Article

Collaborative mapping and the mobilization of Powerful Geographic Knowledge at school

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e-204972

How to cite this article:

GANZ, T. M.; STEFENON, D. L. Collaborative mapping and the mobilization of Powerful Geographic Knowledge at school. **Geousp**, v. 27, n. 3, e-204972, sep./dec. 2023. ISSN 2179-0892. Available at: https://www.revistas.usp.br/geousp/article/view/204972. doi: https://doi.org/10.11606/issn.2179-0892.geousp.2023.204972.en.

revista geo USP espaço e tempo

Volume 27 • nº 3 (2023)

ISSN 2179-0892

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Abstract

This article presents reflections from a case study that counted with the participation of 225 high school students from a public school in the countryside of the State of Paraná, Brazil, with whom didactic sequences were developed with the Google My Maps platform. Through them we analyze the didactic potential of collaborative mapping regarding the mobilization of powerful geographic knowledge in school, through the theoretical and methodological framework offered in Alaric Maude's typology. From this perspective, geographic knowledge is seen as a set of references capable of deepening the ways in which students see the world and themselves, and of offering conditions for the promotion of greater awareness for social action. It was concluded that the collaborative mapping techniques mobilized and studied throughout the research contributed to the construction of different dimensions of powerful geographic knowledge, evidencing its potential for the promotion of different knowledge linked to geographic thinking in basic education.

Keywords: powerful knowledge; collaborative mapping; Geography teaching.

O mapeamento colaborativo e a mobilização de conhecimentos geográficos poderosos na escola

Resumo

Esse artigo apresenta reflexões de um estudo de caso que contou com a participação de 225 estudantes de Ensino Médio de uma escola pública do interior do Paraná, com os quais foram desenvolvidas sequências didáticas com a plataforma *Google My Maps*. Através delas analisamos as potencialidades didáticas do mapeamento colaborativo no que diz respeito à mobilização de conhecimento geográfico poderoso na escola, por meio do balizamento teórico-metodológico oferecido na tipologia de Alaric Maude. Nessa perspectiva, o conhecimento geográfico é visto como um conjunto de referências capazes de aprofundar as formas pelas quais os estudantes veem o mundo e a si mesmos e de oferecer condições para a promoção de uma

maior consciência para a ação social. Concluiu-se que as técnicas de mapeamento colaborativo mobilizadas e estudadas ao longo da investigação contribuíram para a construção das diferentes dimensões do conhecimento geográfico poderoso, evidenciando o seu potencial para a promoção de diferentes saberes ligados ao pensamento geográfico na educação básica.

Palavras-chave: conhecimento poderoso; mapeamento colaborativo; ensino de Geografia.

Mapeo colaborativo y movilización de conocimientos potentes geográficos en la escuela

Resumen

Este artículo presenta reflexiones de un estudio de caso que contó con la participación de 225 alumnos de enseñanza media de una escuela pública del interior de Paraná, con quienes se desarrollaron secuencias didácticas con la plataforma *Google My Maps*. A través de ellas analizamos el potencial didáctico del mapeo colaborativo con respecto a la movilización de conocimientos geográficos potentes en la escuela, a través del marco teórico y metodológico ofrecido en la tipología de Alaric Maude. Desde esta perspectiva, el conocimiento geográfico es visto como un conjunto de referencias capaces de profundizar las formas en que los estudiantes ven el mundo y a sí mismos, y de ofrecer condiciones para la promoción de una mayor conciencia para la acción social. Se concluyó que las técnicas de mapeo colaborativo movilizadas y estudiadas a lo largo de la investigación contribuyeron a la construcción de las diferentes dimensiones del conocimiento geográfico poderoso, destacando su potencial para la promoción de diferentes saberes vinculados al pensamiento geográfico en la educación básica.

Palabras-clave: conocimiento poderoso; cartografía colaborativa; enseñanza de la geografía.

Introduction

This text is based on the results of a master's degree research carried out within the scope of the Postgraduate Program in Education at the State University of the Center West – Unicentro, Irati, Paraná. It seeks to reflect on the didactic potential of collaborative mapping practices in basic education.

The objective of the study was to verify how collaborative mapping practices were able to intellectually empower students to think through Geography and adopt more critical and reflective positions concerning their reality and the production of their own knowledge, enhancing the learning of powerful geographic knowledge (Young, 2008; 2011; Maude, 2016; Lambert and Solem, 2017).

The fact that society is going through a context of profound changes was also considered, primarily due to the increasing popularization and use of ICT – Information and Communication Technologies, and that these transformations considerably deepen the new forms of interactive communication in the network space, directly influencing school education through the raw amount of data available and the density of hyperlinks that multiply and share at increasingly greater speeds.

Network space has become an environment through which students recognize and attribute meanings to spaces, events, and geographical situations. Different geographical forms materialize through diverse interactions and social relations, even if virtual. Precisely due to this characteristic and its nature so present in the networks of global society, geographic education is invited to adapt to this new reality to find approaches and methodologies that produce and reproduce critical and conscious geographic knowledge at school.

This text initially presents essential elements of the ideas of powerful geographic knowledge and collaborative mapping to present the main findings of the investigation. They are central references to the approach taken in this investigation. Next, the theoretical-methodological design of the research is explained, and then reflect on its main results.

Powerful Geographic Knowledge and collaborative mapping

As suggested by Michael Young (2008; 2011; 2014; 2016), the concept of Powerful Knowledge was conceived as a curricular principle, a way of reflecting on what is taught and what is learned through the formal curriculum mobilized by the school.

Firstly, it is necessary to recognize that the author suggests the existence of different ways of learning, which have their due importance within different and specific communication contexts. Among them, learning from everyday experiences stands out. It is closely related to knowledge arising from the dimension of cultural and community experiences and the construction of collective sensitivity and common sense. However, especially when talking about school learning, such knowledge, however significant it may be, tends not to fulfill the function of promoting the understanding of the totality of aspects and contradictions that emerge from the space and complex ways of life of contemporary societies, because it is not part of its nature and intentions. For Young (2007; 2011), the school needs to move towards forms of knowledge that

are structured based on specialized subject knowledge, which would even justify the existence of schools based on the offering of curricula and knowledge that, generally, are not possible to be accessed in spaces other than school spaces. For the author, this perspective is the basis of the idea of acquiring powerful knowledge, i.e., knowledge that allows students to expand their ways of seeing.

Looking at Geography teaching, more specifically, Maude (2016) suggests that the concept of powerful geographic knowledge can be thought of from two perspectives. The first revolves around the question of what makes knowledge effectively powerful. From this perspective, a curriculum that incorporates powerful knowledge focuses on the type of knowledge that students do not have access to at home or in non-school contexts, whose access is facilitated through a guided and systematized pedagogy.

However, when we think about the social responsibility of the school and the emancipatory potential of Geography, the definition of powerful knowledge as exclusively specialized subject knowledge is not enough to support the construction of curricula and account for the totality of knowledge that composes them. This means that the fact that specific knowledge is included in the curriculum and has a scientific basis does not qualify it, *a priori*, as powerful knowledge. This requires considering its potential for change and the consequences that this particular knowledge could bring to the person who learns it. Here, we are referring to a second way of looking at the idea of powerful knowledge, which revolves around the empowerment that this knowledge offers to those who possess it, which, in the author's words, it represents:

> [...] discover new ways of thinking; better explain and understand the natural and social worlds; think about alternative futures and what they could do to influence them; have some power over their own knowledge; be able to engage in current debates of significance, and go beyond the limits of their personal experience (Maude, 2016, p. 72).

This perspective, which is taken as the basis for developing the argument of this research, recognizes that the power of geographic knowledge in school has to do with its willingness to promote the individual ability to think and act to achieve a given effect or result through elaborate forms of reflection, analysis, interaction, and action. This tends to allow the student to question the authority of the arguments they are exposed to and the power relations involved in producing knowledge. For Geography taught at school, evidently, this conception can bring an important political dimension, contributing to the construction of critical and broad awareness about the spatiality of phenomena.

From this perspective, Geography should not exclusively consider scientific-subject knowledge as the only curricular reference for acquiring powerful geographic knowledge. Although this is an essential source in building curricula, the essence of powerful knowledge cannot be contained in a ready-made list of content and/or academic skills to be learned. Instead, according to Maude (2016), it must be based on flexibility and acceptance toward the experienced world and the contexts where learning occurs in a constant search to make sense of the geographical space experienced at its multiple scales.

Given this need to promote the encounter of these different types of knowledge that make up the content of the map and classes, and with the perspective of building powerful geographic knowledge at school as a horizon of pedagogical practice, exploring the potential of mapping collaborative was sought as a resource for the construction of Geography classes in basic education.

Taking into account the conditions and objectives of this research, what is being called collaborative mapping here is, precisely, a set of techniques and procedures that allow the collaborative production of maps, specifically in this investigation, using Web 2.0 platforms. This type of resource constitutes a new operating paradigm for the world wide web, where users begin to play much more active roles in the production of information, allowing the creation of online social and collaborative networks with different purposes (O'Reilly, 2007; Canto, 2011; Bravo and Sluter, 2018).

Therefore, collaborative mapping represents an essential innovation in how maps can be produced and used and can even support the production of knowledge about geographic space, especially at school. This approach leads to the realization that the action of mapping is no longer an exclusive prerogative of a qualified and specialist cartographer (Bravo and Sluter, 2018; Machado and Camboin, 2019; Girardi and Coelho, 2021; Petsch *et al.*, 2022). Unlike this, users of electronic devices with internet access can enter data and/or customize their own maps on platforms created for this purpose.

The possibility of inserting different layers of spatial information can be used as a subsidy for users to become author-readers and create ways of representing, understanding, and thinking about the world based on the multilinearity typical of cyberspace (Girardi and Coelho, 2021; Petsch *et al*., 2022). Furthermore, web mapping platforms have mechanisms that allow the personalization of content, whether in terms of particular elaborations or the insertion of multimodal information elements, such as texts, videos, sounds, and photographs, which can reveal information and produce meanings about the represented places. In other words:

> By mediating a relationship with space and allowing the addition of new layers of informational content on its platform, collaborative mapping enables - in addition to the development of a system with a flow of decentralized and personalized information - the emergence of a spatiality marked by experimentation of space, to the detriment of a contemplative spatiality. (Ribeiro and Lima, 2011, p. 45, free translation)

From this perspective, the information in a collaborative digital map is not just a graphic representation, as it acquires the ability to create and communicate knowledge in an interactive and multilinear way. In other words, they become a broader interface of collective intelligence, which often resembles social networks, in which spatial recognition is expanded very dynamically and allows users to have a broad experience in space.

For Girardi and Coelho (2021), collaborative mapping practices advance cartography from a paradigm of *cartographic communication*, based on information controlled by cartographers in search of efficiency to transmit information through the language of maps, to a paradigm

of *cartographic visualization*. The latter is guided by discovery, the systematization of data and spatial information online, and the interactivity offered by technological devices and new mapping platforms that outline new sensibilities about space, opening up the possibility of exploring different forms of cartography within the school (Seemann, 2012; Canto, 2011).

This new paradigm brings to light a need for reflection regarding cartographic literacy practices at school, already consolidated in Brazilian geographic education since the 90s, with particular reference to the propositions of Simielli (1999). Among these propositions and consensuses, the idea that it is up to school Geography to develop the cognitive potential of students stands out so that they become conscious mappers and critical readers of maps through the apprehension and application of fundamental concepts of cartographic language, such as location, orientation, scale, and legend. Therefore, collaborative mapping would suggest a fusion between the mapper and the reader (Girardi and Coelho, 2021).

Given this, the resignification of the cartography paradigm seems to point to an equal resignification of educational practices that need to move beyond the traditional map approaches at school without neglecting them. Therefore, it is necessary to take them as a starting point to disseminate and promote new and different ways of approaching working with maps to bring this new approach to school cartography.

For Silva *et al*. (2021, p. 223), the relationship between students and digital maps "awakens curiosities, sensations, and perceptions, encouraging the student to imagine, create situations, observe, relate events and experiences, and thus, learn autonomously." In other words, "such maps express a different way of establishing communication and sharing an idea-image of the environments experienced in their material and symbolic dimensions" (Ribeiro; Lima, 2011, p. 46).

It is also worth saying here that "a map is known for being able to demonstrate power [...] and collaborative mapping brings the opportunity to be an instrument of complaints and solutions for society" (Tavares *et al*., 2016, p. 44). From a better understanding of their geographies, students can be included in contemporary social struggles and encourage the exercise of citizenship, as more enlightened citizens aware of the contradictions that shape their lived spatiality can participate more actively in their reality and intervene in it. At this point, collaborative mapping intercepts the practices of social cartography (Ascelrad, 2010; Gomes, 2017), adding to the movement to re-signify the role of communities – in this case, schools – in mapping processes and contributing to the promotion and visibility of elements of life that may generally be neglected by the cartographies that circulate at school.

Based on the understandings assumed in this investigation, such propositions suggest a possible approach between collaborative mapping practices and the idea of a school curriculum based on powerful geographic knowledge. From this perspective, the knowledge produced in schools, in addition to seeking to account for the specialized dimensions of the curricula, also tends to be taken from the demands of the locality and students' experiences in their multiple scales.

Therefore, so that school Geography can implement didactic processes that envision the construction of powerful knowledge, the appreciation of epistemological principles and conceptual pillars of science must be accompanied by profound attention to the different knowledge and

demands of the community and the school. In this way, the concepts, representations, and reasoning processes that make up the specific way Geography thinks about the world can be taken as new referents for understanding the world of life, i.e., as powerful geographic knowledge.

Theoretical-methodological design of the investigation

The research that gave rise to this article took place in the form of a case study, which, in addition to mobilizing collaborative mapping techniques integrated into didactic sequences in high school classes at a school located in the urban center of Imbituva/PR, also included the researcher's participant observation. Regarding the nature of this type of research in the educational field, it can be said that:

> […] are based on a perspective that conceives knowledge as a process socially constructed by subjects in their daily interactions while they act in reality, transforming it and being transformed by it. […]. The researcher's direct and prolonged contact with the events and situations investigated makes it possible to describe actions and behaviors, capture meanings, analyze interactions, understand and interpret languages, and study representations without detaching them from the context and unique circumstances in which they manifest themselves. (André, 2013, p. 97, free translation)

This research methodology favors the focus on the multiple dimensions of the educational process that are inevitably revealed from the school's daily life during educational practice. To capture the meanings expressed throughout the participatory research process and establish relationships and inferences about the *corpus* of the proposed research, we used multiple sources to produce primary data, which we describe below.

Firstly, we developed two didactic sequences based on the content of the formal curriculum of the public network in the state of Paraná, which were carried out by around 225 second and third-year high school students from a school in the interior of the state. The web mapping platform Google My Maps[1] was used, from which we extracted a set of collaborative maps produced by students as products.

To create the collaborative maps proposed for the didactic sequences, we generated a collaborative map for each group of students with a maximum of five members. The digital file was shared on Google Drive with access and editing permission through hyperlinks made available to students on the Google Classroom platform and through messaging applications. The map-making activities occurred during the students' after-school hours, in the school's computer laboratory, or using their equipment.

The research sought to consider the use of Google My Maps from the perspective of mapping via the web or VGI (voluntary geographic information) platforms, seen as platforms for geographic information collected and shared by the general public, that is, by users with or

1 My Maps is a service from the Google suite, based on a Web 2.0 platform, which allows one to create and customize collaborative digital maps. The platform has a feature through which it is possible to share the map edition online.

without formal education in cartography. The practice of sharing and the possibility of generating digital content are the aspects that characterize these platforms, with "collaborative mapping" being the expression used to determine the collaborative nature of this sharing of geographic information on digital maps (Bravo and Sluter, 2018).

The didactic sequence proposed for the second-year students dealt with the Geography of Paraná. Throughout ten different activities, students researched and produced content about the state based on the spatial reference of its five major regions of Paraná relief[2]: Coastal Plain, Sea Mountain Range, First Plateau, Second Plateau, and Third Plateau. These activities aimed to lead students to understand geographic situations related to municipal and state spatiality to deepen their knowledge concerning their most immediate geographic space. The educational product created throughout the activities was an interactive map of the State of Paraná, with its main geographical characteristics.

The curricular proposal for the third-year students of the state network is linked to several issues linked to geopolitics. Therefore, based on the theme of globalization and geographic networks, the activities of the proposed didactic sequence brought different geographic situations through which we sought to address concepts and topic contents related to the proposed topic. Among them, we can highlight the characteristics of capitalism, socioeconomic inequalities between countries, the concentration of income in the world, the international division of labor, and the various interconnections of the globalized world.

The educational product created by students throughout the didactic sequence was a set of eight digital maps, which highlighted the relationships between the local and the global from different perspectives so that students understood how geographic situations and the range of events that dynamically characterize, produce, and reproduce space.

We used a research field diary to record information, observations, comments, and reflections regarding everyday practices to support reflections on the work developed with the didactic sequences throughout its application. Furthermore, students responded individually to a semi-structured questionnaire with open and closed questions at the end of the activities.

Such research instruments allowed us to produce data about using collaborative mapping practices as teaching and learning tools, constructing powerful knowledge, and improving students' geographic thinking through such teaching practices.

The data analysis process was based on a qualitative-interpretative process in which, through comparing results and discovering the relationship between the information obtained using the research instruments, we identified the existing patterns among the findings. We seek to extract their meanings and make inferences and generalizations regarding the content generated while applying the didactic sequences.

Using powerful geographic knowledge as a reference for analysis (Young, 2008, 2011; Maude, 2016; Lambert and Solem, 2017), this study did not seek to analyze the learning of a pre-determined list of prescribed content. Instead, a qualitative interpretation of the learning was

2 Classification by Reinhard Maack (1981).

undertaken based on Maude's Typology of Powerful Geographical Knowledge (2016), expressed in Table 1 below, which served as a categorical reference in the analysis of these results:

Table 1 – Typology of Powerful Knowledge in Geography

Type of powerful geographic knowledge	Essential characteristics
Type 1 - Knowledge that provides students with "new ways of thinking about the world"	Based on the significant concepts of Geography (place, space, interconnection, landscape), it seeks to expand students' knowledge of the world beyond their own experience by providing them with additional points of view.
Type 2 - Knowledge that provides students with powerful ways to analyze, explain, and understand	It concerns the different levels of geographic reasoning (analysis, understanding, generalization, explanation, etc.), which, when mobilized, favor understanding the subject contents of Geography and improving geographic thinking.
Type 3 - Knowledge that gives students some power over their own knowledge	It concerns the active processes of the construction of geographic knowledge. It is directly related to the epistemological bases of Geography and the student's freedom to question what is already known and the acquisition of knowledge.
Type 4 - Knowledge that enables young people to follow and participate in debates on significant local, national, and global issues	It concerns citizenship training, the development of youth protagonism, and critical sense in the face of socio-spatial reality.
Type 5 - Knowledge of the world	It concerns students' subject knowledge or general geographic knowledge concerning the characteristics of space, the environment, societies, and cultures.

Source: Prepared by the authors based on Maude (2016) and Lambert and Solem (2017)

Given this categorical system, the students' productions, i.e., the collaborative maps, presentations, texts, and the researcher's field diaries, were analyzed based on the typology above to seek evidence in a delimited and objective way about the possible learning of powerful geographic knowledge through the collaborative mapping actions conducted throughout the experiment.

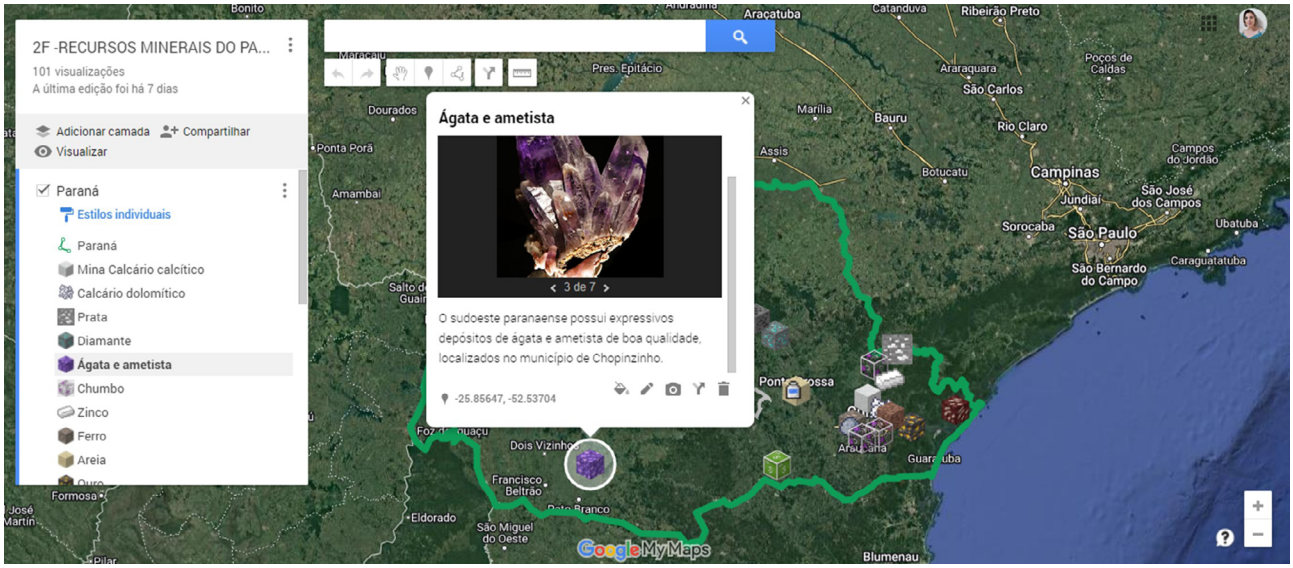
Based on the evidence collected through the research instruments and the analysis of their interaction with the theoretical framework listed, below we will present some of the teaching potential demonstrated to constitute a sufficient picture of the main results of the research.

Results and discussion

Student productions, especially maps produced collaboratively through the Google My Maps platform, constitute the primary artifacts among the research results. As seen in Figure 1, collaborative digital maps enabled students to represent places and phenomena through markers on the map spatially.

For example, students received a list of the primary mineral resources in Paraná to carry out this activity. They were asked to search which cities in the state they could be found in and then proceed to insert their location on the map with the 'Add marker' tool. When a point is inserted, an information box opens where the location's geographic coordinates are automatically entered. Students used these spaces to attach various information, such as the mineral resources corresponding to that location, their mineral deposits, how they are explored, and their possible economic uses. This was done with texts, photos, and videos attached to the map through upload (uploading digital files) or hyperlinks.

Figure 1 – Partial reproduction of the map produced by group 10 of second-year high school students from a school located in the interior of the state of Paraná



Source: Ganz, 2022.

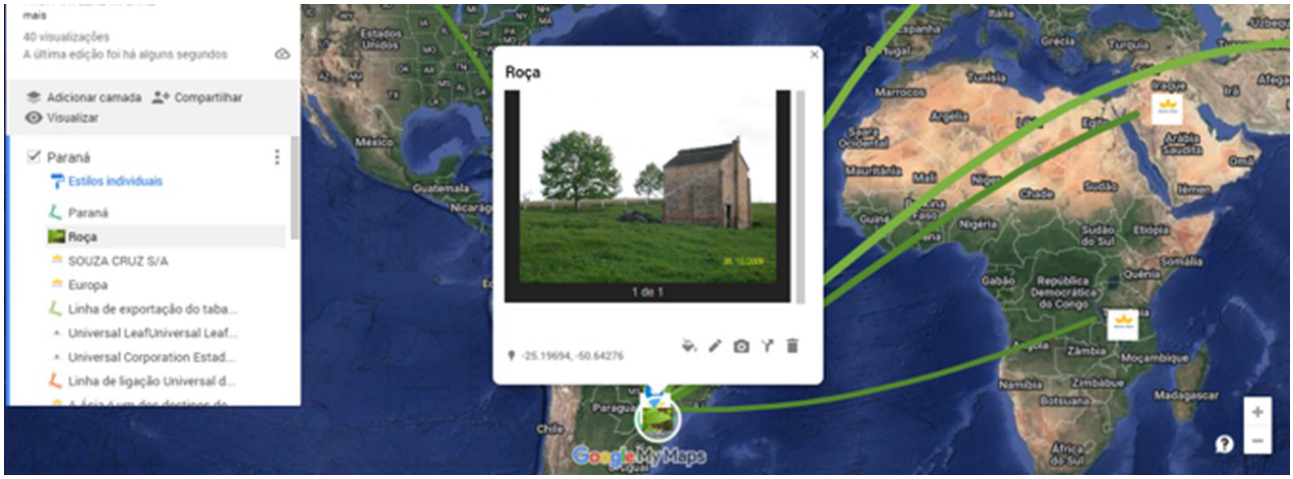
This dynamic allowed students to reflect on the interactions between society and nature and mineral exploration's natural, social, and economic constraints. This exercise, in the wake of the National Common Curricular Base (BNCC), including and through spatial representation, activates several principles of geographic reasoning, such as analogy, differentiation, connection, and order.

We also verified that the collaborative mapping techniques mobilized allowed students to interact with representations of geographic space based on satellite images at various scales. The students' spatial thinking was stimulated by analyzing the spatial attributes of the represented phenomena linked to a geographic concreteness that gives meaning to knowledge. We verified

with this activity that collaborative mapping enhances learning and understanding of the proposed content by exploring the spatiality of the phenomena of certain curricular content phenomena, with which the student is often not immediately familiar, by creating explanation models that can consciously represent and reflect on geographic space.

In another sample of the maps produced, for example, the students used the 'Draw a line' and 'Add directions' tools to spatially represent how the production and export of tobacco in the Municipality of Imbituva takes place (see Figure 2 below). Tobacco farming is an activity carried out by many of these students' families, forming part of the daily life and work of many.

Figure 2 - Partial reproduction of the map produced by group 7 of third-year high school students from a school located in the interior of the state of Paraná



Source: Ganz, 2022.

With this activity, they illustrated the spatial and socioeconomic relationships between the local and the global through a geographical situation directly related to their realities. They also visualized and conceptualized some of the geographic networks involved in the relationship. Analyzing the material produced, we discussed various characteristics of globalization and how it affects the organization of life and work locally.

We found that the creation and study of this map allowed the students in the class to understand better geographical situations inherent to their place of experience, which often tends to be neglected in school programs and curricula. Through the mapping action, it was possible to explore how and why this phenomenon acquires the characteristics represented and how the place connects to other places in the world through different networks, nodes, and connections.

Another theme explored by students throughout the didactic sequences refers to the geographical situations related to the expansion of the Covid-19 pandemic in the world. On this map, as seen in Figure 3 below, the students recorded where the first case of Covid-19 was detected in China and how the virus spread around the world, passing through Italy and the disclosure of the first case in Brazil until the arrival of the disease in Imbituva, thus revealing the evolution of the pandemic situation in the municipality.

Figure 3 – Partial reproduction of the map produced by group 8 of third-year high school students from a school located in the interior of the state of Paraná

Source: Ganz, 2022.

The students also identified the countries that produced the vaccines, the inputs needed for their application, and how they arrived in Brazil. With this activity, we analyze the global impact caused by the pandemic and reflect on how globalization and rapid global interconnections contributed to the spread of the virus. We also discuss how this process, combined with the technical-scientific revolution, triggered a worldwide mobilization of governments and transnational corporations in search of treatments and vaccines.

Such activities could explore different geographic aspects to a certain extent, highlighting their dynamism and movement. This is in line with the propositions of Silveira (1999, p. 21), who states that "thanks to new techniques and the circulation of information, the geography of the current world emerges as a totality and, therefore, we are faced with the need to produce a methodological scheme that allows us to draw up a portrait of places in the history of the present." The examples above show that collaborative mapping can be a possible way to meet these needs, one of its most essential potentialities. Web 2.0 platforms like My Maps favor the representation, spatial analysis, and interpretation of more diverse geographical situations.

The practice of teaching and learning through collaborative maps contributed to constructing a methodological proposal concerned with identifying meanings in school content through geographical situations. This is stated by verifying that, through the digital maps produced by the students, it was possible to visualize the material location of a specific spatial section and allowed the relational perception between the variants inherent to a geographical situation.

We found that, in addition, the movement of representation of geographic situations by students allowed them to analyze how techniques, organizations, innovations, and actions of groups or large corporations spread in a specific space and modify it in a dynamic, interrelated and interdependent way, determining socio-spatial transformations and the constant reconfiguration of geographic situations based on the reordering of their variables. Using collaborative mapping

platforms via the web provides geographic education with the possibility of building teaching processes that go beyond direct instruction and lead students to more proactive attitudes concerning the construction of their knowledge. This statement is supported by the premise that collaborative mapping does not require memorizing information. On the contrary, it guides students toward understanding more interactive learning processes that facilitate grasping concepts and formulating new geographic reasoning.

Analysis of the results in light of Maude's Typology

For Bravo and Sluter (2018, p. 1903), "collaborative mapping carries with it a connotation of empowerment of communities and citizens who previously did not participate in the process of creating geographic information." Supporting the author's statement and per the categorical references of Maude's Typology (2016), it can be stated, initially, that the production of collaborative digital maps by students is directly associated with the construction of Type 3 Powerful Geographic Knowledge, or *knowledge that gives students some power over their own knowledge*. We defend this argument by noting that for students, producing digital content and exploring geographic thinking through collaborative maps was an empowering experience, as they activated a new way of building knowledge that provided them with the possibility of significantly mobilizing concepts and content of Geography.

Collaborative mapping practices presented great epistemic potential for school Geography, considering that such practices facilitated the construction of meanings about real geographic space based on the informational potential of cyberspace, establishing an access route for students to discover how knowledge is created, tested, and evaluated by geographic science. We found that students produced geographic knowledge and digital content throughout the didactic sequences.

We argue that this learning dynamic meets the idea that powerful knowledge allows those with access to it to question the authority on which it is based (Young, 2014). In other words, when creating collaborative maps, learners go beyond the position of information receivers to assume themselves as authors of knowledge since such digital products are created by the sum of many intelligences that open themselves to dialogue and negotiation of meanings in favor of a collective construction of geographic knowledge at school.

When we asked students if they considered that they had produced geographic knowledge with activities on the My Maps platform, the majority of them, 98.5%, responded affirmatively, even justifying their answers with several examples, among which we highlight the following:

> By working, I was able to open my mind about the topic, and with the research and putting together the work, I was able to learn to find my way around (J.3E)[3].
>
> The activity was something new and different, which made me interested in doing it. With the opinion and knowledge of each person in the group, we discovered many things that we didn't know before (A.3D).
>
> In each presentation and when carrying out the activity, I managed to create my own knowledge about the state (A.2C).

Furthermore, collaborative mapping practices have been shown to favor the development of students' geographic reasoning substantially, equipping students with Type 2 Powerful Geographic Knowledge, i.e., *knowledge that provides students with potent ways of analyzing, explaining, and understanding*. This occurred when they used different spatial concepts such as location, orientation, shape, and distribution to trigger reasoning processes such as analysis, synthesis, generalization, superposition, association, and prediction, which are inherent to geographic analysis.

Throughout the didactic sequences, we verified that school cartography, practiced through collaborative mapping, contributed to students being equipped to read spatial arrangements and global networks, enabling the mobilization of various principles of geographic reasoning such as analogy, differentiation, distribution, extension, location, connection, and spatial order.

Considering the importance of admitting that, among its different roles, "Geography at school has the purpose of forming geographic ways of thinking on the part of students" (Cavalcanti, 2012, p. 12), collaborative mapping demonstrated to allow the study of geographic phenomena based on the alignment between cartographic language and geographic reasoning. This highlights its role as a teaching tool capable of contributing to materializing the way of thinking about geographic science.

From the above, it becomes evident that collaborative mapping practices have broad potential to provide students with *new ways of thinking about the world*, per Type 1 Powerful Geographic Knowledge. For Maude (2016, p. 12), "Ways of thinking are powerful because they may provide a student with new perceptions, values, and understandings, new questions to ask and new explanations to explore." While applying the didactic sequences, we verified that the spatiality represented by the maps, associated with the density of informative hyperlinks and the constructed geographic knowledge, favored the outlining of more robust and dynamic geographic thinking connected to new multilinear and collaborative ways of learning through cyberspace.

Of all the students who carried out the activities with My Maps, 92% believed that they started to think differently about geographic space. A critical indication to strengthen this argument is that some of the most recurrent phrases among students throughout the didactic sequences were: "I didn't even imagine that," "I didn't know it existed," etc. We can reinforce this statement with the students' own considerations:

3 Students are referred to by the first letter of their name, followed by their school year and high school class to preserve their identity.

> Daily, we don't realize much of what we experience, but when we stop to debate and understand globalization, we realize that there is a world that goes beyond what we know, and we start to see the it differently (E.3E).
>
> When you delve deeper into something, you can discover a different world. I believe that my view has changed a lot (LA.3C).
>
> We got to know places in the world that we had no idea we were linked to in such a significant way (B.3E)
>
> In research, we know very different realities than those we are used to in Brazil (B.3D).
>
> I had no idea such cool places existed. The geographic visibility of My Maps is incredible. I met several important cities and several companies around the world (M.3D).

These new ways of thinking using Geography, described by the students, are characterized by many of their central concepts. They are understood through collaborative mapping practices and the explanatory schemes they created on digital maps. We noticed that collaborative mapping promoted the cognitive development of students, who became, at the same time, mappers and readers of spatial information.

For us, it is clear, therefore, that students needed to use the contents and concepts of Geography to represent the spatialities of the proposed geographical situations, supporting the proposition that maps at school need to go beyond the status of the mere location to present themselves as an instrument to favor the effective construction of geographic knowledge (Cavalcanti, 2012; 2013; Castellar, 2020).

Thus, one of the fronts that allow us to measure the breadth of powerful knowledge constructed by students concerns evidence of understanding of subject content and access to broader general geographic knowledge. Although it is not the only source of verification of learning, conceptual or subject knowledge is an essential reference, as its learning serves as a basis for geographic thinking, which, in turn, is the route to access powerful knowledge. It comes close to what Maude (2016) calls Type 5 Powerful Geographic Knowledge, i.e., *knowledge of the world*. For the author, this type of knowledge takes students beyond everyday experience by allowing young people to gain a more profound knowledge of the global diversity of environments, peoples, and cultures and develop notions of global interconnection and citizenship.

To evaluate this learning dimension, we asked students, through an open question in the semi-structured questionnaire, to describe three Geography contents that they learned during the didactic sequence. The diversity of content mentioned is a strong indication that the activity provided students with the understanding of various concepts inherent to the subject content of Geography, which in turn led to the improvement of geographic knowledge. When we asked students if they had discovered new places and new realities through the activity with My Maps, 96% of them responded affirmatively, confirming what we found throughout the entire course of applying the didactic sequences.

Another important finding is that, among all the students who answered the question above, none made statements such as "I don't know" or "I don't remember." On the contrary, they all listed contents and briefly discussed them in their own words, as in the highlights below:

> I learned about my state, got to know its cities and tourist attractions better, about the relief, and also how to locate myself on the map (J.2C).
>
> We are all 'mixed,' cultures are not just local; they are several in one. For example, I am Brazilian and from Paraná, but I receive cultural influence from other places in the world, such as the USA, England, and Japan (Y.3C).
>
> I thought I lived in a closed world, but by studying globalization, I understood that the world is much bigger (J.3C).
>
> The work made me reflect that the pandemic only happened so quickly because of globalization, at the same time that it slowed down because of the world's technology (N.3D).

We found that collaborative mapping practices promoted diverse reflections on the global diversity of spaces and developed a more consistent argumentation equipped with a more robust geographic vocabulary, which directly collaborated with the training of young apprentices.

In general, the collaborative maps gave students the possibility of formulating geographic questions, understanding personal dilemmas, and pointing out alternatives to solve problem situations inherent to their realities, thus enhancing the discussions and notes of the groups in the classroom, promoting the student protagonism and the empowerment of young people. The students' statements support this statement:

> With the opinion and knowledge of each person in the group, we discovered many things that we didn't know before (A.3D).
>
> Class presentations helped show the leading and most exciting details of the matter, which they could easily convey in a conversation (A.2F).
>
> The way of using the application to group information helped with learning and presenting the topic in the classroom so that we could see and talk about things in a more transparent and more organized way (B.2F).

Concerning talking and debating about the themes covered in the didactic sequences, 88% of students considered themselves capable of this task, and many exemplified it as follows:

> I absorbed a lot of information and even explained to my mother how footwear exports work in Imbituva (V.3E).
>
> I could already speak, having understood the work and enjoyed so many stories across the topics (N.3C).
>
> Now, I can talk to people more about this theme without getting lost and wondering what that is (D.2F).

Based on these data, we can state that collaborative mapping practices provided students with access to Type 4 Powerful Geographic Knowledge or *knowledge that enables young people to follow and participate in debates on significant local, national, and global issues*. For Maude (2016, p. 14), "The ability to follow and participate in public debates is essential to full and equal participation in society and its conversations about itself, and without this ability, young people lack power." Based on this premise, we can state that the ability to use geographic thinking to discern and evaluate social, political, and economic situations is very relevant in today's world and consists of one of the strongest vocations of school Geography: preparing young students to examine issues and play their role as active citizens in the context in which they live.

From the evidence demonstrated, we can state that although Maude (2016) presents us with a typology with five categories of powerful geographic knowledge, they do not present themselves as distinct learning in educational practice. On the contrary, they merge, complementing each other to support geographic education. We consider *geographic thinking the link* between the different types of powerful geographic knowledge proposed by Maude (2016) and the essence of Geography as powerful knowledge. Therefore, we agree that:

> Thinking geographically is a uniquely powerful way of seeing the world. (...) provides a language – a set of concepts and ideas – that can help us see the connections between places and scales that others frequently miss (Jackson, 2006, p. 9).

Powerful geographic knowledge, therefore, when pervading the objectives of Geography as a school subject, becomes a perspective capable of referencing and giving meaning to the activity of thinking through Geography, providing students with greater intellectual autonomy that clarifies and complexifies their understanding of the world.

Final considerations

Given the set of results presented, it is argued that collaborative mapping can be a relevant tool for exploring the potential of geographic education, offering different ways of appropriating students' spatialities. Furthermore, it tends to provide alternatives for educational practice in favor of developing knowledge that expands the ways of seeing the world.

During the didactic sequences, we found that My Maps became a very intuitive and easy-to-use resource for students, presenting great didactic potential, as the platform allowed the exploration of various Geography contents through the exercise of spatialization of phenomena. All of this allows us to characterize collaborative mapping practices as a tool for the construction and appropriation of geographic knowledge at school, a link between the student and the materiality of geographic space, with the power to strengthen their relationship with spatial thinking and the places represented, in its different scales. Collaborative mapping practices provided simultaneous learning of different geographic contents by enabling the insertion of personalized spatial records coming from different media sources. They promoted the understanding of spatial interrelations through associative reasoning and new forms of representations.

As a digital tool, the collaborative mapping platform My Maps favored a teaching procedure through which students assumed power over the construction of their own knowledge, which put them in direct contact with different aspects, concepts, and processes related to geographic science, leading them to reflect on the production of scientific knowledge itself.

Empowered by new ways of learning and thinking about geographic space, students became capable of making more complex generalizations and taking the newly acquired knowledge as a starting point for new learning. We consider that the pedagogy mobilized in the research led students to develop robust ways of analyzing, explaining, and understanding geographic space. We also assessed that the geographic concepts constructed and mobilized by students during activities with collaborative maps provided the expansion of their repertoires concerning scientific and geographic knowledge.

Furthermore, mapping practices could lead students to greater knowledge of the diversity that characterizes the world's geographic space. This is due to the multilinear media essence of collaborative maps that presented students with various places, situations, and events characterized by different natural, social, cultural, and economic aspects.

Therefore, school knowledge produced from this perspective proved capable of helping prepare students for the world of life. We make this statement because we found that, throughout the research, collaborative mapping practices demonstrated that they could enable students to approach spatial and social issues that were significant to them, especially those related to local geographies. Furthermore, the dynamics of active learning, especially those linked to freedom and autonomy in the construction of knowledge, such as learning through investigation, the production of content, and the presentation of the material produced, as well as discussions held based on what was systematized by them on the maps, presented good potential in the task of strengthening students' critical arguments, stimulating reflection and encouraging more enlightened attitudes toward their own reality.

The data collected during the research allows us to affirm that such practices encouraged the students' youthful protagonism, both in constructing their own knowledge and their ability to think through Geography and position themselves regarding their own reality.

Developing the ability to think through Geography is one of the great didactic potentialities of collaborative mapping, as it allows students to activate, in addition to curricular content, new learning processes that lead to new knowledge and geographic reasoning processes through which knowledge can be constantly transformed and re-elaborated. Collaborative mapping contributes to mobilizing among students these *new ways of thinking about the world*, which enables them to continue learning, attentive to the current reality on its multiple scales, and which serves their personal and collective demands, which is, at the same time, in our view, a prerequisite for a life with autonomy, freedom, respect for diversity and commitment to social justice.

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Article editor:
Amanda Regina Gonçalves

Received on: 26 Nov. 2022
Approved on: 28 June 2023