STUDIA UBB PSYCHOL.-PAED., LXIX, 1, 2024, p. 115-134
(Recommended Citation)
DOI:10.24193/subbpsyped.2024.1.06

Colombian Teachers' Network on STEM: Approaching Concepts and Strategies for Collaborative Work and Educational Innovation

Heidy Natalia GARCÍA CADENA[1]

ABSTRACT. The article analyses the strategies and concepts that configure the accompanying process provided to teachers by the Secretariat of Education in Bogotá, Colombia, through a Continuing Professional Development Program. The content analysis performed in this article is meant to evaluate the conceptualization of a national program on continuing professional development of primary and secondary school teachers in Bogotá, a program estimated to impact on teaching collaboration and educational innovation. The STEM + TRANSFORMS Teachers Network is where this process is carried out, with teachers who have pedagogical initiatives in educational innovation with a STEM (Science, Technology, Engineering and Mathematics). The content analysis was carried out by examining two reference documents for STEM networks and programs in Colombia and Latin America, and conducting an interview with the institutional support coordinators of the Network. The findings will enable an understanding of approaches and challenges related to educational innovation through STEM processes and cooperative work.

Keywords: Collaboration, accompanying, STEM, innovation

ZUSAMMENFASSUNG. In diesem Artikel werden die Strategien und Konzepte analysiert, die den Begleitungsprozess für Lehrer gestalten, den das Bildungsministerium in Bogotá, Kolumbien, im Rahmen eines Programms zur beruflichen Fortbildung anbietet. Die in diesem Artikel durchgeführte Inhaltsanalyse soll die Konzeption eines nationalen Programms zur beruflichen Weiterbildung von Lehrern der Primar- und Sekundarstufe in Bogotá bewerten, ein Programm, von dem angenommen wird, dass es sich auf die Zusammenarbeit im Unterricht und die Bildungsinnovation auswirkt. Das STEM + TRANSFORMS Lehrernetzwerk ist der

[1] PhD candidate in Psychology and Education Sciences, West University of Timişoara, Romania, teacher and researcher at the Secretariat of District Education in Bogotá-Colombia. E-mail: heidy.garcia10@e-uvt.ro

Ort, an dem dieser Prozess durchgeführt wird, mit Lehrern, die pädagogische Initiativen in der Bildungsinnovation mit einem STEM (Science, Technology, Engineering and Mathematics) haben. Die Inhaltsanalyse erfolgte durch die Untersuchung von zwei Referenzdokumenten für MINT-Netzwerke und -Programme in Kolumbien und Lateinamerika sowie durch ein Interview mit den institutionellen Unterstützungskoordinatoren des Netzwerks. Die Ergebnisse ermöglichen ein Verständnis der Ansätze und Herausforderungen im Zusammenhang mit Bildungsinnovationen durch MINT-Prozesse und kooperative Arbeit.

Schlüsselwörter: Zusammenarbeit, Begleitung, STEM, Innovation

1. INTRODUCTION

The organization of teacher networks in Colombia and Latin America has been a strategic response to the socio-educational challenges of the region and implies environments for sharing knowledge, strategies, and resources, to inspire teachers to improve their pedagogical practices and develop solutions that meet the specific needs of each educational community.

This article analyzes how the Red STEM + Transforms Network brought together teachers from primary and secondary public education sectors in Bogotá, Colombia to form a team with Latin American teachers. This team of teachers was trained and supported by the Bogotá Education Secretariat (hereinafter referred to as SED), which is the government institution responsible for administering the public education system in Bogotá.

The promotion and accompaniment program for researchers and innovative teachers is conducted by SED through a strategic university alliance. The STEM Network's institutional configuration and responsibilities, which are designed to be a professional learning community (PLC), table 1 provides a continuing professional development (CPD) opportunity and contextual explanations about the STEM Network.

Table 1. The institutional context

ADMINISTERING ENTITY	The Secretariat of District Education (SED) is a government agency that is part of the administrative structure of the Capital District of Colombia. It was created in 1955, by the Council of Bogotá, Mayor's Office. The SED is the responsible body for the childhood education (pre-school), basic (primary and secondary) and the average public sector in the city of Bogotá.

An administrative division of the SED is accompanying the STEM network of teachers	The Directorate of Science, Technology, and Educational Media of the District Education Secretariat, responsible for CPD and promoting educational strategies related to the fields of science, technology, and educational media within the educational system of the city of Bogotá.
Interinstitutional agreements have been created to offer training and assistance to the Network.	UNNO Institute is the Scientific Park of Social Innovation (Parque científico de innovación social) at Universidad Minuto de Dios (Hereinafter Uniminuto).

Source: (Secretaría Distrital de Educación, 2019)

According to Yemail (2022), the STEM Teachers Network was established with a group of teachers who were previously associated with the Science and educational technologies projects. The projects in mention are listed below:

i. *Plan saber digital (Digital Knowledge Plan):*
   The aim of this strategy is to enhance the learning environments in Educational Institutions that are focused on STEM, through an accompanying program specialized in science and technology, is part of the framework of educational policy in Bogotá for the integration of technologies. (Secretaria de Educación de Bogotá, 2020).

ii. *The SED-CISCO Academies program*, which has been established, is aimed at training 15,000 young graduates from public schools in Bogotá in technology and innovation, using a methodology that promotes leadership, creativity, and problem-solving.

In 2021, the STEM Teachers Network was constituted with 40 teachers who had taken part in Plan saber Digital and other from the Cisco Academy programs. In 2022, 22 additional teachers were added who were trained in bilingual teaching in United States with the support of the SED, particularly in English and STEM aspects, resulting in a total of 62 teachers participated in this network.

The STEM team and SED support worked together in 2021 to establish a mission, vision, and governance framework, which was created through a participative process articulating aspects of the Sustainable Development Goals of the United Nations. Precisely, the objective of this strategy is to promote educational environments that emphasize STEM, according to Deaza (2022), precisely the network's official call to associated more teacher´s occurred in the year 2022, after completing the procces in mention.

The process of organizing the Network and institutional support for the team of teachers was also associated with the strategy called Bogotá STEM territory launched in 2021, which are the specifical public policies strategies from providing equal access to STEM in the city; through this strategy, the educational system of Bogotá will be connected to SIEMENS network of 17 STEM territories in Latin America for a collective impact in education, which ranged experiences to creating institutional structures and long-term public policies. (Redacademica, 2022; Siemens Stiftung, 2022)

To comprehend how the CPD for teachers involved in the STEM Network was anticipated and outlined in the program's background documents, a content analysis was performed, and it will be illustrated in the following sections of the article, guided by the following questions:

- ✓ What strategies are implemented in the training and accompaniment process to promote collaborative work among teachers?
- ✓ What strategies are used to ensure the sustainability and development of the network?
- ✓ What are the main ideas guiding the institutional support the District Education Secretariat (SED) offers to the STEM Network?

2. THEORETICAL FRAMEWORK

Teacher collaboration is the main category of analysis, according to Navarro and Pérez (2023), Soares et al. (2020), and Prenger et al. (2020), while talking about networks as PLCs. Teaching collaboration in networked PLCs is an approach that involves active and coordinated interaction between educators with the aim of promoting, creating, or consolidating pedagogical or didactic processes (Vangrieken, 2017). This involves collaborating on lesson plans, sharing educational resources, reflecting on pedagogical practices, and creating a collaborative environment to address educational challenges.

One of the components of collaboration is leadership. Ahumada and Pino-Yancovic (2020), Provan and Kenis (2008), and Mellado et al. (2020) affirm that leadership processes are essential for defining, updating, and clearly and explicitly concretizing the goals and action plan of collaborative work in teacher networks. Professional development can be promoted through participation in formal and informal leadership roles, as well as engaging in different forms of interaction.

The creation of management processes for solving problems identified in school contexts can be achieved through collaboration between teachers. In this way, teachers learn together through a process of inquiry and collective management that relies on analysis of specific classroom situations (Horn and Little, 2010; Butler and Schnellert, 2012; Krichesky et al., 2018)

The second category of analysis is innovation. Barraza (2005) and Rivas (2000) indicate that the process of curricular innovation is divided into three distinct categories: 1) Diagnostic development practices include the definition of models and the creation of strategies for collecting information. 2) The definition of models and approaches, as well as curricular evaluation practices, are part of curriculum structuring practices. 3) Didactic innovation emphasizes that an innovation derived from reform involves curricular restructuring, which arises as a response to problems identified in schools.

Based on research findings highlighting the benefits of networks as PLCs for teachers (Vangrieken, 2017), the SED conceptualized in their strategic development documents the establishment and support of a teachers' network starting as an opportunity for CPD.

In this context, the next sections present the research focus, methodology, and findings with the aim of identifying how CPD for teachers was conceptualized to occur within the STEM Network.

3. METHODOLOGY

Krippendorff (2004) and Paramo (2011) define content analysis as a systematized approach to examining and comprehending document content, considering data as carriers of meaning. A systematic process is followed for content analysis that involves several steps, starting with collecting the sample of data to be analysed through codification involves identifying and classifying the various categories or topics present in the content.

To comprehend the concepts that are part of SED in relation to teacher CPD within the networked PLC approach, a content analysis of the SED-adopted institutional and public policy documents, as well as the discourse from interviews with the STEM Network Program coordinators, was conducted.

Below are presented the corpus, categories, and sub-categories of content that were identified, along with the methodological parameters and criteria that were considered for conducting the interview.

3.1. Selection of the body of information

The Ministry of Education's website and virtual documentary repositories were used as starting points for data collection to identify the guideline documents for the STEM Network and the accompanying documentation generated at the institutional level.

The research categories were classified qualitatively; latent content analysis relies on the researcher's inferences from the document corpus. The interpretation of agency and association within the texts results in an indirect content analysis. Therefore, it is framed in an open model, as described by Páramo (2011) and Pérez-Serrano (1994). Below is the list of specifications for the documentary corpus:

Table 2. The documentary corpus.

Document Code	*Reference*	*Document Type*
D1-STEM G-Colombia-STEM G-Colombia	Ministerio de Educación Nacional. (2022). Visión STEM, Educación expandida para la vida. Bogotá, D.C., Colombia	Book national guidelines for STEM education in Colombia
D2- STEM G-Latinamérica-STEM G-Latinamérica	Gras, M. (coord) y C. Alí (2023). Educación STEM y su aplicación. Una estrategia inclusiva, sostenible y universal para preescolar y primaria. Movimiento STEM	Guidelines of Networking teachers STEM Latin America
D3-Interview-Interview	Semi-structured interviews	Interview transcript

Source: Own elaboration

3.2. Semi-structured interview

Considering that Uniminuto operates the institutional support of the STEM Network's SED, two semi-structured interviews lasting one hour were conducted with the coordinators of the accompaniment for the two instances mentioned.

Data gathering in research and qualitative analysis is accomplished through the use of semi-structured interviews. This approach combines open and structured interviews with a reflexivity component and the process of researchers being conscious and critical of their influence, perspective, and position in the investigative process (Ibrahim & Edgley, 2015) is referred to as the latter.

The process of deriving meanings from data is inductive, subjective, and recurring (Krippendorff, 2004). A framework with pre-defined questions or topics serves as the starting point, but the interviewer can explore specific areas in greater depth based on the interviewee's responses. By utilising these themes, conceptualizations can be obtained and meanings can be expanded (Hernández, Fernández, and Baptista, 2010).

The interview was based on two purposes: 1) to identify strategies, lines of action, and the results derived from their implementation, understanding how the coordinators for the STEM Network program translated the stipulations of the policy documents and the expectations about the program. 2) Identify opportunities for cooperation and educational innovation in institutional support.

The participants consented to the recording of the interview, and transcription was performed with the transcription in *Transkriptor software* of the audio recording into text. The interviews were performed online in Spanish, in december of 2023, and the translation into English, for the purposes of the article, was done by the author, in the process of the analysis.

3.3. Definition of subcategories

Considering the indirect content analysis method, the categories presented below were selected during the revision of the documentary corpus, they were identified as fundamental to the structure of the programme:

Table 3. Categories and subcategories

Categories	Sub-categories based on the review of the documentary corpus
Educational collaboration and innovation	Quality of education
	Educational management
	Accompaniment
	Social innovation

Source: Own elaboration

4. RESULTS

The results of the content analysis are organized in two parts: The first part is dedicated to analyzing and contrasting the conceptualizations of the subcategories related to the previous item. The second part is descriptive and presents the strategies of formation and accompaniment of the STEM Network that were identified in the interviews with the coordinators.

4.1. Analysis of conceptualizations:

The first part of the analysis focuses on examining the concepts that constitute the accompanying process, which are part of the subcategories of analysis. It is based on the question *How are the most relevant elements of the teaching collaboration conceptualized in the institutional accompaniment carried out by the District Education Secretariat (SED) for the STEM Network*? For this purpose, the following tables present the identified concepts from the documents corpus.

4.1.1. Conceptualizations of the subcategories

Table 4. Accompanying concept

Documentary corpus	*Conceptualization*
D1-STEM G-Colombia	The Ministry of Education in Colombia (MEN) defines it as a component of the programs for teachers and managers in the public education system to evaluate classroom practices, improve them, and promote collaborative work. Document 1 outlines the need for accompaniment to encourage the revision of the 'Index of Educational Innovation' and the 'Synthetic Index of Educational Quality'. (Institutional aspects are to be expanded in the ITEM DE concept analysis.).
D2- STEM G-Latinamérica	The concept of accompaniment in the Latin American STEM Network is situated in the World Bank's Coach model, which promotes teacher professional development through different forms, such as individual and group sessions, in person or at a distance.
D3-Interview	Institutional accompaniment to the STEM Network was defined by the interviewees as dynamization to empower teachers in processes of management of pedagogical projects based on STEM, collaborative work, and participation in city scenarios - country, as evidenced by the training and support strategies of the previous ITEM.

Table 5. Conceptualization of innovation

Documentary corpus	*Conceptualization*
D1-STEM G-Colombia	The Ministry's innovative approach is to promote collaborative and transdisciplinary work in the education system to transform five areas: governance and institutional management, curriculum and pedagogical practices, teacher capacity development, management of pedagogical knowledge, and networks and alliances. This approach promotes collaborative work, curricular integration, and teacher development with an emphasis on social innovation and proposes an ecosystem of relationships between institutions that promotes experiences, practice centers, and job opportunities in the logic of the Fourth Industrial Revolution.
D2- STEM G-Latinamérica	The conceptualization of innovation by the SIEMENS STEM Latin America Network, is based on the definitions of the Economic Commission for Latin America and the Caribbean is the agency of the United Nations which defined social innovation as forms of management, administration, execution, instruments and combinations of factors aimed at improving social and living conditions in the region. This concept has emerged as a response to persistent social problems of social diagnostics UN, UNESCO Latin America.
D3-Interview	Interviewed 1: "Todavía no tenemos una una definición colectiva de innovación, [...] uniminuto, apoya mucho porque tienen un Parque de innovación social que le han metido muchísimo a lo que somos hoy, la innovación desde lo social. [...] estamos innovando desde lo social, nuestros proyectos transforman, pero después también desde el colectivo y desde las pensadas que tenemos al interior del colectivo nos dimos cuenta que no era innovación social, que es innovación educativa." [A collective definition of innovation hasn't been established yet [...] Uniminuto offers a lot of support due to their Park of Social Innovation, which has played a significant role in social innovation [...] Our projects are changing as a result of our perspective of social innovation [...] But then, from the collective and the thought that we have within the collective, we realized that it was not social innovation, but rather educational innovation.]

Table 6. Management education conceptualization

Documentary corpus	*Conceptualization*
D1-STEM G-Colombia	The concept of educational management of the Ministry of Education in Colombia is based on the perspective of knowledge management through the involvement of various actors in the educational system and the investment of resources, and involves four areas: Management; pedagogical and academic management; community management; and administrative management.
D2- STEM G-Latinamérica	Alliances Management structures Exchange Coordination Shared objectives among actors and organizations in the territories to generate long-term sustainable organised process for knowledge management and innovation in order to build permanent monitoring to mobilise actions aimed at achieving the goals
D3-Interview	During the interview, no direct question was asked about the concept of management; however, in the process of narrating network structuring strategies, it can be deduced that the practice corresponds to the management vision of documents 1 and 2.

4.1.2. Conceptual correlations and discussions

a) The concept of quality education as a transversal axis of STEM processes in Latin America.

In documents *D1-STEM G-Colombia* and *D2- STEM G-Latinamérica*, the concept of quality was found, but it was not mentioned in the interviews. This concept in the guidelines documents is understood as an aspect that underlies all processes of educational management and innovation.

According to Moyano and Rodrigo (2022), the lack of quality in Latin America is based on comparisons with other parts of the world as a sign of educational needs. Mostly, progressive sectors look at the American case and say that high rates of youth unemployment: a) "affirm that educational systems are inadequate to the needs of the production and service sectors"; b) unemployment in skilled labor sectors; and c) low levels of education.

A correlation can be observed between the parameters established by the World Bank and international organisations in the table of concepts of accompaniment and innovation; precisely, the alignment of the SDGs with

STEM development processes in the accompanying program aligns with this perspective of addressing social inequalities, the solution of contextual problems that affect public schools, and pedagogical actions aimed at sustainability.

According to Lacayo (2015), Moyano and Rodrigo (2022), and Bianchetti (2009) the paradigm of educational quality in Latin America has undergone a change due to society's economy, and the reformulation of educational content and institutional models connects economic principles with education and the theory of human capital.

The neoliberal project expanded the concerns raised by the United States by managing multilateral funding organisations in Latin American countries. Accurately, documents 1 and 2 show that the articulation of the Sustainable Development Goals in STEM processes in education presupposes the development of quality in education, and this concept is promoted by the World Bank and by international institutions that carry out socio-educational diagnoses in Latin America.

The use of this concept and its articulation in different educational processes by government bodies has been pointed out in various debates in Colombia as interference in the public education sector. The concept of educational quality has evolved in Colombia's educational policy, according to the social and political beliefs that were shaped by the educational reforms of the past 30 years, as Mejía (2015) emphasized. It initially had a Taylorist and Fordist approach, but currently it is using the Toyota production system and has been transferred to the educational system.

Mejía (2015) suggests that STEM's inclusion in the educational system is a new concept of human capital that prioritizes competencies and standards. These conceptual relations can be observed with recurrence in the conceptualization developed in documents 1 and 2. As stated by Mejía (2015), quality is considered a factor in reassembling the social outcomes of the school. It always appears to be related to equity as a justification to address the exclusion and vulnerability of social groups that are part of the public sector of education in Latin America.

b) The idea of innovation and its connection to management.

The documentation corpus identifies innovation as a recurring concept, and documents 1 and 2 define it as the body of knowledge. Practices and values that promote challenges and ideas to improve or transform school contexts, in addition to the cooperation and participation of various actors and permanent teamwork among the subjects and organisations involved, are key factors in creating innovative initiatives in public education.

In the process of institutional accompaniment to the structuring of the STEM Network, this way of conceptualising innovation can be evidenced in the involvement of teachers in workshops where problems were identified to generate work challenges based on the SDGs.

The documents *D1-STEM G-Colombia* and *D2- STEM G-Latinamérica* indicate that innovation is created through the education public policy strategy known as the Educational Innovation Ecosystem (Ecosistema de innovación educativa) and a monitoring and evaluation model known as the Educational Innovation Index (Indice de innovación educativa). The first term is about a network of networks between people and organizations that establish the conditions and interactions required to promote changes in the educational system.

Based on a shared understanding of transformations on the following levels: 1) Microsystems are useful for teachers, students, and directors of institutions. 2) Mesosystems are relationships that develop between several nearby environments, such as institutions, cities, and communities of the territory. 3) Macrosystems: long-term relations with government bodies and/or international entities, such as the Siemens Network of Latin America.

Considering the different areas of management of STEM Network support, the innovation horizon is framed in the ecosystem of educational innovation set out in documents *D1-STEM G-Colombia and D2- STEM G-Latinamérica*. The components of this ecosystem include research, experimentation, and dissemination of educational innovation practices. In the structuring of the STEM Network, these components were developed with the participation of teachers in the STEM Olympics, in academic events of dissemination of pedagogical projects, and in the creation of a research group between teachers and Uniminuto, registered before the Ministry of Science, Technology, and Innovation of Colombia.

Open educational management is associated with this perspective of innovation. According to Greco, Grimaldi, and Cricelli (2013) and Ramírez (2015), this perspective of management in education is a form of work that extends participation and interdisciplinary work to both internal and external experts of the organization leading it. As for new ideas, the push for open participation and the sharing of knowledge among many people suggests that this way of working can benefit from working with outsiders to make things run more smoothly and encourage open innovation spaces.

Thus, the support of the SED related to inter-institutional management addresses a process of formation and accompaniment to establish significant connections between teachers of the network and other institutions such as universities and public and private entities. This organization of accompaniment is

situated in the perspective of open education, which promotes the opening of knowledge and the facilitation of collaboration in the construction of knowledge and positions the need for reflective and practical spaces in educational communities.

Flores (2021), while describing educational management models in Latin America, refers to those related to the concept of global society, the information revolution, advances in communications, the fall of socialist systems, and the economic recession resulting from the neoliberal model, which in turn is reflected in educational policies and management structures and is legitimised in the quality discourse linked to the notion of social justice, and three management aspects: teacher training, curriculum reforms (contents, methods, and materials), and the management of the education system.

4.2. Strategies for teacher training and support in the STEM Network

The second section emphasizes the following questions: What strategies are implemented in the training and accompaniment process to promote collaborative work among teachers? And what strategies are used to ensure the sustainability and development of the network?

The Ministry of Education of Bogotá accompanies the STEM + Transforms Teachers Network, through the Directorate of Sciences, Technologies and Educational Media, in agreement with the Scientific Park of Social Innovation (PCIS) of UNIMINUTO. UNIMINUTO is a university academic research entity focused on Regional Ecosystems of Science, Technology, and Innovation in Colombia.

> ***Strategy 1 of accompaniment****: Structure of the Network from workshops and conversations between the SED, Uniminuto and the teachers.*

Accompaniment promotes the *formation of teacher communities*, through open calls for voluntary participation. Teachers who participate have teaching contracts in the public and governmental education systems, and then the role of the coordinating team of the Ministry of Education is as facilitators:

> [For the teachers' network, to start organizing a accompaniment route pedagogical and methodological [...] we did not have such a clear vision, we had to go review other references and also start to see what happened when we met with teachers, we always perceive our support as dynamizers]. (Translation of textual transcriptions interviewed 1)

According to interviews, when the STEM Network began, the community of teachers was identified and formed by acknowledging similar pedagogical experiences at first meetings. Therefore, it became relevant to establish a shared identity or vision for the group.

> [The teachers were the ones who made the decisions about the mission, vision, governance, and everything else, we provided tools for them to make those decisions, just for that, the agreement between SED and Uniminuto was made.] (Translation of textual transcriptions interviewed 2)

The product of this process was the editing and diagramming of a document with mission, vision and brief reference of the network that was constituted as an advertising piece to summon other teachers to participate in the Network. In addition, to create a work plan, it was necessary to characterize pedagogical processes in common after calling teachers to workshops to organize the structure and strategic plan of the network. A description of the specific activities in the teacher workshops is provided based on the interests and pedagogical processes of the participating teachers.

> [One of the tasks in the workshops with the teacher´s involved sticking paper on the wall with questions intended, they were very participative [...] Our role involves moderating inquiries about Sustainable Development Goals: What are your thoughts on the SDG that aligns with your community's context?, What actions do you want to take to resolve a problem?, What are your ideas? [...] They selected the SDGs that were most relevant to their context, and from there, the 6 nodes with those 6 themes were created.] (Translation of textual transcriptions - Interviewed 2)

In this manner, the interviewees agreed that the first strategy to organize collaborative work was the dialogue between teachers for the formation of work subgroups (they were called Nodes), for the construction of a documentation sheet was done to identify key information related to classroom practice.

This fact sheet compiles general data on pedagogical practices. Some teachers say that they have implemented various practices in the classroom, but they have not had the opportunity to organize them in a structured manner.

<u>Accompanying Strategy 2:</u> Promote the leadership of teachers belonging to the Network.

The aim of the support is to establish and empower teachers as innovators in educational institutions, with diverse pedagogical processes. According to the interview conducted by the management team of the Network from the Education Secretariat, after the formation of the work teams (Nodes), the accompanying process in the consolidation of the network continued with the structuring of a work proposal.

During the interview, interviewees emphasized the importance of teachers being positioned and empowered as leaders in the network in order to guarantee the governance and sustainability of the network, therefore the steering node was conceived as a fundamental strategy.

> [Always with the intention that the teachers are the ones who do all the construction processes [...] We proposed two significant fronts during the dynamization and accompaniment process [...] Oversee the network's internal governance and facilitate knowledge-building scenarios. Concerns that there is a [...] steering node for network governance.] (Translation of textual transcriptions Interviewer 2)

In this process, teachers interested in leading the nodes applied through videos explaining their professional profile and motivations to represent the network. The SED support facilitators discussed how to organize meetings to consolidate the network and specific nodes during their meetings. Three types of network meetings were created after considering the participants' preferences for virtual or face-to-face meetings when choosing modalities: 1) Face-to-face meetings and general events where all teachers on the network participate, seeking to provide a comfortable and conducive space for interaction. Virtual meetings that are customized for each node. 3) The introduction of the concept of exploring other spaces and sharing experiences resulted in itinerant chairs that link other institutions in the process. The following item will provide additional information about the latter.

<u>Supporting strategy 3</u>: *Connecting the network to institutional and inter-institutional management processes.*

Through the integration of another work strategy of the Bogotá Education Secretariat, the STEM Olympics, the next phase in the structuring of the Network involved consolidating pedagogical proposals, as a result, the pedagogical projects were developed and implemented by teachers who participated in the Red STEM.

For this, they had to form institutional teams of teachers and students who identified problems or socio-educational challenges and created creative solutions for STEM subjects. During the call and development of projects to participate in the STEM Olympics, the Science Directorate, Educational Technologies, and Media of the SED had manuals for the identification of challenges or problems and sequences for the creation of solutions and prototypes, aimed at encouraging teamwork and promoting the development of problem-solving skills and competencies in teacher-student teams.

As a result, the network's general organisation was established in 2021, and it was expanded in 2022 with an open call that brought together other teachers. Consequently, the accompaniment was focused on recognising and strengthening the management team of the STEM Network and the management of alliances with other institutions, universities, and companies with the purpose of strengthening teacher training processes, contributing to the systematization of pedagogical proposals, and participating in dissemination scenarios for pedagogical projects.

Finally, itinerant seminars (cátedras itinerantes) are the third space for dialogue, meetings, and training for teachers in the Network. These are experiences of training and dialogue between peer teachers and experts developed in strategic institutions for the development of STEM processes in Bogotá, Colombia (Universities, museums, technological institutes).

The methodology developed for each of these meetings made it possible to explore various thematic areas, based on the interests and requirements of training and professional development expressed by the founding teachers of the Network in 2021, particularly dialogues and training with experts revolve around STEM education, technology projects, and the integration of inter- and transdisciplinary curricular approaches.

Role of quality concept in STEM Networks and educational systems in Latin America

The focus of this content analysis has been on the concept of quality as a factor that influences all management processes within STEM networks in Latin America. It concerns educational policy postulates that are specifically designed for the public education sector, specifically targeting populations in conditions of social vulnerability or poverty. Demographic assessments indicate that these populations require a range of interventions to improve educational quality.

The concept of quality and new models of educational management in Latin America have generated numerous analyses and discussions. The majority of these are derived from studies of popular pedagogy that concentrate on teachers

and students in the public sector, emphasizing the significance of comprehending public educational policy.

The economic system's challenges are connected to social development, which has an ideological meaning and intention. This aspect can be demonstrated by examining the correlations between the concept of quality and the parameters of institutions such as the World Bank regarding public policies in educational innovation and sustainable development. One of the research topics is the conceptual understanding of educational innovation and the involvement of teachers in STEM pedagogical projects.

CONCLUSIONS

Through this content analysis, it has been identified that the implementation of STEM support programs promotes the empowerment and leadership role of teachers in promoting pedagogical proposals, fostering an environment where innovation can generate alternatives for intervention in educational contexts and collaborative work strategies that are consolidated through the network structure and that can reach from micro to macro contexts (school, city, country). However, in the conceptualization of innovation, it was identified that the empowerment work and leadership role of teachers are part of the results of accompanying social innovation.

Precisely, it was evidenced that the concept of social innovation is prominent in the STEM vision documents of the Ministry of Education of Colombia and the SIEMENS Latin America Network. However, the research possibility of investigating teachers' perceptions of the specific meanings of social innovation and educational innovation remains open, with the aim of better understanding their interpretations and implementation perspectives in the classroom. This reflection can also be incorporated into the exploration of educational research perspectives and the generation of knowledge about STEM educational processes.

Another significant aspect is understanding how teachers perceive their relationship with institutional support, the leadership dynamics, and their operational scope in educational institutions with STEM programs. This is significant because this network of educators generated the proposal with institutional support, encouraging various dialogues and reflections on the new benchmarks of STEM education and the development of educational policies surrounding these issues, particularly in relation to collaborative work.

The above is due to the contrast between the organizational perspective of the network and the established teacher networks in Colombia's public sector, which began in the 1980s as voluntary initiatives by primary and secondary school teachers. These networks were created to counter the education system,

influenced heavily by the ideas of Latin American popular pedagogy and have significantly impacted social movements and protests among this sector of teachers in Colombia from the 1990s to the present. It is necessary to continue identifying the changes and adaptations of teacher networks from their historical beginnings in Colombia with the National Pedagogical Movement to the dialogues generated with new references in public educational policy.

According to the content analysis, the network's success has been attributed to the collaborative work and leadership of teachers. The collaboration between educators and their leadership capacity have contributed significantly to the progress and development of the network, highlighting the relevance of these qualities in the educational field.

Finally, there are still challenges in establishing effective strategies for engaging educational institution managers in the STEM Network. This finding suggests that, despite the achievements in terms of collaboration between teachers, it is necessary to work on the implementation of strategies that promote the participation of the directors of educational institutions.

Even though the solutions of the educational institutions and policymakers in Columbia have undertaken are relevant to the international contexts, they can be informative for other educational institutions and leaders in the attempt to upskill the teachers to foster better educational quality and innovation in their pedagogical processes.

Acknowledgement

I would like to express my gratitude to the team from SED in Bogotá, Colombia for their valuable support and access to the data. Also, my appreciation to Prof. Simona Sava (West University of Timisoara, Romania) and Prof. Rolf Arnold (Technische University of Kaiserslautern, Germany), my PhD supervisors, for their feedback and coordination.

REFERENCES

Barraza Macías, A. (2005). Una conceptualización comprehensiva de la innovación educativa. *Innovación Educativa, 5*(28), 19-31. Recuperado de: https://www.redalyc.org/articulo.oa?id=179421470003

Butler, D. L., & Schnellert, L. (2012). Collaborative inquiry in teacher professional development. *Teaching and Teacher Education, 28*(8), 1206–1220. https://doi.org/10.1016/j.tate.2012.07.009

Deaza, L. (Host). (2022, 13 de octubre). Bogotá territorio STEM [Podcast]. Red Académica. Recuperado de https://www.redacademica.edu.co/podcast-ulia-yemail-cortes-Bogotá -territorio-stem

Flores-Flores, H. (2021). La gestión educativa, disciplina con características propias. *Dilemas contemporáneos: educación, política y valores, 9*(1), 00008. https://doi.org/10.46377/dilemas.v9i1.2832

Greco, M., Grimaldi, M., & Cricelli, L. (2013). Open innovation actions and innovations performance. *European Journal of Innovation Management, 18*(2), 150-171. doi: 10.1108/EJIM-07-2013-0074

Gras, M. (coord) y C. Alí (2023). Educación STEM y su aplicación. Una estrategia inclusiva, sostenible y universal para preescolar y primaria. Movimiento STEM

Hernández, R., Fernández, C., & Baptista, M. d. (2010). Metodología de la Investigación. (J. M.Chacón, Ed.) Mexico D.F.: Mc Graw & Hill.

Horn, I. S., & Little, J. W. (2010). Attending to Problems of Practice: Routines and Resources for Professional Learning in Teachers' Workplace Interactions. *American Educational Research Journal, 47*(1). https://doi.org/10.3102/0002831209345158

Ibrahim, N., & Edgley, A. (2015). Embedding Researcher's Reflexive Accounts within the Analysis of a Semi-Structured Qualitative Interview. *The Qualitative Report, 20*(10), 1671-1681.

Krichesky, G. J., Murillo F. Javier. La colaboración docente como factor de aprendizaje y promotor de mejora. Un estudio de casos. *Educación XX1*, 21(1), 135-155. Disponible en: https://www.redalyc.org/articulo.oa?id=70653466007

Krippendorff, K. (1990). Metodología de análisis de contenido: Teoría y práctica. Paidós Comunicación.

Lacayo Parajón, F. J. (2015). Calidad de la educación o nuevo paradigma de educación?. Grupo de Incidencia en Política Educativa del Consejo de Educación Popular de América Latina y el Caribe (CEAAL). Ministerio Federal de Cooperación Económica y Desarrollo. (2015). Debate sobre calidad educativa.

Mejía, M. R. J. (2015). La calidad de la educación, una disputa polisémica por sus sentidos. En Miradas desde la Educación Popular, Documento de trabajo no.6, Colección Acceso a la educación. Serie Debate sobre calidad educativa (p. 7). Recuperado de http://biblioteca.clacso.edu.ar/Costa_Rica/ceaal/20160506035311/Debate_sobre_calidad_educativa.pdf

Mellado, M. E., J. C. Chaucono y Villagra, C. (2017). Creencias de directivos escolares: implicancias en el liderazgo pedagógico. *Psicología Escolar e Educacional, 21*(3), 541-548. doi: 10.1590/2175-35392015021679

Ministerio de Educación Nacional. (2022). Visión STEM, Educación expandida para la vida. Bogotá, D.C., Colombia.

Navarro Navarro, L., & Pérez Norambuena, S. (2023). Redes de aprendizaje profesional docente en contextos escolares chilenos. *Cuadernos De Investigación Educativa, 14*(1). https://doi.org/10.18861/cied.2023.14.1.3269

Páramo, P. (2011). La investigación en ciencias sociales: Estrategias de investigación. Universidad Piloto de Colombia. ISBN: 978-958-8537-25-2.

Pérez Serrano, G. (1994). Investigación Cualitativa. Retos e interrogantes: Métodos. Editorial La Muralla, S.A.

Prenger, R., Poortman, C. L., & Handelzalts, A. (2019). The Effects of Networked Professional Learning Communities. *Journal of Teacher Education, 70*(5), 441–452. https://doi.org/10.1177/0022487117753574

Provan, K. G., & Kenis, P. (2008). Modes of network governance: Structure, management, and effectiveness. *Journal of Public Administration Research and Theory, 18*(2), 229–252. https://doi.org/10.1093/jopart/mum015

Rivas Navarro, M. (2000). Innovación educativa: Teoría, procesos y estrategias. Síntesis. España.

Rodriguez Moyano, I., & Rodrigo, L. (2022). La evaluación de la calidad de la educación en Argentina. Tendencias y trayectoria de la política educativa nacional (1990-2022). *Revista Latinoamericana De Políticas Y Administración De La Educación, (17)*, 13-25. Recuperado a partir de https://revistas.untref.edu.ar/index.php/relapae/article/view/1479

Secretaría de Educación de Bogotá (2019). Funciones y deberes. Recuperado de https://www.educacionBogotá.edu.co/portal_institucional/nuestra-entidad/funciones-y-deberes. Fecha de consulta: noviembre de 2023.

Siemens Stiftung. (2022). Territorio STEM Bogotá: Una Capital para el Talento con Escuelas como Escenario de Innovación. Recuperado de https://educacion.stem.siemens-stiftung.org/territorio-stem-Bogotá/. Fecha de consulta: noviembre de 2023.

Soares, F., Galisson, K., & Van de Laar, M. (2020). A Typology of Professional Learning Communities (PLC) for Sub-Saharan Africa: A Case-study of Equatorial Guinea, Ghana, and Nigeria. *African Journal of Teacher Education, 9*(2), 110–143. https://doi.org/10.21083/ajote.v9i2.6271

Vangrieken, K., Meredith, C., Packer, F, Kyndt, E. (2017). Teacher communities as a context for professional development: A systematic review. *Teaching and teacher education. 61*, 47-59. http://dx.doi.org/10.1016/j.tate.2016.10.001

Yli-Renko, H., Autio, E., & Sapienza, H. J. (2001). Social capital, knowledge acquisition, and knowledge exploitation in young technology-based firms. *Strategic Management Journal*. https://doi.org/10.1002/smj.183