, but also remove structural barriers and create conditions conducive to collective learning.

In the field of teacher training, the results suggest the relevance of strengthening competences for the facilitation of professional learning communities, as well as incorporating hybrid modalities that combine face-to-face mentoring and digital training, especially in contexts where curricular heterogeneity and lack of resources limit the sustainability of collaborative practices. It is also essential to foster reciprocity and horizontal exchange of knowledge, so that collaboration does not depend exclusively on institutional intervention, but emerges as a sustainable and autonomous professional practice.

However, this study has some limitations that need to be considered. The sample is restricted to teachers in the city of Bogotá, which may affect the generalisability of the results to other contexts. In addition, the research focused on teachers active in networks, which could potentially underestimate the challenges faced by those who do not participate in these spaces.

Based on these results, future lines of research could be oriented towards longitudinal studies to analyse the sustainability of professional learning communities over time, as well as quasi-experimental designs to assess the impact of specific interventions, such as the reduction of administrative burden or the implementation of cross-mentoring. It would also be relevant to explore how teacher collaboration is transformed in contexts of greater decentralisation or in cities with different levels of resources.

Finally, while the findings of this study are situated in the reality of Bogotá, it is possible that they present elements that could be transferable to other Latin American and international urban contexts that share similar structural and organizational challenges. The necessity for flexible policies, the significance of teacher autonomy, and the value of professional learning communities have been identified. The applicability of these principles to diverse educational systems is contingent upon their adaptation to the institutional and cultural environments of each territory.

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