

RESEARCH GROUPS IN MATHEMATICS EDUCATION AS AN OBJECT OF STUDY: A VIEW OF THE STATE OF ART

 Carlos Alex Alves^I

 Leandro Londero da Silva^{II}

TRANSLATED BY Tikinet Edições Ltda.^{III}

^I Universidade Estadual Paulista “Júlio de Mesquita Filho” (Unesp), Bauru (SP), Brazil; carlos.alex@unesp.br

^{II} Universidade Estadual Paulista “Júlio de Mesquita Filho” (Unesp), Bauru (SP), Brazil; leandro.londero@unesp.br

^{III} São Paulo (SP), Brazil; traducao@tikinet.com.br

Abstract

This article presents a state of the art about research groups in mathematics education as an object of study. We analyzed a set of 25 papers validated in a survey at the Brazilian Digital Library of Theses and Dissertations and Google Scholar, elucidating their authors, titles, themes, areas of investigation and methodological approaches. The main results evidenced the presence of articles published in periodicals, by the Oral History and Mathematics Education Research Group, and works that analyze/describe aspects of trajectory, constitution, identity, scientific habitus, functioning, collaboration and/or scientific production of the research groups. We argue that future research may privilege the magnitude of research groups in mathematics education in Brazil.

MATHEMATICS EDUCATION • RESEARCH GROUPS • STATE OF ART

GRUPOS DE PESQUISA EM EDUCAÇÃO MATEMÁTICA COMO OBJETO DE ESTUDO: UMA VISÃO DO ESTADO DA ARTE

Resumo

Este artigo apresenta um estado da arte sobre grupos de pesquisa em educação matemática. É feita a análise de um conjunto de 25 trabalhos encontrados na Biblioteca Digital Brasileira de Teses e Dissertações e no Google Acadêmico. Os principais resultados evidenciaram a presença de artigos publicados em periódicos pelo Grupo de Pesquisa História Oral e Educação Matemática e de trabalhos que analisam/descrevem aspectos de trajetória, constituição, identidade, *habitus* científico, funcionamento, colaboração e/ou produção científica dos grupos de pesquisa. Conclui-se que pesquisas futuras podem privilegiar a magnitude dos grupos de pesquisa em educação matemática no Brasil.

EDUCAÇÃO MATEMÁTICA • GRUPOS DE PESQUISA • ESTADO DA ARTE

LOS GRUPOS DE INVESTIGACIÓN EN EDUCACIÓN MATEMÁTICA COMO OBJETO DE ESTUDIO: UNA VISIÓN DEL ESTADO DEL ARTE

Resumen

Presentamos un estado del arte sobre los grupos de investigación en educación matemática como objeto de estudio. Analizamos un conjunto de 25 trabajos encontrados en la Biblioteca Digital Brasileña de Tesis y Disertaciones y en Google académico. Los principales resultados evidenciaron la presencia de artículos publicados en publicaciones periódicas por el Grupo de Investigación Historia Oral y Educación Matemática, y de trabajos que analizan/describen aspectos de trayectoria, constitución, identidad, habitus científico, funcionamiento, colaboración y/o producción científica de los grupos de investigación. Sostenemos que las investigaciones futuras pueden privilegiar la magnitud de los grupos de investigación en educación matemática en Brasil.

EDUCACIÓN MATEMÁTICA • GRUPOS DE INVESTIGACIÓN • ESTADO DEL ARTE

GROUPES DE RECHERCHE SUR L'ENSEIGNEMENT DES MATHÉMATIQUES EN TANT QU'OBJET D'ÉTUDE: UNE VISION DE L'ÉTAT DE L'ART

Résumé

Présentation d'un état de l'art sur des études au sujet des groupes de recherche sur l'enseignement des mathématiques un ensemble de 25 travaux validés par un inventaire à la Bibliothèque Numérique Brésilienne de Thèses et Dissertations et au Google Académique a été analysé. Les principaux résultats ont mis en évidence l'existence d'articles parus dans des périodiques, par le Groupe de Recherche Histoire Orale et Enseignement Mathématique, et de travaux qui analysent/décrivent des aspects du parcours, de la constitution, de l'identité, de l'habitus scientifique, du fonctionnement, de la collaboration et/ou de la production scientifique des ces groupes de recherche. On soutient que des recherches futures peuvent rendre compte de l'ampleur des groupes de recherche sur l'enseignement des mathématiques au Brésil.

ENSEIGNEMENT DES MATHÉMATIQUES • GROUPES DE RECHERCHE • ÉTAT DE L'ART

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THE RESULTS OF THE RESEARCH REPORTED IN THIS ARTICLE ARE PART OF AN ONGOING doctoral project, which has the constitution of the mathematics education (ME) area in Brazil as an object of study and investigation. It brings together topics such as productivity research scholarship holders (PQ) from the Conselho Nacional de Desenvolvimento Científico e Tecnológico [National Council for Scientific and Technological Development] (CNPq), what is research in Mathematics Education, scientific societies, events and scientific journals, postgraduate programs university students and research groups.

Works such as those by Alves and Silva (2022, 2023a, 2023b) show PQ scholarship holders and research groups in Mathematics Education active in Brazil. In this article, the demarcated theme rests on research groups in Mathematics Education taken as an object of study in the Brazilian scientific research scenario.

In Brazil, investigation on mathematics education has been developed under different research forums, bringing together diverse theoretical and methodological investigation approaches (Bicudo & Paulo, 2011).

Bibliographical, documentary, phenomenological, depth hermeneutics, systematization, and state of the art studies, among others, emerged throughout the process of crystallization of the ME area as a professional and scientific field. Such research elucidates quantitatively and qualitatively the panorama of scientific productions, lines of research, themes, advances, gaps, and future possibilities of investigations that circumscribe this area of knowledge affiliated with the human sciences and of epistemological, philosophical, theoretical, methodological, and pedagogical bases constituted of conceptions, theories, and practices arising from the sciences of education and mathematics (Bicudo, 1993; D'Ambrosio, 1993; Fiorentini & Lorenzato, 2012).

In this direction, a scientific *habitus*¹ that historically has contributed substantially to the maintenance and advances of science, and primarily to research in ME in Brazil, are the studies developed in research groups (Miguel et al., 2004) – institutionally legitimized by the Directory of Research Groups in Brazil (DGPB) and constituted by their leaders, professors, students, technicians and/or collaborators.

This research forum and indispensable space for training researchers have added institutional and scientific prestige in the scientific-technological community, even though sometimes it does not have full working conditions offered by funding agencies and government bodies, and arguments that justify the relevance of research on research groups have been demarcated in the specific literature (Bicudo & Paulo, 2011; Fernandes, 2017; Mainardes, 2022).

It is worth noting that the VII Encontro Brasileiro de Pós-Graduandos em Educação Matemática [VII Brazilian Meeting of Graduate Students in Mathematics Education] (VII Ebrapem), held in 2003 at the Universidade Estadual Paulista “Júlio de Mesquita Filho” (Unesp), *campus* in Rio Claro (SP), had as its theme “Study and research groups in Mathematics Education: formation, consolidation, and scientific production.” In this sense, the event aimed to debate, reflect, and exchange scientific and paradigmatic experiences around how research groups in the area of ME emerge, consolidate, and maintain themselves.

Along complementary lines, Mainardes (2022) recently discussed the relevance of envisioning research groups as an object of study and a region of investigative analysis. The author presents as a theoretical-methodological possibility the delineation of five investigation areas and three methodological approaches considered in the research processes on the investigated research groups.

1 The mention of scientific *habitus* in this text is a concept linked to Pierre Bourdieu's sociology. In this regard, see, for example, Bourdieu (2002).

Mainardes discusses the current scenario of scientific research that deals with research groups in education as an object of study.

Although detailed later, the five investigation possibilities presented by the author (Mainardes, 2022) include studies of a theoretical nature on research groups, studies mapping the magnitude of research groups, comparative studies between research groups, studies on a single research group, and studies on modes of visibility of research groups. Investigations can be based and methodologically guided by macro, meso, and micro approaches.

Inspired by this scenario, several questions arose: why investigate research groups in ME? In what ways have these research groups contributed to research on ME in Brazil? What studies are these? What themes have been predominantly addressed? How are these research groups constituted, or who are their leaders and other members? How many and what are these groups? How do they work? Where are they geographically located, and in which institutions in the country are these groups housed?

Far from trying to clarify all these questions at once in a single investigation, we have taken the path slowly. Therefore, this scenario was fertile and the basis for justifications, discussions, readings, and reflections that were manifested in a first investigation, now shared in this article and guided by the following research problem: what is the panorama of Brazilian scientific research on research groups in ME as an object of study, identified in the collection of the Brazilian Digital Library of Theses and Dissertations (BDTD) and Google Scholar?

The objective of this article is to present a state of art of Brazilian scientific productions that deal with research groups in ME, elucidating their authors, titles, and themes and outlining their areas of investigation and methodological approaches inspired by the theoretical-methodological assumptions presented by Mainardes (2022).

Research groups: Definitions and investigation possibilities

As a region of investigative analysis or object of study, research groups are defined by the specific literature from different perspectives. Similarly, the same occurs when the subject involves the possibility of investigation.

According to the DGPB, created by the CNPq in 1992 to be the central Brazilian institutional database concerning the inventory of research groups, a research group is defined as a set of individuals who are organized hierarchically under one or two leaderships with expertise, prominence, and influence in the area of professional activity, involvement, and commitment to research activities. These groups work around common lines of research and share facilities and equipment.

This institutional definition is linked mainly to the national legislation regulating the implementation and accreditation of postgraduate programs (PPGs) in their historical consolidation process. In this sense, it is also responsible for the institutional movement of creation and establishment of groups of research in Brazil, as highlighted by Mainardes when he points out that,

In Brazil, the emergence of research groups is closely related to the legislation and recommendations of the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior [Coordination for the Improvement of Higher Education Personnel] (Capes) for post-graduate studies, the work of CNPq, and the Plano Nacionais de Pós-Graduação [National Postgraduate Plans] (PNPGs). (Mainardes, 2022, p. 5).

Therefore, Capes Resolution No. 5 of March 10, 1983, presents operating, accreditation, and recommendations rules for PPGs to organize themselves into areas of concentration and lines of

research to build an identity. Thus, several lines of research emerged, with the creation of research groups. In addition, these documents highlight the importance of group research experiences for the accreditation of PPGs (Resolution No. 5, 1983).

As for the performance of the CNPq, the very creation of the DGPB stands out, contributing to the institutionalization of research groups in the country.

The country's PNPGs – I PNPG (1975-1979), II PNPG (1982-1985), III PNPG (1986-1989), IV PNPG (2005-2010), and V PNPG (2011-2020) (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior [Capes], 1975, 1982, 1989, 2004, 2010) – highlight in evolutionary order the importance of training researchers abroad to create/consolidate research nuclei and centers, exchanges, and research networks, creation of research groups linked to PPGs (and vice versa) for national and regional scientific development; evaluation of the PPGs related to the scientific and technological production of the research groups; support for emerging research groups; incentives for the creation of inter and multidisciplinary research groups; investments in internship grants, mobility of researchers to carry out exchange programs, inter-institutional cooperation actions, and promotion of research networks.

However, the specific literature also presents other conceptions of research groups beyond a strictly institutional definition. In this direction, research groups have also been understood and situated as meetings of people with common interests; communities of practice; epistemic communities; formal organizational entities, and units of analysis that can be investigated (Fernandes, 2017; Mainardes, 2022). In practical research activities, study meetings, development of individual/collective projects, and/or guidance activities, research groups are understood as a “collective that encourages the interdependence of tasks, the sharing of responsibility for results, and cooperation in the solution of complex issues” (Mainardes, 2022, p. 3).

Research groups reveal their institutional, scientific, and technological relevance in their various conceptions. They are also configured as a scientific *habitus* and an essential place for/in/ of the development of scientific research; increased productivity; training and development of researchers, including as a strategic space for succession; development of collaborative research; production of scientific knowledge; source of creativity, boldness, and determination; socialization of scientists; construction and management of a set of ideas, techniques, and tools that subsidize the development of consistent theories; emotional support; pedagogical development of research groups, being an institutional and pedagogical space for the formation of scientific *habitus* (Mainardes, 2022).

Concerning the possibilities of research on research groups, in the survey region of the History of Mathematics Education (HME), Fernandes (2017), for example, points out a category of investigations that strive to study the formation of study, research and work groups in ME.

According to the author, the hermeneutics present in these studies reveals different subjective positions of ME and its processes of linking/subordination to other areas of knowledge, making it possible to explore epistemological aspects of this area. In addition, he points out that the nature of these studies is marked by traces of historicity because “in addition to the declared intention of narrating a story, these investigations highlight the performance of these groups in the constitution and consolidation of the research area, showing articulations and resistances of their performance in different institutional contexts” (Fernandes, 2017, p. 230).

Mainardes also discusses investigation possibilities on research groups as an object of study, given that “beside postgraduate courses, orientation sessions, and participation in scientific events, research groups are fundamental spaces for the acquisition of scientific *habitus*” (Mainardes, 2022, p. 1), contributing to the development of experienced researchers, the training of future researchers, and the production of scientific knowledge. Even so, the author argues about the

relevance of conducting investigations on research groups in their various institutional, functional, and structural aspects.

Despite its importance, there is still limited knowledge of its structure, functioning, and dynamics. Although there are relevant publications, these tend to analyze or report on individual groups, with the need for actual research. (Mainardes, 2022, p. 12).

Based on the specific literature and its gaps, the author mentioned above points out five possible areas of investigation to be developed in the research group. Table 1 outlines these possibilities.

Table 1
Investigation possibilities on research groups: Investigation areas

Research groups: Investigation areas	Investigation area 1 (AI1): Studies of a theoretical nature on research groups, which could be epistemological issues, philosophical issues, ethical issues, issues of group formation and identity construction, the role of researchers/teacher training groups, acquisition of scientific <i>habitus</i> in groups.
	Investigation area 2 (AI2): Studies mapping the magnitude of research groups by area, scientific field, or specific discipline.
	Investigation area 3 (AI3): Comparative studies of research groups in the same and/or different areas.
	Investigation area 4 (AI4): Studies on a single research group – able to investigate its productivity, functioning, study strategies, studies, and research activities.
	Investigation area 5 (AI5): Studies on the modes of visibility of research groups – able to investigate capital accumulation in its various nuances (social, symbolic, economic, or scientific), relationships between productivity indices, and consolidation levels.

Source: Authors' elaboration based on Mainardes (2022, p. 11).

Therefore, these investigative possibilities can be conducted under three levels of methodological approaches. Table 2 summarizes these methodological possibilities.

Table 2
Investigation possibilities on research groups: Levels of methodological approaches

Research groups: Methodological approaches	Macro: This level, of an institutional nature, favors the quantitative and qualitative magnitude of research groups in Brazil.
	Micro: This level, of an individual nature, privileges the practices and strategies of the organization, functioning, work, pressure and/or oppression, leadership, democratic management, levels of autonomy, and distribution of tasks, among other relevant aspects of a specific research group.
	Meso: This level explores aspects involving financing and institutional policies; questions of productivity and scientific and international prestige; research group cultures and networks; working conditions, infrastructure, symbolic, social, economic, and scientific capital; formation and consolidation of groups; relations of tension, cooperation, and competition between members; among others.

Source: Authors' elaboration based on Mainardes (2022, pp. 11-12).

Having these theoretical-methodological aspects that involve the investigation of research groups, Mainardes (2022) highlights in his study about 56 studies, including dissertations, theses, book chapters, and scientific articles, with a predominance of meso level (40%). Furthermore, it reveals fertile ground, especially for investigations at the macro level.

It is in this theoretical-methodological context that our investigation seeks to elucidate/analyze Brazilian scientific productions on research groups in ME as an object of study, highlighting their authors, titles, and themes and outlining their predominant areas of investigation and

methodological approaches at their macro, micro, and meso levels. Clarifying this scenario makes it possible, for example, to understand the current state of the art in our investigative region and, thus, reveal gaps, perspectives, and possibilities for future investigations.

Methodological procedures

Considering the nature of the objective, technical procedures adopted, and the type of approach to the data, the methodological contributions of our investigation are linked to the descriptive bibliographical research of the state of the art (or knowledge) type in a quantitative and qualitative approach (Bogdan & Biklen, 1994; Ferreira, 2002; Romanowski & Ens, 2006).

Fiorentini and Lorenzato (2012) point out that the state-of-the-art research modality has grown substantially in research in the ME area in recent years. Ferreira (2002) and Romanowski and Ens (2006), for example, state that this type of research marks its relevance due to the possibility of mapping a specific area of knowledge/scientific field/discipline in its historical process of crystallization in research, training and/or teaching, and in different theoretical-methodological facets.

This investigative journey reveals what has already been researched in the area, existing gaps, and possibilities for future investigations, contributing to the continuous progress of the area in its scientific advancement in its different epistemological, philosophical, theoretical, and methodological ramifications. Thus, the work of the researcher who uses the state-of-the-art type of research involves carrying out “a balance of the respective areas of knowledge, to diagnose relevant, emerging, and recurrent themes, indicating the types of research, organizing the existing information, and locating existing gaps” (Romanowski & Ens, 2006, p. 41).

As a representative in the survey region of research produced in ME in Brazil, we highlight investigations such as those by Fiorentini (1994, 2002), André et al. (1999), Ferreira (2002), Melo (2006), and Mindal and Guérios (2013). These studies were developed from a collection of research surveyed in different databases and analyzed under different strategies, categories of analysis, and possibilities of systematization.

In our investigation, specifically, the analytical bibliographic material surveyed included dissertations and theses from the BDTD, course conclusion works, book chapters, articles published in event proceedings, and articles published in Brazilian journals on Google Scholar, without an initial pre-term time frame defined. Above all, the absence of a time frame is justified by the lack of expression of studies on the subject in the specific literature. Thus, we considered all studies validated by the selection criteria up to 2022. The choice for these databases is justified, mainly, by the possibility of aggregating research from PPGs (BDTD) and other types of research simultaneously (Google Scholar), thus making up a substantial variety of studies about our investigative region.

However, other data sources are equally possible and essential to be explored in the state-of-the-art research modality, such as SciELO Brasil, some specific journals, and proceedings of events promoted by the Sociedade Brasileira de Educação Matemática [Brazilian Society of Mathematical Education]. For example, we highlight works such as those by Bicudo and Paulo (2011) and Martins et al. (2018).

As for data production procedures, we used the search command “research group” and “mathematics education” in the databases adopted in our investigation. In addition, we used as filters the presence of the words research group(s) (or specific name of the research group(s)) and mathematics education (or name of the particular theme) in the titles of the papers. Three articles were validated in the BDTD database, and three articles in the Google Scholar database, 22 articles, totaling 25 papers.² This mapping was carried out from May 24 to 26, 2022.

2 The complete list of the 25 papers validated in our investigation is available at <https://doi.org/10.29327/7194370>

The validated bibliographic material was analyzed mainly by skimming the titles, abstracts, and keywords but also through the complete reading of some studies for a better/more robust understanding of our categories of analysis. This research was carried out from May to June 2022. The analyzes were carried out under the following categories: quantitative by type of study/database; temporality of studies; general characterization of the studies; themes/topics relevant to the research produced in ME present in the studies, and nature of the studies by research area and by the level of methodological approach.

We emphasize that this categorization was built *a posteriori*, theoretically subsidized by Bardin (2011), and motivated by our research interests. However, other ways of systematization can also be developed with analytical material validated in our study. For the organization and presentation of results, in addition to charts, tables, and graphs, we also used the online digital platform Mentimeter linked to category VII, a helpful tool for creating and sharing presentations with interactivity and/or stimulating active learning processes.

In our investigation, using the keywords present in the abstracts of the studies, we produced a cloud of words that portrayed the themes and/or main topics present in the studies. Compound words were placed separately, and others were respected, in the same way as their acronyms, for having this representation in scientific texts. In subsequent sections, we present the results and discussions.

Type of study/database

In this topic, we seek to systematize the analytical material validated in our investigation by type of study and database. Table 3 elucidates this distribution.

Table 3

Number of studies on mathematics education research groups by type of material/database

Type of study	Google Scholar	BDTD	Total
Theses	---	2	2
Dissertations	---	1	1
Course conclusion works	1	---	1
Book chapters	1	---	1
Articles published in scientific event proceedings	3	---	3
Scientific articles published in journals	17	---	17
Total	22	3	25

Source: Authors' elaboration based on the research data.

Among the 25 validated studies, we initially observed diversity in the types focused on research groups in ME, adding investigations developed from the scope of undergraduate to the doctoral course. However, the production of scientific articles published in journals stands out, representing a percentage of 68% of the studies, highlighting Google Scholar as a significant database to be consulted concerning our investigative region.

On the other hand, this scenario elucidates and reaffirms the fertile ground that research groups can be an object of study in the postgraduate context, given the record of the three studies identified in the BDTD, two theses, and one dissertation. These data – on the predominance of articles and the scarcity of theses and dissertations – are close to the results obtained by

Mainardes (2022), who located a total of 56 studies in the field of Education:³ three dissertations, two theses, two books, four chapters of books, and 45 articles. Of this total, there are three articles published in journals related to the field of ME and which were also identified in our present investigation, namely: Scanduzzi and Lübeck (2011), Hoffmann et al. (2019), and Teixeira et al. (2015).

In addition, in the specific scope of the ME area, there are researches on the magnitude of research groups in a macro approach in Alves and Silva (2023a, 2023b), where the authors investigated the constitution of 569 research groups in MS in Brazil, duly registered with the DGPB, evidencing the foundation/activity time, geographic regions, higher education institutions, human resources, historical notes, predominant areas and lines of research. Still in this direction, the works of Alves and Silva (2023c) and Alves et al. (2023) show, respectively, the formation of active research groups in Bahia and involving the problem solving field in Brazil.

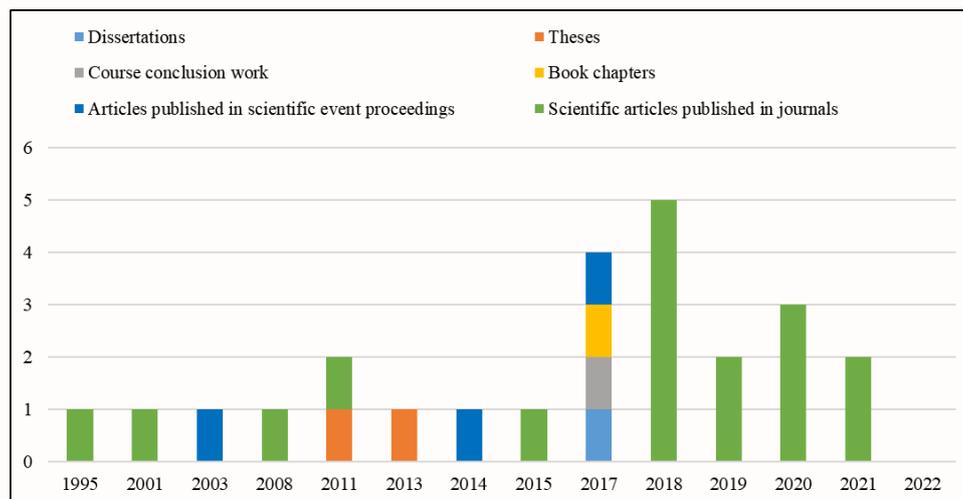
In the conventional paradigms of their way of being and acting, research groups were historically designed and created to promote studies, research, and contribute to scientific and technological sovereignty and not to be objects of analysis and study. Thus, it is plausible to stimulate and design an investigation agenda on research groups, especially in the field of ME, as an emerging and consolidated theme in the years to come (Fernandes, 2017).

Still, in that category, it is essential to highlight the time lapse between the writing of a scientific article and a thesis/dissertation, to the latter's detriment. Furthermore, we recognize that the specific search commands adopted in an investigation like ours may not cover some study(ies) in the investigative region.

Temporality of studies

When considering the temporality of the studies, we observe the movement of their publications and their evolutionary process of interest on the part of the ME scientific community. Figure 1 shows the number of studies by year of publication.

Figure 1
Studies on mathematics education research groups (1995-2022)



Source: Authors' elaboration based on the research data.

3 The complete list of the studies included in the literature review is available at <http://l1nq.com/SPZGk>

The previous data record that the first articles published around our investigative region date from the 1990s and early 2000s, respectively, by Souza and Baldino (1995) and Baldino (2001). We note that these articles have the professor-researcher Roberto Ribeiro Baldino and the Grupo de Pesquisa-Ação em Educação Matemática [Research-Action Group in Mathematics Education] (GPA) in common. At the time of publication, the professor worked at Unesp in Rio Claro (RC) and was one of the leaders of the research mentioned above group.

Another item to be highlighted involves the increase in publications/interest on the subject from 2017 onward, recording various studies, including a course conclusion work (CCW), a book chapter, a dissertation, an article published in event proceedings, and twelve articles published in journals. No studies published in 2022 were identified in the period of our survey.

Furthermore, between 2018 and 2022, there are no records of works developed within the scope of postgraduate studies, which reaffirms the possibility of envisioning this scientific space for the consolidation/training of researchers and the production of scientific knowledge also under a paradigm of fertile ground for research around our investigative region, i.e., as an object of study (Mainardes, 2022).

In our view, these data also reveal the institutional process of crystallization of the ME area in Brazil. Specific literature points out that the Movimento Educação Matemática [Mathematics Education Movement] in the country was located mainly between the 1960s and 1990s, in direct counterpoint to the Movimento Matemática Moderna [Modern Mathematics Movement] (MMM) (Fiorentini & Lorenzato, 2012; Fernandes, 2017).

Thus, a professional and scientific field emerged in Brazilian science, and with it, there was the emergence of a community of mathematical educators and a community in ME. A preponderant fact for its historical legitimacy process is linked to the foundation of the Sociedade Brasileira de Educação Matemática [Brazilian Society of Mathematical Education] (SBEM) on January 27, 1988. The first research groups were also founded and began to collaborate to propose improvements for teaching mathematics, both around the MMM and in the emergence/institutionalization of the ME area in Brazil.

Among them, we can mention the Grupo de Estudos do Ensino de Matemática [Mathematics Teaching Study Group] (GEEM), the Núcleo de Ensino e Difusão do Ensino de Matemática [Mathematics Teaching and Diffusion Nucleus] (Nedem), the Grupo de Estudos de Ensino da Matemática de Porto Alegre [Porto Alegre Mathematics Teaching Study Group] (Geempa), the Grupo de Estudos do Ensino de Matemática do Estado da Guanabara [State of Guanabara Mathematics Teaching Group] (Gemeg) and the the Grupo de Estudos e Pesquisas em Educação Matemática [Mathematics Education Study and Research Group] (Gepem). The first two were founded, respectively, in 1961 and 1962. Geempa and Gemeg were founded in 1970 and Gepem in 1976. Some survived the MMM and followed new paths toward ME. In contrast, others did not resist the movement's failure due to having their existence and role focused on their diffusion in the country as institutional representatives.

As an example, studies such as by Grossi (1994), Lopes (1994), Fernandes and Menezes (2002), Miguel et al. (2004), Silva (2004), Silva (2013), and Fernandes (2017) reflect stories and/or historical notes about the first research groups, scientific events, scientific communities, foundation of postgraduate programs, among other constitutive aspects of the ME, area and its scientific production in Brazil.

This scenario indeed served as a foundation so that, from the 1990s onward, the field of ME could expand in its professional and scientific scope, and, as shown in Figure 1, it is essential to add, grow, and consolidate topics specific aspects that have yet to be explored in their survey region, such

as placing research groups more prominently as a two-way street in research carried out in ME in Brazil, i.e., a product-producer forum for research in ME.

General characteristics of the studies

Although we do not intend to present a detailed description of the studies analyzed in our investigation, we believe it is essential to characterize them in general lines, highlighting some points of convergence between productions/authors.

Among the 25 studies listed, we emphasize the predominant number of works from the Grupo de Pesquisa História Oral e Educação Matemática [Oral History and Mathematics Education Research Group] (Ghoem) – founded in 2002, having as leaders professor-researcher Antonio Vicente Marafioti Garnica and professor-researcher Heloisa da Silva and allocated at the Unesp/Bauru institution.

These studies are articles published in journals. Garnica (2018), Silva (2018), Martins-Salandim (2018), and Baraldi (2018) published in an issue of *Histemat – Revista de História da Educação Matemática*, while Silva and Fillos (2020) published in another journal—*Revista de Educação do Vale do Arinos (Relva)*. These studies are written in a decentralized manner by members of the group and address theoretical and methodological references mobilized by themselves, such as Oral History, Depth Hermeneutics, Teacher Training, History of Mathematics Education, and Inclusive Education, thus contributing to the visibility of the group and, more generally, for research carried out in ME in Brazil.

Silva and Bicudo (2017) summarize some results of Silva's doctoral dissertation (2017), developed in the Grupo de Pesquisa Fenomenologia em Educação [Phenomenology in Mathematics Education Research Group] – founded in 1995, with Maria Aparecida Viggiani Bicudo and Rosa Monteiro Paulo as leaders and allocated at Unesp/RC. In short, the study was carried out with ten leaders of research groups from various institutions in the country, and its main objective was to understand how the modes of knowledge production in ME in these groups take place.

Borba (2003) studied the Grupo de Pesquisa em Informática, outras Mídias e Educação Matemática [Group for Research in Informatics, Other Media, and Mathematic Education] (GPIMEM), also linked to Unesp/RC. As the leader of that group, the author exposes its trajectory, its modes of functioning, and some scientific productions. Hermann's master's thesis (2011) was also developed in and about this research group and analyzed how scientific practice occurs within the group, the styles, and collective thoughts. Souza and Baldino (1995) and Baldino (2001) studies were also linked to Unesp/RC at their production time.

Teixeira et al. (2015) summarize some results of Teixeira's master's thesis (2013) in the survey region of the training of researchers immersed in the Grupo de Pesquisa em Educação em Ciências e Matemática [Research Group on Education in Science and Mathematics] (Educim). According to the Diretório dos Grupos de Pesquisa do Brasil [Directory of Research Groups in Brazil] (DGPB), this research group was founded in 2002 and is led by professor-researcher Sergio de Mello Arruda and professor-researcher Marinez Meneghello Passos, and is located at the Universidade Estadual de Londrina (UEL).

Other points of convergence are observed in Almeida and Ciríaco (2018), Ciríaco and Silva (2021), and Fonseca and Ciríaco (2021) studies. These points are the professor-researcher Klinger Teodoro Ciríaco, from the Universidade Federal de São Carlos (UFSCar), and the themes addressed in the articles: early childhood education, early years of elementary education, initial teacher training, and psychology of mathematics education.

This word cloud reveals the most prestigious themes/topics present in the studies analyzed, such as our survey region “mathematics education,” our research region “research groups,” and the themes/topics of “teacher training” and “psychology of mathematics education (psychology of ME).”

It also highlights theoretical-methodological aspects adopted in research, such as “oral history,” “Ghoem,” “history of mathematics education (history of ME),” “narratives,” “mapping,” “training of researchers,” “learning focuses,” “phenomenology,” “philosophy of mathematics education (philosophy of ME),” among others.

Through it, at the discretion of each reader/researcher, it is possible to diagnose and envision studies/themes/topics/theories/methodologies present and absent in the investigative region of research groups in ME as an object of study and, thus, design studies, research, trajectories, and the search for these and other epistemological, philosophical, theoretical, methodological, and pedagogical references.

Furthermore, this broad spectrum of theories and methodological approaches revealed in our investigation is an inherent characteristic of the field of ME itself, given its multi/interdisciplinary essence (Bicudo & Paulo, 2011; Oliveira, 2017).

Investigation areas and levels of methodological approaches of the studies analyzed

Concerning the areas of investigation and levels of methodological approaches discussed by Mainardes (2022), we sought to characterize the 25 studies analyzed in our investigation by areas of investigation and levels of approaches separately. Finally, we operate interweaving to obtain a panoramic classification systematization. Table 4 presents such a summary.

Table 4

Systematization of the studies analyzed on research groups in mathematics education

Studies	Investigation areas	Levels of methodological approaches	Number	Classification
Baldino (2001); Teixeira (2013); Teixeira et al. (2015); Garnica (2018); Silva (2018).	A1	Micro	5	A1-Micro
Fonseca and Ciríaco (2021).		Meso	1	A1-Meso
Oliveira (2017); Amorim (2017).	A2	Macro	2	A2-Macro
Mendes and Silva (2014); Hoffmann et al. (2019); Valente (2020).	A3	Meso	3	A3-Meso
Silva and Fillos (2020).	A4	Micro	1	A4-Micro
Souza and Baldino (1995); Curi and Pires (2008); Martins-Salandim (2018); Baraldi (2018); Almeida and Ciríaco (2018); Bianchini et al. (2019); Sales (2020); Ciríaco and Silva (2021).		Meso	8	A4-Meso
Borba (2003).		Micro-Meso	1	A4-Micro-Meso
Scandiuzzi and Lübeck (2011); Hermann (2011).	A1-A4	Micro-Meso	2	A1-A4-Micro-Meso
Silva (2017); Silva and Bicudo (2017).	A1-A3-A4	Micro-Meso	2	A1-A3-A4-Micro-Meso

Source: Authors' elaboration based on the research data.

In general terms, our analysis pointed to uniform and multiform studies, understood here, respectively, as those inserted in a single joint classification and studies inserted in several categories because, even privileging to the maximum a predominant core of each study, given the verticality and horizontality of some of them, they ended up extrapolating the uniformity and were classified in different areas of investigation and different levels of methodological approaches.

The A4-Meso classification recorded the highest number of studies on the analytical material (8 studies). From this perspective, Souza and Baldino (1995) present a research agenda of the GPA, research activities, and a summary of its scientific production. Curi and Pires (2008) analyzed the scientific production of two specific research groups. In this direction, Martins-Salandim (2018) and Baraldi (2018) investigated the scientific production of the Ghoem around the group's lines of research (depth hermeneutics and inclusive education). The same occurs with Almeida and Ciríaco (2018) and Ciríaco and Silva (2021). Bianchini et al. (2019) and Sales (2020) presented scientific productions from their respective research groups.

Considering the number of studies, next, we recorded five articles in the A1-Micro classification. In these studies, the observed evidence corresponding to the parameters of the referred classification were mainly philosophical/epistemological discussions/questions, presentation of its organization, management of activities, operation, and entry regarding the GPA (Baldino, 2001); analysis of formative, learning, identity, and acquisition aspects of the scientific *habitus* about the functioning of the research group Educim (Teixeira, 2013; Teixeira et al., 2015); theoretical-methodological discussions of the Ghoem on the lines of research "mapping the training and performance of teachers who teach/taught mathematics in Brazil" (Garnica, 2018) and "oral history, narratives, and teacher training: research and intervention" (Silva, 2018).

This predominance of studies scored in the ME survey region is in line with the results pointed out by Mainardes (2022) for the area of education, in which 40% of studies were recorded at the meso methodological approach level – discussing relevant trajectories and/or reflections to the research groups studied.

Another aspect observed in Table 4 concerns the absence of studies in A5 (see Table 1) and the scarcity of studies in the A2-Macro classification. Regarding these two classifications, Oliveira (2017) and Amorim (2017) surveyed many research groups in ME and articulated the themes of EaD and rural education, respectively, in the DGPB. Next, they characterized these groups based on an analytical-descriptive approach and some quantitative and qualitative variables, such as foundation year, geographic and institutional location, number of members, researchers' background and lines of research, objectives, and repercussions.

We conjecture that this shortage is generalized in education, as per Mainardes (2022, p. 11):

As indicated, the investigation of research groups in Brazil has emphasized the approach of individual groups and the investigation of groups in specific areas of knowledge, academic fields, or some regions of the country. Thus, there is a lack of more comprehensive studies regarding the quantitative and qualitative dimensions of research groups in Brazil. The DGPB/CNPq allows researchers to access research groups registered with the CNPq, and from there, several aspects can be explored, such as the number and characteristics of research groups in large areas and specific fields, the rates of growth, comparative studies (inter and intragroup), etc. Studies of this nature are critical when there is no data on research groups in an area or a specific field, and they can constitute the first stage of the investigation to analyze later aspects of the meso and micro level.

Thus, this investigative classification can be seen as a fertile ground to be explored in research carried out in the field of ME. Furthermore, we highlight the multiple classifications attributed to

Silva (2017) and Silva and Bicudo (2017) [A1-A3-A4-Micro-Meso], Scanduzzi and Lübeck (2011), and Hermann (2011) [A1-A4-Micro-Meso], and Borba (2003) [A4-Micro-Meso] studies.

Some evidence identified in the content of these studies for such systematization were: (i) the vertical and horizontal investigation of the modes of knowledge production in ME in research groups, under four core ideas: group work; the movement of being part of the research group: constitution, permanence, and modification; theme generation; and production and authorship of investigations (Silva, 2017; Silva & Bicudo, 2017); (ii) how scientific practice took place and its impact on the construction of identity, thinking styles, and the collective thinking around GPIMEM members (Hermann, 2011); the constitution, dynamics, paths taken, training/identity, experiences of cooperation, and conviviality around GEPETno (Scanduzzi & Lübeck, 2011); and, finally, (iv) modes of operation, aspects of collaboration, and analysis of scientific productions around GPIMEM (Borba, 2003).

Final considerations

The investigation reported in this article was based on state of the art research with a quantitative and qualitative approach. The main objective was to describe and analyze Brazilian scientific productions on ME research groups as an object of study – allocated in the BDTD collection and Google Scholar. In this movement, we elucidate their authors, titles, and themes and outline their areas of investigation and methodological approaches inspired by the theoretical-methodological assumptions presented by Mainardes (2022).

The view of state of the art built from the 25 studies validated in our investigation points to a significant number of articles published in journals about our investigative region, i.e., research groups in ME as an object of study. These works were published mainly between 2018 and 2021 by the members of the Ghoem.

Among the studies analyzed, we also observed that many were linked to research groups from Unesp. This institution is an exponent concerning the training of masters and doctors in the Postgraduate Program in Mathematics Education at Unesp/RC and the Postgraduate Program in Education for Science at Unesp/Bauru, which is the geographical and institutional location of Ghoem.

Concerning the systematization process employed based on the theoretical-methodological assumptions of Mainardes (2022), the results pointed out in the ME survey region were in line with the results of this author's study in the field of education, namely, a predominance of studies in the investigation areas and levels of methodological approaches that try to investigate aspects of the trajectory, constitution, identity, scientific *habitus*, functioning, collaboration, and scientific production of the research groups taken as objects of study.

For the research on our investigative region to reach scale, horizontality, and verticality, we emphasize the importance of openness and mutual collaboration among researchers, leaders of research groups, their members, and institutions that allocate them. Nevertheless, our study pointed out the need for a paradigmatic expansion around the essence and role historically attributed to research groups, i.e., to be a research product-producer forum in terms of producing research/scientific knowledge and letting oneself be a product of research/objects of study.

About the mentioned absence of studies around the modes of visibility of research groups and their relationships between the accumulation of productivity and levels of consolidation, for example, and the scarcity of works in the A2-Macro classification, our study revealed a fertile ground for future investigations that may favor the quantitative and qualitative magnitude of research groups in ME in Brazil.

Finally, we emphasize that the panoramic view of state of the art here envisioned and presented from the paths thought and built in our inquiry can be explored, interpreted, and complemented under other analysis perspectives around the analyzed works and/or even linked to other theoretical-methodological references. Thus, other researchers are expected to show interest in this research agenda.

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The data underlying the research text are informed in the article.

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