

Collaboration from *Freire's* perspective in the tessituras of collaborative work and groups in mathematical training

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Abstract

The mapping and analysis of scientific productions published in the Annals of the National Association of Graduate Studies and Research in Education, from 2000 to 2023, part of the Doctoral research, seek to understand, through the Systematic Literature Review, the meanings of collaboration from the Freirean perspective in the fabric of work and collaborative groups in spaces for training teachers who teach mathematics, shared in Working Group 19: "Mathematical Education". This action within the scope of qualitative research provided an understanding of the object of study, based on an interpretative and critical view of Freire's theoretical-methodological framework and the interpretative thematic analysis of the data. The Systematic Literature Review made it possible to interpret the data through the foundations of collaboration from the Freirean perspective, conceptualized as a dialogic-collaborative action, and it also confirmed the absence of studies on collaboration in this conception in mathematical education which explicitly dialogue with Paulo Freire.

Keywords

Collaboration; collaborative group; collaborative work; mathematical training; Problem-Solving Mathematical Education.

A colaboração na perspectiva *freireana* nas tessituras do trabalho e grupo colaborativos na formação matemática

Resumo

O mapeamento e a análise das produções científicas publicadas nos Anais da Associação Nacional de Pós-Graduação e Pesquisa em Educação, no período de 2000 a 2023, como parte de uma pesquisa de doutorado, buscam compreender, por meio da Revisão Sistemática de Literatura, os sentidos da colaboração na perspectiva *freireana* nas tessituras do trabalho e de grupo colaborativos em espaços de formação de professores/as que ensinam Matemática, compartilhados no Grupo de Trabalho 19: "Educação Matemática". Essa ação no âmbito da investigação qualitativa proporcionou entender o objeto de estudo, a partir de um olhar interpretativo e crítico sobre o referencial teórico-metodológico *freireano* e a análise temática interpretativa dos dados. A Revisão Sistemática de Literatura possibilitou interpretar os dados através dos fundamentos da colaboração na perspectiva *freireana*, conceituada como uma ação dialógico-colaborativa, e também constatar a ausência de estudos sobre a colaboração nessa concepção na formação matemática que dialogam de forma explícita com Paulo Freire.

Palavras-chave

colaboração; grupo colaborativo; trabalho colaborativo; formação matemática; Educação Matemática Problematicadora.



La colaboración desde una perspectiva *freireana* en el tejido del trabajo colaborativo y los grupos en educación matemática

Resumen

El mapao y análisis de las producciones científica publicado en los Anales de la Asociación Nacional de Posgrado e Investigación en Educación, de 2000 a 2023, como parte de una investigación de doctorado, buscan comprender, por medio de la Revisión Sistemática de Literatura, los significados de la colaboración desde la perspectiva *freireana* en el tejido de trabajos y grupos colaborativos en espacios de formación de profesores que enseñan Matemáticas, compartidos en el Grupo de Trabajo 19: "Educación Matemática". Esta acción en el ámbito de la investigación cualitativa proporcionó una comprensión del objeto de estudio, de partir de una mirada interpretativa y crítica del marco teórico-metodológico de Freire y del análisis temático interpretativo de los datos. La Revisión Sistemática de Literatura permitió interpretar los datos a través de los fundamentos de la colaboración desde la perspectiva *freireana*, conceptualizado como una acción dialogico-colaborativa, y también confirmó la ausencia de estudios sobre la colaboración en esta concepción en la educación matemática que dialogaran explicitly con Paulo Freire.

Palabras clave

Colaboración. Grupo Colaborativo. Trabajo Colaborativo. Formación Matemática. Educación Matemática Basada en Problemas.

1 Introductory assumption

Among the formative practices experienced in doctoral research in the Graduate Program in Education (PPGE) of the Federal University of Juiz DE Fora (UFJF), we highlight a moment that we consider relevant – the mapping of research through a Systematic Literature Review (SLR) of scientific productions in the different databases –, which provided us with "[...] a systematic process of surveying and describing information about the research produced on a specific field of study, covering a certain space (place) and period of time" (Fiorentini *et al.*, 2016, p. 18).

This action within the scope of qualitative research allowed us to understand the epistemological, theoretical and methodological bases of Freire 's *theory* of dialogical action (Freire, 2021b), intertwined with collaboration in the weights of collaborative work and groups in the mathematical training of teachers. In this context, from *Freire's* perspective, collaboration infers dialogical action, collaboration expands unity, collaboration requires organization and collaboration favors cultural synthesis.

In the meantime, from an interpretative and critical look at the theoretical-methodological framework of Paulo Freire and Mathematics Education researchers, we

will analyze the meanings of collaboration in the data produced in the research. Thus, SLR, as a research modality, follows specific protocols to understand the research of the investigated *corpus* through the bibliographic databases consulted, the search strategies used in each database, the selection process of scientific articles that discuss and approach the specific field of study, the inclusion and exclusion criteria of the selected articles and the analysis process of each scientific production (Galvão; Ricarte, 2019).

Through readings and reflections on the works of the great educator and globally recognized researcher Paulo Freire, in the course of the formative journey of the first author of this article, and in a more systematic and consistent way in the doctorate in Education at PPGE/UFJF, we seek to understand the meanings of collaboration from the *Freirean* perspective in the tessitures of collaborative work and groups in teacher training spaces that teach mathematics in early childhood education and in the early years of elementary school, shared in the articles published in the Working Group (WG) 19: "Mathematics Education", of the National Association of Graduate Studies and Research in Education (ANPEd).

It is worth noting that Paulo Freire's contributions, according to Kohan (2019, p. 15), "[...] are not limited to a written work, much less to a method, nor to a theoretical paradigm, but also concern a practice and, more generally, a life dedicated to education, a life as a school, a school of life [...]", which inspire us with their teachings of life and permanent formation. "Training that is based on the critical analysis of their practice" (Freire, 2002, p. 28).

In view of this, the theme researched within the scope of the doctorate in Education and shared in this article, considering our formative and professional trajectories, has disturbed us and affected the use of Paulo Freire's critical pedagogy in our research in Education and Mathematics Education.

For this reason, the keywords "collaboration", "collaborative work", "collaborative group" and "*Freire's perspective*" were used to map the articles published in WG 19 - "Mathematics Education" and published in the Annals of ANPEd Meetings from 2000 to 2023. These will be analyzed in the following sections, which discuss the fundamentals of collaborative actions from *Freire's* perspective in the tessitures of research carried out in the area of Mathematics Education.

2 Research methodology on the paths taken

In this qualitative research, we sought to describe the data produced in dialogue with the investigated object, considering “[...] that the richer the understandings, the more varied the sources or data on which we seek to support ourselves to understand and express both the research themes and the understandings produced” (Fernandes; Garnica, 2021, p. 5) in the context of SLR.

The systematic review, according to Petticrew and Roberts (2006, p. 2, our translation), “[...] is a method that gives meaning to the set of information and a means of contributing to the answers to questions [...]”, as it is “[...] a method to map areas of uncertainty and identify where little or no relevant research has been done, but where new studies are needed”. In choosing this method, we used some methodological procedures based on the study of these authors, focusing on the object investigated in the doctoral research in Education.

In the formative spaces of the university and basic school, we defend the permanent and collaborative mathematical formation of teachers, woven with a Problematizing Mathematical Education (Oliveira; Carneiro, 2024), based on the assumptions of Paulo Freire's critical theory, based on a problematizing education as a formative principle, mediated by the dialogical relationship, through praxis that implies action and critical reflection of reality (Freire, 2021a) and “learning *from* and *with* you” (Freire, 1978, p. 85).

In this scenario, we feel instigated to analyze the meanings of collaboration from *Freire's perspective*. For this, we delimit the research question, pointed out as an essential step to start the SLR, which is intended: “How is collaboration from the *Freirean* perspective woven into the scientific productions of ANPEd's WG 19: “ Mathematics Education ”, which discuss collaborative work and groups in the training of teachers who teach mathematics?”.

After outlining the guiding question, in order to map the results of scientific productions published in ANPEd's Annals of National Scientific Meetings, we searched for articles. Thus, the definition of the keywords –“collaboration”, “collaborative work”, “collaborative group” and “ *Freirean* perspective” - was an essential step for the composition of the analyzed *corpus*, which will be shared in the following section. Thus,

"precise keywords are important" (Petticrew; Roberts, 2006, p. 101, our translation) to properly access the information related to the investigated phenomenon.

In the search process in this database, we verified all scientific productions in the "Poster, work and commissioned work" modalities of WG 19, made available in the Electronic Proceedings on the ANPEd *website*¹. Thus, we consulted the articles from 2000 to 2023 referring to the 23rd to 41st Meetings, and the Proceedings of the last Meeting are included on another website².

It is noteworthy that, from the 39th National Meeting of ANPEd, the category "Thematic Panel" was added and the category "Complete work" was changed to the categories: "Expanded abstract-work" and "Expanded abstract-poster". The 41st National Meeting of ANPEd changed the category "Abstract expanded-poster" to "Abstract expanded-work in progress".

The selection in the database initially consisted of reading the title, abstract and keywords of all the papers of the modalities of each ANPEd Meeting (Table 1). To organize the data of the works that dialogue with the research question, we read the full texts and prepared Table 1.

Table 1 below shows the number of works published in the Annals of ANPEd Meetings from 2000 to 2023, highlighting the number of scientific productions that dialogue with the investigated object.

Table 1 – Quantitative of works published in the Annals of ANPEd Meetings, in WG 19, which dialogue with the research

(continues)

| Annals of ANPEd Meetings/Event Location/Year | Job categories | Number of works published in the Annals | Quantitative of works that dialogue with the research |
|--|---------------------------|---|---|
| 23rd Meeting CAXAMBU-MG, 2000 | Full paper | 18 | - |
| | Posters | 3 | - |
| 24th Meeting CAXAMBU-MG, 2001 | Full paper | 13 | - |
| | Posters | 2 | - |
| 25th Meeting CAXAMBU-MG, 2002 | Full paper. | 10 | - |
| | Posters | 3 | - |
| | WG08 - Commissioned Work. | 1 | - |

¹ Available at: <https://anped.org.br/reunioes-nacionais/>. Accessed on: Feb 20th, 2025

² Available at: <https://base.pro.br/sites/41anped/>. Accessed on: Feb, 20th. 2025

(continues)

| <u>Annals of ANPEd Meetings/Event Location/Year</u> | Job categories | Number of works published in the Annals | Quantitative of works that dialogue with the research |
|--|---------------------------|--|--|
| 26th Meeting Poços de Caldas-MG | Full paper. | 11 | - |
| | Posters | 1 | - |
| | WG08 - Commissioned Work. | 1 | - |
| 27th Meeting CAXAMBU-MG, 2004 | Full paper | 13 | 1 |
| | Posters | 3 | - |
| | WG08 - Commissioned Work. | 1 | - |
| 28th Meeting CAXAMBU-MG, 2005 | Full paper. | 20 | - |
| | Posters | 4 | - |
| 29th Meeting CAXAMBU-MG, 2006 | Full paper. | 20 | - |
| | Posters | 1 | - |
| | WG08 - Commissioned Work. | 1 | - |
| 30th Meeting Caxambu, MG, 2007. | Full paper. | 15 | - |
| | WG08 - Commissioned Work. | 1 | - |
| 31st Meeting CAXAMBU-MG, 2008 | Full paper. | 16 | - |
| | Posters | 3 | - |
| | WG08 - Commissioned Work. | 1 | - |
| 32nd Meeting CAXAMBU-MG, 2009 | Full paper. | 10 | - |
| | Posters | 5 | - |
| 33rd Meeting ³ CAXAMBU-MG, 2010 | - | - | - |
| 34th meeting Natal/RN, 2011 | Full paper. | 15 | - |
| | WG08 - Commissioned Work. | 1 | - |
| 35th meeting Porto de Galinhas, PE | Full paper. | 12 | 1 |
| | Posters | 1 | - |
| | WG08 - Commissioned Work. | 1 | - |
| 36th Meeting Goiania-GO, 2013 | Full paper. | 20 | 1 |
| | Posters | 4 | - |
| | WG08 - Commissioned Work. | 1 | - |
| 37th meeting Florianópolis, SC (2015) | Full paper. | 15 | - |
| | Posters | 3 | - |
| | WG08 - Commissioned Work. | 1 | 1 |
| 38th Meeting São Luís-MA, 2017 | Full paper. | 11 | 1 |
| | Posters | 1 | - |
| | WG08 - Commissioned Work. | 1 | - |

³ We were unable to access the data from the Proceedings of the 33rd ANPEd Meeting available on the website.



(conclusion)

| <u>Annals of ANPEd Meetings/Event Location/Year</u> | Job categories | Number of works published in the Annals | Quantitative of works that dialogue with the research |
|---|-------------------------------------|--|--|
| 39th Meeting Niterói-RJ, 2019 | Expanded Summary - Job | 9 | - |
| | Expanded Summary - Poster | 5 | - |
| | WG08 - Commissioned Work. | 1 | - |
| 40th Meeting Belém-PA, 2021 | Expanded Summary - Job | 19 | 1 |
| | Expanded Summary - Poster | 2 | - |
| | WG08 - Commissioned Work. | 1 | - |
| 41st meeting Manaus-AM, 2023 | Expanded Summary - Job | 16 | 2 |
| | Expanded summary - Work in progress | 9 | - |
| | WG08 - Commissioned Work. | 1 | - |

Source: Prepared by the authors of the article with RSL data (2023).

Of the 18 ANPEd Meetings consulted in the RSL process – 23rd to 41st –, we found the total number of works published in the Annals of this national event, in WG 19, in the following categories: *Full paper* – 219; *Posters* – 34; *Commissioned work* – 14; *Expanded abstract* – Work – 44; *Expanded abstract* - Poster – 7; *Expanded abstract* - *Work in progress* – 9. Of these 327 works published in WG 19, we found 14 works that share conceptual aspects of collaboration in collaborative work and group contexts in the training of teachers who teach mathematics. No research, however, presents Freire 's perspective on collaboration in the context of the theory of dialogic action. So, “[...] in collaboration, required by the dialogic theory of action, the dialogic subjects turn to the mediatizing reality that, when problematized, challenges them” (Freire, 2021b, p. 229).

Of the 14 works found in the RSL, we used as exclusion criteria those that had as their focus of study: mathematics teachers at the beginning of their careers; Information and Communication Technologies in the formation and pedagogical practice of mathematics teachers; professional and metacognitive development of mathematics teachers; the knowledge produced by mathematics teachers. These excluded scientific productions make important considerations about collaboration, work and collaborative



groups, but do not discuss issues related to the training of teachers who teach mathematics in early childhood education and in the early years of elementary school, which is the object of study in doctoral research. Thus, we selected eight works (Table 1 and Framework 1) that dialogue with the research, through the interpretative thematic analysis of *Freire's* perspective in the tessituras of scientific productions disclosed in the ANPEd database.

After reading the complete texts that dialogue with the investigated object, we identified three scientific productions that cite Paulo Freire in their references: the work of Lopes (2004) mentions the book *Pedagogy of autonomy: knowledge necessary for educational practice* in the references, but does not explicitly dialogue with the researcher; the work of Megid (2012) references this *Freirean* work in the text and highlights the importance of dialogue in formative meetings; and the work of Oliveira, Lima and Tomé (2023) dialogues with Paulo Freire in reflections on collaborative practices in the tessitures of study and research groups in Mathematics Education, presented in some parts of the text, highlighting citations of this work by Freire and also *Pedagogy of the oppressed*. Therefore, in the thematic categorical analysis (Bardin, 1977; Bauer, 2017; Minayo, 2014), which makes up the SLR of the research published in ANPEd WG 19, we reflect on collaboration in the *Freirean* perspective woven at work and in collaborative groups in the context of the training of teachers who teach mathematics.

Based on Bardin (1977) and Minayo (2014), we operated the thematic analysis in three stages: *First stage - Pre-analysis; Second stage - Exploration of the Material; and Third stage - Treatment of the results obtained and interpretation*. Through these three stages based on the authors, according to Oliveira and Carneiro (2023, p. 9), we proposed “[...] pre-analysis of the selected documents; investigation of the data; approach and interpretation of the results obtained in the research”, in the process of thematic analysis of the data produced in RSL (Framework 1).

In this context, “[...] content analysis is a social construction. Like any viable construction, it takes into account some reality, in this case the text *corpus*, and it must be judged by its result” (Bauer, 2017, p. 203). Therefore, the selected database, ANPEd, contributed to the *corpus* analyzed in this research and to the finding of the absence of *Freire's* perspective on collaboration in works and collaborative groups in the training of teachers who teach mathematics in early childhood education and in the early years.

In the first stage, “Pre-analysis of the selected documents” (Oliveira; Carneiro, 2023), we carried out the “floating reading” (Bardin, 1977; Minayo, 2014) of the complete works and the expanded abstracts (Framework 1) selected in the RSL, through “[...] direct and intense contact with the field material, allowing itself to be impregnated by its content” (Minayo, 2014, p. 316), with the objective of identifying and understanding, in the texts read and interpreted in this first moment, the meanings of collaboration in the *Freirean* perspective in the tessituras of the research published in the ANPEd Proceedings, in WG 19. Thus, we highlight in the scientific production’s dialogues with works by Paulo Freire that reflect on the meanings of collaboration in teacher training and practice.

Framework 1 – Scientific productions selected for the *corpus* of analysis

| Annals of ANPEd Meetings/Event Location/Year | Theme/Author/Category of work |
|---|---|
| 27th Meeting CAXAMBU-MG, 2004 | Mathematics Education in childhood: the professional development of a group of teachers - Celi Aparecida Espasandin Lopes, Unicsul, São Paulo (Work) |
| 35th meeting Porto de Galinhas, PE | Learning in Mathematics built in the Pedagogy course and its impacts on the practices of teachers in the early years - Maria Auxiliadora Bueno Andrade Megid, PUC, Campinas (Work) |
| 36th Meeting Goiânia-GO, 2013 | Mathematical knowledge in early childhood education: the process of continuing education of a group of teachers - Priscila Domingues de Azevedo, UFSCar, São Carlos (Work) |
| 37th meeting Florianópolis, SC (2015) | Professional development of teachers who teach Mathematics: collaboration and curricular materials under the Education Observatory Program (Obeduc) - Andréia Maria Pereira de Oliveira, UFBA, Salvador (Work commissioned) |
| 38th Meeting São Luís-MA, 2017 | Teacher learning in collaborative groups that teach Mathematics in childhood: a look at magnitudes and measures - Maria Auxiliadora Bueno Andrade Megid, PUC-Campinas; Alessandra Rodrigues de Almeida, Pecim-Unicamp, Campinas (Work) |
| 40th Meeting Belém-PA, 2021 | Collaboration and professional development of mathematics teachers: understandings present in research defended between 2013 and 2020 - Ana Cristina Ferreira, UFOP, Ouro Preto (Expanded Abstract-Work) |
| 41st meeting Manaus-AM, 2023 | Teacher learning narrated by mathematics teachers after developing interdisciplinary projects - Celi Espasandin Lopes, PUC-Campinas (Expanded Summary-Work) Collaborative practices in the tessitures of study and research groups in Mathematics Education: possibilities for dialogues and learning among peers - Sandra Alves de Oliveira, UNEB/Campus XII and PPGE/UFJF; Bertrand Luiz Corrêa Lima, PPGE/UFJF; Neila Maria de Almeida Tomé, PPGE/UFJF (Expanded Abstract-Work) |

Source: Prepared by the authors of the article with RSL data (2023).

In this first stage of the thematic analysis, after the "floating reading", we constituted the *corpus* of analysis of the scientific productions (Framework 1) of RSL (Oliveira; Carneiro, 2023). For Bardin (1977, p. 96-97), "[...] the *corpus* is the set of documents taken into account to be submitted to analytical procedures. Its constitution often implies choices, selections and rules".

In this regard, we corroborate the statement of Oliveira and Carneiro (2023, p. 13): "[...] the stages experienced in the process of systematic literature review, as well as the type of content analysis used to investigate the data produced in the research, were important for the constitution of the *corpus* of analysis".

To highlight the reflections of authors of the papers and of the expanded abstracts selected in the ANPEd database, we used the colors yellow, blue, green and red. In addition, to emphasize excerpts from each direct quotation presented in the scientific production, we used italics, which refers to our emphasis in the keywords and expressions that dialogue with the investigated object, which contributed to the interpretative thematic analysis of the data produced in the research.

In the interpretative and investigative readings of each author and authors of the scientific productions analyzed through the three stages, we found the theoretical and methodological foundations of each keyword, as well as their contributions to mathematical training and teaching practice.

According to data explained in Table 1 and framework 1, of the eight selected works, three scientific productions cite Paulo Freire (Lopes, 2004; Megid, 2012; Oliveira; Lima; Tomé, 2023) and five scientific productions implicitly show this great educator and researcher in reflections on collaboration, collaborative work and collaborative group (Azevedo, 2013; Ferreira, 2021; Lopes, 2023; Oliveira, 2015; Megid; Almeida, 2017). Keywords and expressions that weave the meanings and meanings of collaboration in *Pedagogy of the oppressed* and other books written by Paulo Freire intertwine the citations in the eight works, such as: dialogical action, communication, communion, commitment to collaborate, dialogue, responsibility, dialogical subjects, dialogical theory of action, working together (Freire, 2021b).

The second stage, "Data investigation", and the third stage, "Approach and interpretation of the results obtained in the research", provided the identification and interpretation of the meanings of collaboration in the *Freirean* perspective shared in the

later section. Indeed, the analytical, interpretative and investigative readings of the texts that made up the *corpus* of analysis in this study provided us with reflective looks at collaborative and permanent mathematical formation in the context of collaborative work and groups, permeated by the exchanges of experiences in the places of formative and dialogical meetings.

It is worth mentioning that we understand, as Forner and Malheiros (2019, p. 59), “[...] from Paulo Freire’s perspective on the importance of reading the world, that his work inspired and opened possibilities for his understanding of education to be taken to different areas of knowledge, including Mathematics Education”. Thus, the first author of this article, under the guidance of the second author, her advisor of the doctorate in Education, inspired Paulo Freire’s critical pedagogy to experience the theoretical-methodological perspective of Problematizing Mathematics Education proposed in her doctoral research with the participation of teachers of basic education and students of the degrees in Mathematics and Pedagogy.

Problematizing Mathematics Education, according to Oliveira and Carneiro (2024, p. 19), “[...] enables dialogical interactions with the other to discuss and propose different mathematical issues and experiences of diversified teaching practices that contribute to thinking critically [...]”, according to Freire (2021b, p. 79), “[...] the concrete dimensions of reality” and the dialogical teaching-learning processes of Mathematics in formative environments.

In the second stage of the thematic analysis, “Data investigation” (Oliveira; Carneiro, 2023), we experienced interpretive and investigative readings of the data shown in Framework 1, paying attention to the issue and the objectives of the SLR.

Therefore, the third stage of the thematic analysis, “Approach and interpretation of the results obtained in the research” (Oliveira; Carneiro, 2023), includes inferences and interpretations of the analysts, relating the results found in the research with the theoretical framework and the objectives foreseen in the investigation (Bardin, 1977; Minayo, 2014). Therefore, “[...] the results obtained, the systematic confrontation with the material and the type of inferences reached can serve as a basis for another analysis arranged around new theoretical dimensions, or practiced thanks to different techniques” (Bardin, 1977, p. 101). In this perspective, we emphasize that the scientific productions

shared in this article, resulting from the SLR, can be analyzed through other guiding questions and other objectives.

Thus, “[...] a text *corpus* offers different readings, depending on the biases it contains” (Bauer, 2017, p. 191). The thematic analysis of the investigated *corpus* “[...] enabled analytical, interpretative and investigative readings of the texts that made up the systematic review of the literature experienced in this study” (Oliveira; Carneiro, 2023, p. 14). In the following thematic category, we will reflect on collaboration in the *Freirean* perspective intertwined in collaborative work and group actions in the training of teachers who teach mathematics.

3 Senses of collaboration in *Freire's* perspective woven into collaborative work and group in mathematical training

The investigative and critical readings of all the complete works and the expanded abstracts published in the ANPEd Proceedings, in WG 19, related to the guiding question of this study, provided an interpretative thematic analysis of the meanings of collaboration in *Freire's* perspective in the tessitures of research that dialogue about collaborative work and group in mathematical training. “Thus, the meaning is always a dynamic, fluid, complex formation, which has several zones of varied stability. [...] As is well known, in different contexts the word easily changes its meaning” (Vigotsky, 2001, p. 465).

Even without the explicit presence of this great educator and researcher, Paulo Freire, in the discussions presented in the scientific productions analyzed, he is included in the fundamentals of collaboration in different contexts of collaborative work and groups.

It should be noted that the interview with Paulo Freire recorded at his residence, with Ubiratan D'Ambrosio as interviewer and Maria do Carmo Domite as mediator, was shown repeatedly at the 8th International Congress of Mathematics Education (ICME-8), which took place in Seville, Spain, in 1996 (D'Ambrosio, 2021; Freire; D'Ambrosio; Mendonça, 1996). It reflects essential issues for mathematical training and teaching-

learning processes, which need to be further presented and discussed in study and research groups in Mathematics Education.

The “mathematized movements” (Freire; D’Ambrosio; Mendonça, 1996) present in daily experiences, as Paulo Freire pointed out in the interview, weave our collaborative actions in permanent formation and praxis. For this reason, like Forner and Malheiros (2020, p. 502), “[...] we believe, inspired by Paulo Freire, that, in the pedagogical process, there must be a permanent dialogue between theory and practice, evidencing its inseparable character, becoming praxis [...]”, which, according to Freire (2021b, p. 93), “[...] implies the action and reflection of men on the world to transform it”.

In the books *Education as a practice of freedom*, *Pedagogy of the oppressed* and *Letters to Guinea-Bissau: records of an experience in process*, among others, Paulo Freire reflects on the meanings of collaboration in teacher training and practice, which dialogues with the authors of the research shown in Table 1 and discussed below. In view of this, we highlight in italics the expressions that represent the meanings of collaboration from *Freire's perspective*.

Collaboration in contexts of *dialogic action* (Freire, 1978, 2021b) intertwines collaborative work and group and contributes to the realization of *knowledge and professional development* (Lopes, 2004) in the *interaction with the other* emphasized in these scientific productions. In this environment of collaborative mathematical training, the insertion in *collaborative groups* (Megid, 2012) provides opportunities for *dialogical and problematizing practices in the interaction with peers* (Freire, 1978, 2021b), who meet to share knowledge, experiences and learning of teaching and to *learn new possibilities of pedagogical actions*, having “[...] as a basic principle the dialogue between the participants, the willingness to exchange experiences, to learn, to communicate, considering that the quality of communication [...] qualifies the development of a pedagogical action” (Megid, 2012, p. 4).

It is important *to create training spaces* that privilege *collaborative work* (Azevedo, 2013) in what is *dialogical* between teachers who meet to *learn from each other* in a *collaborative partnership* and in constant *dialogue with each other* (Freire, 1978, 2021b, 2022).

In *collaborative work and group* contexts (Oliveira, 2015), the creative capacity is experienced in *joint actions* woven in *dialogical communion* that happens in *collaboration*

with the other in the formative activities entangled by the creative force of dialogue (Freire, 1978, 2021b, 2022). *Collaborative groups constitute formative and dialogical environments* (Megid; Almeida, 2017), which *grow together in the common effort to critically analyze the mediatizing reality that is problematized and seek to transform it* (Freire, 1978, 2021b).

In this scenario, *collaboration* involves the *protagonism of professionals* who seek *to build their knowledge and their teaching learning through belonging and negotiation of meanings* (Ferreira, 2021) of the actions experienced *in working together, learning and teaching together*, in a *horizontal relationship*, permeated by *mutual trust and help* (Freire, 1978, 2021b, 2022) woven into collaborative work and groups constituted in teacher training and practice.

In addition, *collaboration* involves *shared decision-making*, promoting the exercise of *teacher autonomy collectively* (Lopes, 2023), in *collaborative work* experienced in formative spaces, which is based on *ethics and democracy*, providing *dialogue and collective responsibility with each other, learning and teaching together in collaborative work and groups* (Freire, 1978, 2021b, 2022).

The *collaborative actions* experienced in teacher *training and practice*, in a *dialogical relationship* established with the participants of study and research groups that discuss *common projects through collaborative work and groups* (Oliveira; Lima; Tomé, 2023) give us the opportunity to learn-teach new meanings and meanings *together for the formative processes* intertwined with mathematical knowledge-making in *pedagogical praxis* (Freire, 1978, 2021a, 2022).

The analytical, interpretative and investigative readings and re-readings of each text identified in the SLR allowed us to understand the meanings of collaboration from the *Freirean* perspective implicitly evidenced in scientific productions. Through the third stage of the thematic analysis, "Approach and interpretation of the results obtained in the research", intertwined with the stages "Pre-analysis of the selected documents" and "Investigation of the data" (Oliveira; Carneiro, 2023), we understand the meanings of the keywords, explicitly or not, in the works and expanded abstracts published in the ANPED Proceedings, in WG 19.

In fact, it was possible to present and reflect the meanings of collaboration in the collaborative work and group weights shown in the scientific productions of the authors

who dialogue with the *Freirean* perspective pointed out in each text analyzed in the three stages experienced in the process of the thematic analysis of the SLR. Therefore, Framework 1 contributed to the organization of these data entangled in some works by Paulo Freire that emphasize the relevance of dialogic action within the scope of permanent and collaborative training (Freire, 2001, 2021b; Imbernón, 2021). "Permanent training that is based, above all, on reflection on practice" (Freire, 2001, p. 25), in which "[...] the work methodology and the affective climate are pillars of collaborative work" (Imbernón, 2021, p. 60).

In agreement with Soares (2020, p. 157), "[...] permanent training, from Freire's perspective, is constituted as a principle and practice of training capable of unveiling ideologies, because it is problematizing, critical and continuously seeks a transforming action of reality". The permanent and collaborative mathematical formation defended in the doctoral thesis of the first author of this article dialogues with the reflections of Soares (2020), as it involves a Problematizing Mathematical Education, which "[...] seeks to problematize all moments of the proposed and elaborated formative activities in the teaching-learning processes of mathematics in the spaces of formation" (Oliveira; Carneiro, 2024, p. 18), concatenated with the *concrete reality* (Freire, 1981) of the dialogical and collaborative subjects participating in formation and research.

According to Freire (2021b, p. 228), *collaboration* infers *dialogical action*, "[...] which cannot occur except between subjects, even if they have different levels of function, therefore, of responsibility, it can only take place in communication". *Collaboration* also expands the *union* in dialogic action, since we rely on the joint work and mutual support of all those involved in the training processes, always seeking to Be More. "This search for being more, however, cannot be carried out in isolation, in individualism, but in communion, in the solidarity of existences, hence it is impossible to occur in the antagonistic relations between oppressors and oppressed" (Freire, 2021b, p. 105).

What Paulo Freire discusses in *Pedagogy of the oppressed* on collaboration corroborates the reflections of the authors highlighted in the scientific productions (Framework 1), who more often cite the researcher Fiorentini (2006) to explain the meanings and senses of collaboration. According to the author,

In collaboration, everyone works together (co-labor) and supports each other, aiming to achieve common objectives negotiated by the group collective. In collaboration, relations, therefore, tend to be non-hierarchical [sic], with shared leadership and co-responsibility for conducting actions (Fiorentini, 2006, p. 52).

These conceptual aspects dialogue with Paulo Freire's reflections on collaboration in his work *Pedagogy of the oppressed*: "Co-laboration, as a characteristic of dialogic action, which cannot occur except between subjects, even if they have different levels of function, therefore responsibility, can only take place in communication" (Freire, 2021b, p. 228). Dialogic communication, therefore, is essential in the experience of working together with dialogue and shared leadership, mediated by negotiations of responsibilities and democratic decision-making (Boavida; Ponte, 2002; Fiorentini, 2006; Hargreaves, 1998; Ibiapina, 2008).

Thus, the quote by Fiorentini (2006) on collaboration in the scientific productions of Azevedo (2013), Ferreira (2021) and Oliveira (2015) dialogues with Paulo Freire, by emphasizing joint work, mutual support, common objectives, the group collective, dialogical relationships, shared leadership and co-responsibility in training actions to conceptualize collaboration in the collaborative work and group weights analyzed in this research.

It is noteworthy that other researchers mentioned in the selected works (Table 1), to reflect on collaboration, such as: Boavida and Ponte (2002), Hargreaves (1998), Ibiapina (2008) and others emphasize collaboration as a fundamental strategy to "[...] help solve concrete and real problems" (Boavida; Ponte, 2002, p. 12) in formative spaces, in democratic and shared decision-making (Hargreaves, 1998; Ibiapina, 2008), thus contributing "[...] to the development of schools, the professional development of teachers and student success" (Hargreaves, 1998, p. 19).

In addition, *collaboration* requires *organization* in the dialogical theory of action, with "bold and loving testimony". Thus, "[...] when seeking unity, the leadership already seeks, equally, the organization of the popular masses [of the subjects participating in the training]". Therefore, "[...] in the dialogical theory of action, the organization will never be the juxtaposition of individuals who, gregarized, relate mechanically" (Freire, 2021b, p. 242), but of an organization that happens in a horizontal relationship.

Finally, *collaboration* favors *cultural synthesis*, which "[...] is the modality of action with which, culturally, it will face the strength of culture itself, as the maintainer of the

structures in which it is formed” (Freire, 2021b, p. 247). In this way, the *cultural synthesis* in the theory of dialogical action seeks to “[...] constitute the climate of creativity” in formative practices, “[...] creating together the guidelines for its action” in a dialogical and problematizing relationship, without “[...] denying the differences between one vision and another, on the contrary, it [sic] is based on them. What she denies is the invasion of one by the other. What it affirms is the indisputable subsidy that one gives to the other” (Freire, 2021b, p. 248-249) in permanent and collaborative mathematical training and in teaching praxis.

With regard to permanent formation, we corroborate the statement of Forner and Malheiros (2020, p. 503): “Paulo Freire, in his legacy, uses the term *permanent formation*, because he understands that the human being is under construction, that is, unfinished, in search of completeness” in the formative paths followed in encounters with others. In his work *Education in the city*, Paulo Freire highlights the permanent teacher training program as a priority, “[...] because he understands that educators need a serious and competent political-pedagogical practice that responds to the new physiognomy of the school that is sought to be built” (Freire, 2001, p. 80). In view of this, continuing education considers the teacher as a participant in the process, according to Soares (2020, p. 157-158), “[...] providing favorable conditions to critically reflect on their practices, uncertainties and curiosities, with possibilities to read the context in which they are inserted, in the search for overcoming oppressive conditions”.

The characteristics of the theory of dialogical action – *collaboration, union, organization and cultural synthesis* –, presented in *Pedagogy of the oppressed*, contributed to the organization and thematic analysis of the data, considering the reflections of authors of the works and expanded abstracts.

In this RSL process, creativity and curiosity moved us with great joy (Freire, 2021a) to research the meanings of collaboration from the Freirean perspective, paying attention to our formative experiences in the study, research and training groups in Mathematics Education that we participate in the formative spaces of the university and the basic school. These experiences in our training and professional trajectory contributed to the interpretative thematic analysis proposed in this research.

4 FINAL CONSIDERATIONS

The meanings of collaboration in *Freire's* perspective woven with collaborative work and group show the remarkable presence of Paulo Freire in the reflections shared by the authors who implicitly dialogue with this educator and researcher, when discussing the conceptual aspects of collaboration, collaborative work and collaborative group in their research.

In this context, we corroborate the statement of Forner and Malheiros (2019, p. 60-61): "Paulo Freire preaches, in his works, a dialogical education, that is, based on dialogue between peers, in a collaborative way and that aims to reinforce the critical capacity of the student". Thus, "[...] dialogue, which is always communication, founds collaboration" (Freire, 2021b, p. 228), present in the investigated *corpus*, which highlights the relevance of the constitution of a collaborative working group in the different formative contexts of study and research groups in Mathematics Education.

The SLR made it possible to organize the data and interpret them from the fundamentals of collaboration in *the Freirean perspective*, which involve dialogic action in the interaction *with the other*, "*learning from and with you*", problematizing communication, dialogic subjects, collaborative communion, common effort, mutual help, teamwork, among other assumptions that intertwine collaborative practices in collaborative work and group contexts.

Finally, we emphasize that collaborative work and groups within the scope of permanent and collaborative mathematical training provide dialogic and problematizing teaching practices in the encounter with the other who shares teaching knowledge, experiences and learning. Therefore, *collaboration infers dialogic action, collaboration expands unity in dialogic action, collaboration requires organization in the dialogic theory of action, and collaboration favors cultural synthesis* (Freire, 2021b). Thus, working together, in a dialogical relationship, we can create training spaces that privilege collaborative work and group in the dialogical activities between teachers and future teachers who are in the training environments to "learn from and *with you*" (Freire, 1978) in a collaborative partnership and in constant dialogue with the other, experiencing in these training spaces a Problematic Mathematics Education.

In this “problematizing-action” environment, the theoretical-methodological perspective of Problematizing Mathematics Education involves an investigative action-dialogical-problematizing methodology of significant generating themes (Freire, 2021b) experienced in the spaces of training at the university and in basic school. The proposed methodology seeks to interact students in a dialogic and problematizing relationship with teachers participating in pedagogical praxis in the formative processes.

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