

**CARTOGRAPHY AND GEOGRAPHY TEACHING: TRAJECTORIES AND
DIALOGUES BETWEEN BRAZILIAN ACADEMIC RESEARCH AND OTHER
CARTOGRAPHIC KNOWLEDGE (1970-2026)**

***CARTOGRAFIA E ENSINO DE GEOGRAFIA: TRAJETÓRIAS E DIÁLOGOS ENTRE
PESQUISAS ACADÊMICAS BRASILEIRAS E OUTROS SABERES CARTOGRÁFICOS
(1970-2026)***

***CARTOGRAFÍA Y ENSEÑANZA DE LA GEOGRAFÍA: TRAYECTORIAS Y
DIÁLOGOS ENTRE INVESTIGACIONES ACADÉMICAS BRASILEÑAS Y OTROS
CONOCIMIENTOS CARTOGRÁFICOS (1970-2026)***



Raquel de Padua PEREIRA¹
e-mail: raqueldepaduapereira@gmail.com

How to reference this paper:

PEREIRA, Raquel de Padua. Cartography and geography teaching: trajectories and dialogues between Brazilian academic research and other cartographic knowledge (1970-2026). **Revista Geografia em Atos**, Presidente Prudente, v. 10, n. 00, e026008, 2026. e-ISSN: 1984-1647. DOI: <https://doi.org/10.35416/2026.11423>.



| Submitted: 26/02/2026
| Revisions required: 17/03/2026
| Approved: 25/03/2026
| Published: 18/06/2026

Editors: Prof. Dr. Nécio Turra Neto
Prof. Me. Karina Malachias Domingos dos Santos

¹ Federal University of ABC (UFABC), São Paulo – São Paulo (SP) – Brasil. Geographer (USP), Master's in Urban and Regional Planning (UFRJ) and Ph.D. in Geography (Unicamp). Currently, she is a visiting professor affiliated with the Bachelor's Degree in Human Sciences at the Federal University of ABC. She works at the interface between the areas of Human Geography, Urban Planning and Geography Education. She was a teacher in basic education in the public and private school systems of the municipality of São Paulo.

ABSTRACT: This paper revisits some of the most significant contributions of academic research in the field of Brazilian middle and high school cartography and their impact on geography education. Through a literature review, as well as the identification and interpretation of trends, the main paradigms in the field of geography regarding middle and high school cartography have been identified, beginning in the 1970s and continuing to the present. The aim is to provide an overview of this journey as a contribution to the state of the art in the field, highlighting its advances and obstacles. Furthermore, the text engages with other cartographic concepts that take a critical and disruptive stance toward traditional representations, concluding with a reflection on the future directions and possibilities for the field, taking into account the diversity of its subjects.

KEYWORDS: Geography teaching. Cartography. School cartography. Critical cartography. Spatial thinking

RESUMO: Este texto revisita algumas das mais relevantes contribuições das pesquisas acadêmicas na área da cartografia escolar brasileira e seus impactos no ensino de geografia. Através de revisão bibliográfica, identificação e interpretação de tendências, identificou-se os principais paradigmas na área da Geografia sobre cartografia escolar, a partir da década de 1970 em diante. O objetivo é oferecer uma síntese deste percurso como forma de contribuição ao estado da arte na área, pontuando seus avanços e entraves. Além disso, o texto dialoga com outras concepções cartográficas, alinhadas a uma vertente crítica e disruptiva das representações tradicionais, concluindo com uma reflexão sobre os rumos e possibilidades futuras para o campo, considerando a diversidade dos sujeitos.

PALAVRAS-CHAVE: Ensino de Geografia. Cartografia. Cartografia escolar. Cartografia Crítica. Pensamento Espacial.

RESUMEN: Este texto repasa algunas de las contribuciones más relevantes de la investigación académica en el ámbito de la cartografía escolar brasileña y sus repercusiones en la enseñanza de la geografia. Mediante una revisión bibliográfica, la identificación y la interpretación de tendencias se han identificado los principales paradigmas en el ámbito de la geografia en relación con la cartografía escolar, desde la década de 1970 en adelante. El objetivo es ofrecer una síntesis de este recorrido como contribución al estado actual de la investigación en el área, señalando sus avances y obstáculos. Además, el texto dialoga con otras concepciones cartográficas, alineadas con una perspectiva crítica y disruptiva de las representaciones tradicionales, y concluye con una reflexión sobre los rumbos y las posibilidades futuras para el campo, teniendo en cuenta la diversidad de los sujetos.

PALABRAS CLAVE: Enseñanza de la geografia. Cartografia. Cartografia escolar. Cartografia crítica. Pensamiento especial.

Introduction

The practice of representing space through graphic elements has accompanied human history since its most remote records, as indicated by studies on cave paintings and prehistoric maps (Almeida, 2010a; Oliveira, 2010). This form of communication is older than the development of writing itself and has been taking on new meanings over time (Joly, 2023). Thus proceeds cartography in its different facets: as a scientific systematization of exact techniques, such as mathematics and geometry; also as a technique and artistic expression, through drawing and painting (Castrogiovanni, 2001). In this way, the production and use of maps, plans, and charts, as a whole, establish a specific type of language (Almeida; Passini, 1989; Callai, 2023).

Currently, with information and communication technologies massively incorporated into the daily lives of the population on a global scale, the use of maps for the most diverse activities is commonplace. Digital maps serve as support for countless *software* and applications that are developed around satellite-based geolocation systems—an applied aspect of geographical knowledge (Rosa, 2011). We can say then, roughly speaking, that the use of maps has become quite popular.

However, even before this new era, marked by the technical-scientific-informational environment (Santos, 1996), maps have been part of school education. In formal education, they occupy a prominent place in the Geography discipline (Callai, 2023)—perhaps even synonymous or symbiotic, in a frequent direct association between Geography and maps, whether in the scientific or school context (Cavalcanti, 2021). Indeed, cartography, although it is an autonomous field of knowledge, with its own construction, crosses the trajectory of academic Geography and school Geography—which, not by chance, also walk together (Cavalcanti, 2021).

Decades of research organize a vast scientific production on the subject. In this text, far from trying to reproduce it completely, we attempt to identify and synthesize some of the main trends verified in the scope of this production, from the 1970s to the present time, without, however, exhausting them—an unnecessary and, obviously, impossible task. We are interested, therefore, in reflecting on part of this journey from a critical perspective, which recognizes the history of the development of school cartography and its main methodological foundations, from a point of view of geographical science interconnected with teaching, as well as its contemporary challenges. Our main objective is to contribute to the state of the art on the area,

going through remarkable contributions in the context of scientific research in Geography that has, in some way, maps as its object of study, especially in Cartography and Geography Teaching. Furthermore, the text is intended for reflection on new conjectures for Cartography itself in the academic context, in terms of research and teacher training, as well as teaching in basic education.

Regarding the methodology, influential scientific contributions in research on School Cartography from the 1970s onwards were selected. The selection criterion started from two parameters: first, the identification of the most frequent topics in the syllabi of public notices for higher education teaching career competitions, launched in the year 2025 by some of the main Brazilian public universities in the area of Cartography, Geography Teaching, and Human Geography, such as USP, Unicamp, Unesp, UFBA, UFABC, UNIFESP, among others; then, the relationship of these themes with bibliographic references, in turn searched in Brazilian and international databases, such as Portal Capes, Scopus, *Web of Science*, *Scielo*, in addition to scientific production repositories. For the contributions of Social and Critical Cartography, digital tools for searching and cross-referencing references and citations were explored, such as *Connected Papers*, *Litmaps*, and *Semantic Scholar*. Having formed, then, an overview of the main works and articles found in these databases, the literature review that supports the text's line of reasoning was carried out.

It is worth noting that such a methodological choice occurred through the possibility of interpreting² the guidelines and thematic choices of public notices for higher education teaching career competitions as a mirror of the lines and theoretical currents that currently prevail in the academic scope of the area in question. In this way, we understand that this reading can provide us with clues both about what is expected for the continuation of research, and about what is practiced in terms of training future teachers and, ultimately, about a future of teaching practices in Geography in basic education. Furthermore, this same overview also allowed us to identify which other cartographic currents are being incorporated into the academic debate in the area.

We work with the hypothesis that the production and use of maps are inexorable to scientific geographical practice and, especially, to school practice (Almeida, 2010a; Almeida; Passini, 1989; Callai, 2023; Castellar, 2017), since the assimilation and use of cartographic language is an elementary part of the construction of geographical reasoning (Castellar, 2017)

² It is important to emphasize that this review is based on the author's own interpretations, which serve as support for the line of reasoning developed throughout the text. In this sense, it derives from a specific analytical scope, aligned with the methodology adopted.

and of the spatial practices of signification (Straforini, 2018) that substantiate the teaching of geography. From this assumption, we observe the persistent presence of the so-called traditional cartography and the paradigm of cartographic literacy in research on teaching methodologies, while at the same time we pay attention to scientific and technological advances and disruptive ways of producing maps, which can redefine the research itself and the spatial practices involved in teaching. However, these changes and incorporations of new cartographies depend on a permanent political critique of the techniques, methods, contexts of scientific production, and use of maps as a social practice themselves, as well as of the conditions of teacher training and work.

In the next session, we address some of the main contributions of research in Brazilian school cartography, its foundations, and impacts on teaching methodology proposals; in the following session, we analyze the concept of cartographic literacy and its theoretical and methodological implications; subsequently, we go through the criticisms of school cartography towards other cartographies: critical, social, and digital as allusions to uses in the present and future; in the last session, we weave together the reflections and syntheses of the journey.

Main foundations of Brazilian School Cartography

School cartography can be characterized as an area of teaching and research, situated at the intersection of cartography, education, and geography (Almeida, 2010b). It is a body of knowledge under construction, which is influenced by social and technological factors and, therefore, is in constant transformation. For Almeida (2007), cartographic conceptual tools, associated with graphic language and supports and materials, integrate the conceptual, didactic, and epistemological foundations oriented towards the teaching and learning of geographic space, constituting the basis for the construction and interpretation of spatial representations.

The educational field, in turn, provides the dimensions of the curriculum and teacher training, mediated by learning processes and teaching methods appropriate to the specificities of cartographic knowledge. Simultaneously, geography contributes with socio-spatial concepts, emphasizing the relationships between society and space and the different spatially produced representations (Almeida, 2007). The convergence of these elements supports school cartography as a pedagogical practice and object of scientific investigation, insofar as it makes

it possible to understand how subjects construct, interpret, and mobilize representations of space within the scope of formal education.

For Castellar (2017), school cartography is fundamental for developing geographic knowledge in children and also for the training of future Geography teachers. In this sense, cartography favors the increase of spatial thinking and the geographic reasoning of schoolchildren, stimulating complex thinking and cognitive development. According to the author, teaching should be student-centered, integrating their daily realities and experiences into the curriculum, so that geographic concepts and cartographic products must be restructured in dialogue with students, promoting meaningful knowledge.

According to Almeida and Almeida (2014), the growth of the school cartography area in the last two decades is notable, from early childhood education to higher education. In fact, such an increase is also verified in postgraduate courses, through which a permanent research agenda has been consolidated, with numerous national scientific events, such as colloquia and symposia, since at least 1995. These authors observed that, in general, such events addressed diverse themes that have permeated the construction and practice of school cartography for a long time, such as representation of space, teaching methodologies, technologies, and teacher training.

In the following table, contributions from fifteen national authors whose research has influenced the area of Cartography and Geography Teaching are presented in a simplified manner. Organized by periods³ of release and vigor of their main works, Table 1 highlights the focuses of the contribution/main concepts and innovation/impacts on pedagogical practices.

Table 1 – Periods, authorship, and perspectives within the scope of Brazilian School Cartography

Period	Author(s)	Main concepts/ focus of contribution	Innovation/ didactic developments
1970	Livia de Oliveira (2010)	Cognitive mapping; methodological basis of children's cartography as cognitive and mental development, Piagetian approach.	Study <i>through the</i> map instead of teaching <i>the</i> map.
1980	Tomoko I. Paganelli (2010)	Perception and locomotion; the child's real experience in urban space, Piagetian approach.	Practical experience as a prerequisite for understanding abstract spatial relationships.

³ It is important to bear in mind that these periods extend through the dialogue and mutual influences that the perspectives establish among themselves. In other words, there is no fixed temporal boundary marking the end of a given perspective.

1980	Janine G. Le Sann (2010)	Thematic methodology; spatial analysis exercises, Piagetian and Bertinian approach.	Systematized application of Bertin's Semiology in didactic materials and in the study of place.
1980	Marcello Martinelli (2010)	Graphic representations; visual variables and thematic cartography, Bertinian approach.	Method for representing data with specific colors and symbols related to spatial phenomena.
1990	Rosângela D. Almeida (2010a)	Spatial representations and relationships; school cartography methodology, Piagetian approach.	Methodology of conscious map construction for understanding cartographic language.
1990	Elza Yasuko Passini (2010)	Cartographic literacy, teaching practice, mathematical contributions; cartography and spatial awareness.	Teacher training and methodologies for elementary education.
1990	Regina A. Almeida (2007)	Tactile cartography; inclusion and accessibility for people with disabilities.	Cartographic methodology and adapted materials for blind and low-vision people.
2000	Sonia Castellar (2017)	Spatial thinking and geographic reasoning; map as a process of cartographic literacy.	Use of the map for the apprehension of knowledge processes and interpretation of geographic phenomena.
2000	Helena C. Callai (2023)	Place and identity; cartography as representation and critical reading of the world.	The map as a political tool and for the construction of the student's social identity.
2000	Angela M. Katuta (2020)	Foundation of spatial notions and skills, resignification of cartographic literacy.	Theoretical innovations and critique of traditional paradigms.
2010	Fernanda P. Fonseca (2012)	Critique of the stability of the map background, deconstruction of the neutrality of the base; integration of other languages.	Problematization of ideologies embedded in traditional cartography; use of artistic and alternative languages.
2010	Gisele Girardi (2023)	Map as an expression of other geographies; semiotic and critical reading of cartography.	Social cartography for human rights, emphasizing subjectivity and language.
2010	Wenceslao Oliveira Jr. (2011)	Geography in audiovisual images, the map as a cultural and imagetic discourse.	Cartography as a narrative that exerts power and creates realities.
2010	Valéria Cazzeta (2011)	Digital technologies, cartography and subjectivity, audiovisual resources.	Interactivity and digital media, diversification of languages and spatial perception.
2010	Tânia S. Canto (2018)	Geotechnologies and teaching practices, languages and representations of cyberspace in the formation of new generations.	Practical use of everyday digital tools as a didactic resource and in teacher training.

Source: Prepared by the author, 2026.

Still according to Almeida and Almeida, from the mid-1990s onwards, there was a predominance in discussions and research regarding points that are considered challenges for school cartography today, namely: teaching methodologies and new technologies. According to the authors, the reason for this challenge lies in the conditions of teacher training and work, often structurally precarious, as well as in the assimilation of technological languages which, in turn, also demand training and preparation.

In this regard, Girardi (2023) adds that, in addition to the academic agenda, the inclusion of the National Curriculum Parameters (PCN), between 1997/98, brought new terms to the educational vocabulary, such as “cartographic literacy” and “conscious mapper student”. On the other hand, in a context of a current crisis in school Geography, associated with a process of scrapping of education and the consequent overwhelming devaluation of the teaching career in basic education (Giroto, 2017), the National Common Curricular Base (BNCC), incorporated into basic education on a national scale from 2018, seems to corroborate the maintenance of a utilitarian character of geography. By associating cartography with its most classic representations, it distances it from its immense possibility of building new ways of thinking about contemporary space within the scope of geography teaching.

The set of these considerations demonstrates that school cartography is influenced by academic research, curricular guidelines, and public policies that range from teacher training to the choice and evaluation of didactic materials. All these aspects are found in the development and application of teaching methodologies, the subject of the next topic.

Teaching methodologies

Teaching methodologies that are based on or use cartography began to spread in Brazil in pioneering research, such as that of geographer Oliveira (2010), which focused on children’s cartography as early as the 1970s. For this author, who influenced a whole generation of researchers, the map is a means of spatial communication, possessing psychological and geographical foundations. In her cognitive approach, Oliveira (2010) states that one must transform the teaching of the map into teaching through the map.

As a spatial expression, there is a variety of instrumental uses of maps by all layers of society, from the layperson to the professional, from the scientist to common sense. However, geography professionals are the pioneers in the creation and dissemination of maps, transforming graphic language into geographical language (Oliveira, 2010).

The author (Oliveira, 2007, p. 20) points out that cartography is a form of communication older than writing, that is, the map has never dispensed with its own modes of “writing” and “reading”, being, therefore, more developed than writing itself. Thus, she considers the map a technical and scientific sophistication that has been improving over time. Recovering Piaget (1971), it is highlighted that the notion of space and its representation go

beyond perception: it occurs through the attribution of meanings by the subject, so that topological relations with space are considered the first to be established in terms of perception and representation. Thus, mapping takes place in synchrony with the development movement of the subject, of their thinking.

Paganelli (2010), in this sense, complemented that the experiences of locomotion and daily displacement in the local geographical space are favorable to the process of operationalizing spatial relations in children. The contribution of Le Sann (2010), in turn, investigated the basic elements of the map through interactive exercises with students in basic education institutions, adding, in addition to Piagetian assumptions, the systematizations regarding the Graphic Semiology of Bertin (1988).

The contribution with methodologies for understanding maps was also the responsibility of Almeida (2010b), whose research emphasized aspects related to perception, representation, and cognitive development. Passini (2010), in turn, brought the importance of the use of graphs by students in the analysis of school cartography. Also highlighted, in the 1990s and 2000s, was the production of school atlases with the dissemination of different types of maps, such as thematic ones and models, through the works of Martinelli (2010) and Simielli *et al.* (1991).

During the 1990s and 2000s, Almeida and Almeida (2014) observed that, regarding theoretical contributions, the prevalence of research presented at academic events on cartography dealt with the representation of space and the construct of spatial relations, strongly based on Piaget (1971). In contrast, they also noted, in more recent waves, the presence of Vygotsky's (1984) ideas in contributions from Language studies.

Oliveira (2010), as well as Callai (2023), states that the map is a valuable resource for teachers in general and, especially, for the area of school geography; therefore, she defends the cognitive perspective employed in qualitative analyses of maps. In this sense, for the author, there is a double problem: excessive abstraction of geographic maps by schoolchildren, added to a didactic problem regarding the use of maps as a mere visual resource, without adaptation to the students' mental development, on the part of teachers. This would be a problem of what has come to be called the "cartographic literacy" process, which we discuss briefly below.

Cartographic Literacy⁴

Map teaching would be between the student's learning and development process, based on three specific spatial relations: topological, projective, and Euclidean. Oliveira (2010) emphasizes the concern about didactic action and the scarcity of studies on maps for children, since graphic spatial representation appears from the beginnings of children's social activities.

The disposition of skills and environmental perception underlie cartographic reading and production, which involve a set of cognitive operations articulated and fundamental to the understanding of spatial representations. Elements such as shape, size, and pattern are not apprehended directly, but result from cognitive processes of rotation, reduction, and abstraction, operationalized through specific cartographic devices, such as projection, scale, and legend.

Scale organizes the reduction relationship between real space and the map, while projection implies geometric transformations necessary for the transposition of the Earth's surface to a plane, demanding from the subject the ability to understand rotations and distortions. The legend, in turn, systematizes the abstraction and standardization of the represented phenomena, allowing for the interpretation of cartographic symbols. Thus, the map is configured as a complex cognitive product, whose reading presupposes the articulation of these mental operations, essential for the construction of spatial reasoning in the context of school cartography and geographic education.

Furthermore, one must work with the inseparable dialectical relationship between teaching and learning. Would it not, then, be more important to learn how to make maps? Oliveira (2010) underlines that the map can be frustrating for those who do not know the mapping process. In practice, if the teacher does not know how to use the map, nor knows what they want to teach through it, it will always be just a distortion of reality. In other words, the value of the map lies in what teachers set out to do, because "a good map is one that correctly presents what one wants to show" (Oliveira, 2010, p. 36). Therefore, we deduce that investment in school cartography in the curricular base of teacher training is essential, in order to remedy the need to adapt cartography to teaching from early childhood.

For Oliveira (2010), physical experience and mathematical experience are complementary dimensions in the construction of cartographic knowledge, mediated by the dynamic relationship between the object and the subject's action. The map, as an object, is not

⁴ The term "cartographic literacy" has given way to the notion of "cartographic *letramento*" in more contemporary research, as will be noted throughout the text.

reduced to a technical artifact, but acquires meaning from the cognitive actions that the subject mobilizes to produce and interpret spatial representation. This process involves a cognitive mapping that takes place on different planes: the mental, responsible for the internal organization of perceived space; the iconic, related to the visual and imagery translation of spatial phenomena; and the linguistic, which enables the naming, description, and communication of spatial relations. Thus, cartographic understanding results from the interaction between concrete experiences and formal abstractions, in which the subject progressively builds representation systems that articulate perception, symbolization, and language within the scope of geographic education.

Simielli (2007), in turn, problematizes the effectiveness of the map as a means of communication through its elaboration process. The map originates information that communicates and produces effects. What, then, would cartography be? A representation of the earth? Art, technique, or theory? For the author, more than these answers, it is interesting to recognize the importance of map users, situating cartography in the general theory of communication (Neiva Jr., 1991), which works with messages and their respective communications.

According to Kolacny (1994), the communicative process is inherent to cartography, in which the cartographer, as a source, elaborates the map as a mediation channel between the real world and the user, who acts as a receiver of spatial information. In this journey, empirical space is transformed into a map image through technical and conceptual procedures that imply selection, generalization, and symbolization of geographic phenomena. The map, therefore, does not constitute a direct reproduction of reality, but a mediated image, constructed according to specific intentions, codes, and conventions, whose interpretation depends on the user's cognitive and cultural competencies. This relationship evidences that cartographic communication is a relational and non-neutral process, in which the effectiveness of spatial representation results from the alignment between cartographic production, the system of signs employed, and the interpretive capacity of the subject who uses it.

For Bertin (1988), cartographic language, because it is specifically graphic, needs to function communicatively for the creation and also for the reading of maps. In semiotics, language symbols occupy the places of words and things. Thus, the subjectivity of information, related to perception, will be different for each reader. The communication facilitated by reading a map occurs, in this way, as a mediation between the reality of the world and the reality of each map user.

In turn, Kolacny (1977) postulates that reality will always be partially represented in the map offered to the user, who interprets the information/communication and, then, returns to reality. Therefore, maps have specific functions for groups of users, for whom the understanding of cartographic language matters more than it does to the cartographer themselves. Therefore, agreeing with Oliveira (2010), teachers must mediate cartographic literacy beyond its mere use as visual resources.

We understand, then, with Simielli (2007), that cartographic literacy is a progressive cognitive process, based on the articulation between spatial perception, conceptual construction, and graphic communication. The understanding of oblique and vertical views, as well as the transition between three-dimensional and two-dimensional images, constitutes an essential step for the appropriation of the cartographic alphabet, based on the fundamental graphic elements—line, point, and area. These components demand specific cognitive operations, expressed in the construction of the notion of a legend, in the understanding of proportion and scale, and in the development of laterality, spatial references, and orientation.

Such a cognitive process supports the overcoming of a conception of cartography restricted to technical drawing, promoting its demystification and affirming it as a means of communication and reading of graphic representations in the teaching-learning process of Geography. Cartographic literacy, thus, establishes itself as a structuring condition for the development of spatial reasoning and for the critical understanding of representations of geographic space.

In this way, cartography is an essential tool for teaching geography, and can be used as a means of communication and knowledge construction, and not just as content to be taught. We must consider, therefore, that cartography is interdisciplinary, in the sense that it is more than the representation of geographic space, constituting a symbolic and technical language that communicates information about space also in the teaching of history, science, among other disciplines. Contextualizing teaching in an educational environment, the pedagogical function of cartography as a resource is to enhance the development of geographic reasoning through cartographic literacy.

Criticisms of school and traditional cartography

So-called traditional cartography, conventionally, works with printed maps, globes, and charts whose symbology is aligned with projective conventions, scale, legend, compass rose, geographic coordinates, and the Euclidean map background. Models, even though they transpose mapped elements to the concrete plane, also work with traditional conventions.

It is this modality that the National Common Curricular Base (BNCC) recognizes as a structuring axis of Geography teaching. As Girardi (2023) warns, this recognition results in a massive diffusion of traditional cartographic models in teaching materials intended for Elementary and High School in Brazil, since public policies, such as the National Textbook Plan (PNLD), are guided by the BNCC.

The criticism of traditional cartography, however, is not new. It has been systematically made by intellectuals such as Harley (1989) and Lacoste (1988), who denounced academic segregation and argued about the power and ideological control hidden in hegemonic maps, which camouflage the intrinsically political biases of cartography in science and Nation-State projects. In this context, there was a conflict over the viability of mapping as a method by the geographic scientific community due to its uses associated with geopolitical strategies, as well as the world map projections themselves—such as the Peters projection, which criticizes Mercator's for its Eurocentric and racist bias.

In this regard, Fonseca (2012) discusses how, in the context of school cartography, the naturalization of some cartographic elements prevents innovations and limits critical reflection on their representations. According to the author, the map background, composed of projection, scale, and metric, is a central focus of this naturalization, as if there were a “topographic truth,” of an ideological nature, which creates obstacles to criticism and new theoretical reflections.

Disguised by a false neutrality, the background of maps is based exclusively on Euclidean metrics, which ends up bringing limitations to other types of spatial representation. Furthermore, the author points out that this excess of “Euclideanism” also overlaps with the use of mapping *software*, resulting in a certain automation of cartographic production associated with geotechnologies.

Fonseca (2012) also perceives that scale and projections suffer from the same problem, where excesses of scalar regionalizations end up hindering the understanding of the spatiality of complex phenomena, while Mercator has become a practically hegemonic projection, despite its deformities and limitations. Thus, what is considered a map is reduced to those that rely on

these types of markers. Conversely, things like cartograms and anamorphic maps are not considered maps in themselves.

The naturalization of these elements, according to Fonseca (2012), reduces maps to a logic excessively linked to location, which often impoverishes the possibilities of other approaches, more linked to the needs of users. Also resorting to Bertin (1988) and Harley (1989), the author emphasizes that such maps can become underutilized and distanced from a cartographic ethic, which cannot dispense with a more critical and expressive approach. Cartography must open itself up as a language for the benefit of students and society as a whole.

Another important aspect the author criticizes is the approach to the globalization map in relation to the complexity of the contemporary world (2014), arguing that cartography needs to live up to its crucial role in geographic education at this historical moment. In the context of a globalized world, thematic maps become powerful resources for the representation of social and economic dynamics, such as global networks and flows, which transcend regional scales. Thus, the very critique of cartography and its naturalized limitations must be incorporated into teaching practices.

Girardi (2023) seems to agree with this line of thought when postulating that school cartography must distance itself from rigid forms and move closer to new practices and expressions. Furthermore, it should not be confined solely to the school environment, limited to teaching, but rather consider mapping as a social practice that engages with and reflects contemporary reality.

In this sense, it is necessary to highlight different types of cartographic production beyond the map, which can be used in multiple ways in the teaching of geography. There are influential and innovative research and productions that fuel a scientific agenda highlighting cartography, yet directed toward more critical studies regarding the use of maps and teaching practices.

Different forms of cartographic production and their uses in Geography Education

Among the new possibilities of employing cartographic products, geotechnologies occupy a prominent place. Geotechnologies include geoprocessing, remote sensing, and geolocation, with *software* like *Google Earth* and QGIS, which create interactive maps in applications and virtual platforms. With such advanced technology tools, it is possible to

manipulate thematic layers with different geographic variables, increasing the dynamism of spatial analysis.

In this way, it is possible to connect the digital daily life experienced by the current generation with Geography Education, while simultaneously fostering interdisciplinarity with areas such as arts, computer science, mathematics, and environmental science (Canto, 2018). The use of these tools is important for the understanding of the spatiality and temporality of current geographic phenomena, but it also requires that teachers be trained to integrate geotechnologies into their pedagogical practices.

In this regard, Canto (2018) postulates that new cartographic literacy practices are undergoing transformation due to the growing diversity of map users, which requires new teaching approaches. For the author, we are facing a new generation, which interacts with the world through the touch of fingertips on an electronic device screen, such as *tablets* and smartphones. Geography education, therefore, needs to consider these types of readers and their different way of interacting with texts.

Furthermore, digital maps, by mixing different forms of language, such as images, texts, sounds, algorithms, and locational devices like GPS, also destabilize the definitions of cartographic representation. This hybridization of languages innovates spatial representations and, in a way, expands cartographic conventions, which evolve and begin to allow for the representation of more complex phenomena. Daily experience, in this context, is permeated by maps whose function is precisely to mediate the interface between the digital world and the concrete world, directly impacting the perception of space and, thus, raising ethical questions.

Cartographic literacy, from this point on, begins to involve more than just codes: it is a social practice and, therefore, requires an understanding of contexts. In other words, the social function of maps must be reevaluated in light of new technologies and mapping practices, as these allow, according to the author, for new forms of interaction and understanding of space. An example is the multiple authorship in the production and consumption of maps, which destabilizes the traditional cartographic paradigm that separates ‘maker’ cartographers from ‘receiver’ users, since users themselves are capable of creating and modifying digital maps in an active process of participation, as in collaborative maps, which are becoming increasingly common.

If cartographic literacy is a social practice, we have in so-called Social Cartography an approach that has been widely explored in different parts of the world by various references, such as Almeida (2013), Boudreau (2025), Kitchin, Gleeson and Dodge (2013), Sletto (2024),

among others. Promoting participation and critical reflection on lived space, it involves participatory mapping, where the subjects of the territory collaborate in the production of maps. This approach contrasts with conventional cartography, revealing power relations and underlying ideologies.

In the context of education, Social Cartography allows for the construction of a critical school geography, where students express their realities and demands, valuing the reading of space as a social and historical construction (Gomes, 2017). Methodologically, it encourages students to produce mental maps, sketches, affective drafts, and other subjective representations of the territory using freer techniques that are less tied to the forms, sizes, and standardized patterns of traditional cartography. In this way, it promotes cognitive autonomy amidst the construction of a spatial thinking based on the perception of lived experience.

Critical Cartography, in turn, is a transdisciplinary approach, admittedly more committed to the discussion regarding the power relations embedded in traditional mapping techniques and dissemination. It seeks to break with the elitism underlying hegemonic cartography, moving toward popular participation in the production of maps. It is, according to Crampton & Krygier (2008) and Acsegrad (2010), an undisciplined cartography, which is built through social and political criticism by historical subjects, who appropriate new technologies to compose insurgent cartographies that are disobedient to the scientific *status quo*. Thus, they prove, with other points of view on space, that cartography is not neutral and, therefore, can be a form of resistance and questioning of prevailing categories of thought.

In contemporary times, maps with a critical bias have been widely instrumentalized by various sectors of civil society. In the artistic field, for example, cartography has been redefined for purposes that go beyond objective spatial representation, based on performative, playful, and narrative mappings, offering new perspectives on space.

Geotechnologies have also been strongly used through Geographic Information Systems (GIS), participatory in free *software*, and through map hacking, which facilitate the creation of alternative maps that challenge the informational control of official agents and corporations. The importance of this branch today is clear, as its challenging content promotes an exploratory movement of emancipatory avenues in cartography that can impact academia, geography teaching, and society.

This perspective finds correspondence in the field of social action, with alternative mapping being a valuable instrument for social movements. In this realm, the methodology of Social Action Cartography (Ribeiro *et al.*, 2013; Silva, 2013) stands out, an analytical tool that

develops from the dynamics of daily relationships, where the urban experience, fraught with complexities and conflicts, is permeated both by the capitalist structure and by the arrangements of the conjuncture of space and social ties.

Social representation, in this way, can be mapped by the embodied subjects themselves (Ribeiro, 2013) who, through the uses of the territory, creatively produce maps based on their own narratives, in a way detached from the metric parameters of traditional cartographic conventions. Thus, these cartographies, initially individual, become collective as they are inserted into local contexts, constituting themselves as readings of a spatio-temporality of resistance against structural violence.

In the context of teaching, this method is conducive to bringing the students' own experiences and perceptions regarding their places, their daily lives, their unique experiences, and knowledge regarding social reality to the center of the learning focus, in a dynamic, critical, creative, and aesthetic way, overcoming objectivism. The intent, according to Ribeiro (2013), is to capture the movement of society, which is necessarily done by overcoming hegemonic representations (including cartographic ones), which favor conformism and complacency in the face of the world.

When it comes to asserting the importance of accessibility to cartographic language in the direction of human rights, promoting the appreciation of diversity, and social, cultural, and sensory inclusion, we have Inclusive Cartography (Almeida; Sena; Carmo, 2018). With the goal of making cartography more accessible to a larger number of people, including within the scope of teaching practices, this strand has been developed in several academic research centers and applied in schools. Among its different approaches, we highlight Tactile Cartography (Almeida, 2007), developed for people with visual impairments; Ethnocartography (Pereira; Sletto, 2024), based on cultural and geospatial representations of indigenous and traditional peoples; and the aforementioned participatory mappings, which promote community representations in peripheral urban contexts. These cartographies are present in various institutional projects, in school environments, in NGOs, and in civil and environmental rights organizations.

There are challenges in employing these cartographies in cartographic education, especially the need for curricular openness, teacher training, and an agenda that includes the collaborative use of digital technologies that allow for the development of multisensory and cultural formats. Centering on the user, their unique corporealities, and their territorial repertoire is a premise for the development of methods and theoretical models that incorporate

these perspectives towards guaranteeing rights and promoting equality (Almeida; Almeida, 2014). Cartography, in this way, is assumed in its social function.

In this scenario of hybridization of languages, the emergence of Artificial Intelligence (AI) on the horizon of 2026 imposes a new layer of complexity on cartographic literacy. If, on the one hand, generative AI algorithms facilitate the manipulation of large volumes of geospatial data and the automated creation of representations, on the other, they deepen the challenge of 'false neutrality,' already denounced by critical cartography. Teaching mediation, therefore, becomes even more essential: in addition to interacting with the fluid map on the screen, students need to unveil the algorithmic 'black box' that selects what should or should not be visible. Thus, the dialogue between academic knowledge and new technological interfaces must be guided by an ethics of representation, ensuring that technology serves as an amplifier of geographical reasoning, and not as a tool for the invisibilization of subjects and their territorialities.

Final considerations

Among the issues listed so far, we can make some comments in the form of an open ending for this text. We perceive that new tensions arise for the perennial questions of communication, language, and cartographic teaching methodology in school: the definition of the map's purpose and the reasons justifying its production; the clarification of the represented object and the selected informational content; the graphic and cartographic language choices mobilized in its conception, as well as the technical resources employed; the characterization of the intended users, including age group and people with disabilities; and, finally, the expected results and the procedures for evaluating the effectiveness of the mapping process in relation to the proposed pedagogical objectives.

Almeida and Almeida (2014) state that the answers to these old questions have been modified by the growing advent of technology. If on one hand there is immense potential to be explored both in teaching and in the daily use of maps, on the other, difficulties remain in adequately preparing the teaching staff of basic education for the teaching of cartography. These are new procedures, new products, and, certainly, new mentalities already native to a frankly digitized world.

In terms of teaching practices, Canto (2018) points out that such challenges will require educators and teachers to immediately consider these new informational and digitized territorial dynamics from the very beginning of teacher training. Since cartographic literacy has been a perennial demand of teacher training since the first research on cartography teaching methodologies, such as those by Oliveira (2010) and Simielli (2007), such concern remains in these new times. Contemporary cartography, furthermore, will require an increasingly plural approach in teaching, incorporating the different nuances that emerge from digital technologies and welcoming the demands of new generations.

Multicultural diversity and inclusion are also first-order issues for school cartography. According to Almeida and Almeida (2014), Tactile Cartography and Ethnocartography, for example, must be incorporated into knowledge production through multisensory cartographies, such as tactile maps for the visually impaired, and ethnic maps, produced by indigenous peoples and traditional communities that represent their worldview regarding their places and territorialities. In this way, the dimension of human rights and citizenship is added. It is emphasized, again, that teacher preparation is essential for working with this type of map in urban, rural, traditional, and indigenous school communities.

Based on Fonseca (2014), we saw that contemporary cartography faces criticism for its still excessively Euclidean approach, and the proliferation of digital maps does not necessarily improve geographical understanding. Critical cartography, in turn, gains strength by suggesting that maps do not just represent, but also produce realities. The interconnection between disciplines, therefore, is vital for a more robust critique of cartography in education.

It is possible to consider, given this panorama, that school cartography has been academically expanded since the 1970s, and this coincides with the renewal movement of Geography (Santos, 2002) towards a critical bias. Therefore, as Katuta (2020) concludes, school cartography is essential for strengthening a more critical geography.

In the school context, the central issue is not just to transmit techniques, but to favor the meaningful construction of cartographic knowledge, towards a more plural perspective. This implies overcoming a merely instrumental view, in which the student only reads ready-made maps, and advancing to practices that stimulate the production of mental maps, sketches, models, social and digital cartographies, promoting intellectual autonomy (Freire, 2025) and critical spatial thinking in an interdisciplinary way (Katuta, 2020).

Despite the development of teaching methodologies as a more frequent and predominant academic bias, it is necessary to maintain the questioning of traditional ontological and

epistemological paradigms. We note that, despite a still persistent presence of perspectives considered traditional, methodologies from more critical strands are being incorporated, even if perhaps in an incipient way. Be that as it may, this is an aspect that reaffirms that school cartography can be a powerful tool to reflect the diverse geographies and territorialities of social movements, marginalized groups, excluded and vilified by the inequality inherent in the capitalist system.

Cartography must, finally, be taken as a language that expresses geography, which allows for new forms of communication and understanding of space. In this sense, political practice must be engaged alongside the creative potential of educators, teachers, and students in the face of the task of linking teaching and learning practices with the dimension of human rights.

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CRediT Author Statement

- ☐ **Acknowledgments:** To the State University of Campinas – Unicamp and the National Autonomous University of Mexico – UNAM, where this research was developed.
 - ☐ **Funding:** National Council for Scientific and Technological Research – CNPq.
 - ☐ **Conflicts of interest:** None.
 - ☐ **Ethical approval:** Not applicable, as this is theoretical research.
 - ☐ **Data and material availability:** All data were extracted from open access research databases and institutional repositories of universities.
 - ☐ **Author contributions:** Single author, responsible for data collection, research, writing and revision of the text.
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