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Visual Learning and Multiple Temporalities

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Abstract

The articulation between different temporalities and spatialities is an important field of discussion for understanding historical information. When considering the Brazilian high school context, specifically the humanities curriculum, this paper discusses the use of a didactic tool for visualizing temporality to enhance the visual literacy of teachers and students as primary and secondary target groups, especially from a synchronic-diachronic perception of historical time. We investigate how the articulation of the multiplicities of time and space might mediate strategies for teaching and learning history, considering visual language in a currently changing curriculum for high school. To this end, we briefly describe the tool's design in the previous phases of our research and its connection to curricular demands, data visualization, and traditional historiographical models. Through user evaluation, we discuss the reception of the tool among teachers and students, as well as the implications for cultural learning. The research was instigated by the distancing many students feel when attempting to place themselves within a historical narrative. During the learning experience, it is essential to understand how history is constructed by the participation of groups and individuals and not by distant, impersonal forces; this broadens the discipline of history to include the narratives of students' lives. In addition, we understand that these social perceptions, which include those of time and space, are lived through multiple languages and cognition channels and are mediated by the teachers. Thus, visual language acts as a mediating device for teaching and learning information literacy so that all narratives can be more easily addressed and all learners are perceived as active agents of social change.

Keywords: data visualization, didactic tool, timeline, history, high school

Introduction

As the title of Bernard Darras' book (1996) provokes, "in the beginning was the image"[1]. Darras questions the role of visuality in human expression, which unveils infinite possibilities in the intersection between visual language and all knowledge domains during various stages of education. Inspired by this premise, Brazil's new proposal for the high school curricular base, as standardized by the Common National Curricular Base (BNCC), foments dialogue between languages and the technologies that make use of them. As described in the normative document, "it is necessary to ensure that young people have learned to work in a constantly changing society, to prepare them for professions that do not yet exist, to use technologies that have not yet been invented, and to solve problems that we do not yet know" (Brasil, 2018, p. 473).

BNCC addresses how the described contemporary challenges extrapolate technological issues and dive into the fluidity of social and cultural relations, as well as the linguistic aspects individuals use to construct their own realities (Brasil, 2018). Following the BNCC guidelines, we propose a specific investigation regarding visual language and its significance in learning processes within the high school context.

As defined by Horn (1998), visual language corresponds to the integration between graphic-verbal (words) and visual (images and forms) elements as an independent form of communication. These elements have specific dimensions and types, and their use is subject to syntax, semantic and pragmatic implications, as well as spatial relationships (such as proximity and similarity). It is the integrated symbolic and contextual use of the elements that establishes communication (Horn, 1998). While Horn (1998) argues that visual language gives rise to visual culture, Freitas (2017) explains that visual language was highly favored by the increasing demands for contemporary information. That, reciprocally, boosted new spheres of culture and

1 *Au commencement était l'image* (Darras, 1996). Translated by the authors.

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visual culture. New relationships with the digital universe and emerging technologies also motivate new approaches to the school environment. As promoted by the BNCC, it is necessary to recognize and use them to explore new possible and compatible languages. In this regard, visual language is an essential intermediate point for the learning process.

In Brazil, high school usually includes 15 to 19 year-olds (Brasil, 2018), an age group rapidly developing cognitively. For Conyers (2016), this propensity for cognitive development makes this school phase favorable for deepening study methodologies and thus challenging existing classroom pedagogies. To this end, Conyers highlights several strategies, including encouraging languages preferred by students to engage them in metacognition and, consequently, aiming for learning about their own lives and interests.

Access to visual language is as necessary as other languages to address information in a systemic and open approach. For instance, schematic language might be as viable as verbality in humanities. According to Risler and Ares (2013), visual language provides students with the insertion of expressive dimensions of knowledge, such as aesthetics and symbols, which directly dialogues with creativity. Making space for visual resources implies the creation of a school culture that is more inviting to new ways of thinking about knowledge, with greater facility in understanding "meanings and its forms" (Coutinho & Lopes, 2011, p.9). In this way, promoting access to visual literacy also becomes a matter of information literacy, the first implying the critical exploration of visuality for communication and the second on educating for the understanding of information in given situations of need (Coutinho & Lopes, 2011).

During the high school years, this linguistic approach also becomes necessary as a strategy for contextualization information. Schmidt and Garcia (2005) explain that students during this phase are highly sensitive to the world and its processes of change. When what is learned in school does not resemble what is lived outside of it, learners might experience disconnection in their education. For the discipline of history, when the student does not understand that the school-taught narrative is compatible with their own, they might face distancing from the social, political, and cultural processes that govern society. Our approach aims to understand which nuances of visual language can be approached in order to contextualize the learning of history, considering the transdisciplinary pedagogies proposed by the high school curriculum.

For that, the subjects of history pose an interesting challenge since secular models of information visualization have been important tools in historical learning by mediating social and physical time and space. Both information visualization and historiographical methods for analysis highlight visual complexity through visual language. Global history, for example, a specific historiographic approach, articulates sequential time (diachrony) with simultaneous time (synchrony) as a way of mapping complex networks of influence and provides evidence of how languages can be integrated into data visualization tools.

Inspired by BNCC's educational itineraries and structural themes regarding articulation between time and space, and the global history case of visuality as didactic mediation, this study focuses on how multiple temporalities might enhance learning in a high school context. To comprehend how this approach might bring new perspectives to visual literacy within the discipline of history, this paper aims to investigate how the proposal of a didactic tool, conducted in the previous phases of this research, might trigger different learning strategies. Considering Brazilian history teachers and high school students as primary and secondary target audiences, we seek to establish a bridge between both research components, utilizing multiplicities of time and space as a visual cognitive strategy aligned with information design methods and data visualization models.

First, this paper discusses the curricular demands for the new Brazilian high school curriculum and its relationship with incorporating new languages into the desired cognitive skill set. Then, we seek to explain the methodological conceptualization of the didactic tool, especially regarding previous models of information visualization and its functions. Finally, we discuss our research methods for user evaluation. We discuss our results based on qualitative data, which foments preliminary hypotheses regarding the use of the tool in its respective use context.

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Visual Learning of Historical Time and Space

Visual Language, the Brazilian High School Curriculum, and Social Perceptions of Time

According to Pereira et al. (2019), Brazilian high school is often a collision point of expectations regarding the positioning of young apprentices in society. Resulting from a series of curricular reforms in the past decades, this particular step in primary education has again received significant attention in the past five years, facing a new curriculum that drastically disrupts all previous attempts. This new curriculum presented schools with a merged model organized around transdisciplinary itineraries and a new organization of disciplines. This model transitioned schools from independent and discrete school subjects, often organized around multidisciplinary themes in dialogue with one another.

Although opinions mostly praised implementing a more personalized approach, the new curriculum has been faced with skepticism. Questions address how to implement such a contrasting pedagogy since the new curriculum requires more workload for students and teachers and new didactic material. A greater challenge is the increased role of many traditional disciplines and the impacts this change might have on an unstable educational system.

As delimited by the normative document for education in Brazil, BNCC, high school itineraries are structured around themes. This paper concerns access to information for youth, focusing on the transition from the discipline of history to part of a wider field of knowledge: the humanities itinerary, consisting of a merging of history, geography, philosophy, and social sciences. For the humanities itinerary, this study focuses on the relationship between time and space. The humanities curriculum emphasizes individual learning competencies, highlighting the intention of bringing multiple languages into the teaching-learning process. A few of the mentioned languages include schematic, iconographic, cartographic, and pictorial, which convey a more visual understanding of information.

The curriculum considers high school to be a phase of critical deep learning and reflection, integrating information obtained in the previous years of primary education. Students are expected to deepen sensemaking practices by understanding, interpreting, and generating information. Although significant efforts are directed toward rethinking high school pedagogies and languages, it is necessary to consider what Coutinho and Lopes (2011) call, in the Brazilian context, a mismatch between the classroom and contemporary languages and their forms of presentation. For them, the mismatch in bringing “non-school languages” (Coutinho & Lopes, 2011, p. 7) into school highlights a gap in the dialogue between the reality of the classroom and life outside of it.

For Scheimer (2010), this new paradigm between languages, the tangible (analogical) and the digital, has had a significant impact on teachers, especially history teachers, from internal and external transformations:

> We can cite as external causes: changes in society, scientific revolution, and changes in the culture of an era. As internal causes, we can mention the exhaustion of traditional theories and models, which lead to the search for new alternatives, student involvement with the media, and the demand for classrooms that contribute to this reality. (Scheimer, 2010, p. 4).

For some, it becomes easier to visualize the external timing of events, processes, and structures permeates everything around them rather than internal causes. The contrasting nature between what is learned and what is applied in students’ lives, might be particularly challenging for learning history (Schmidt & Garcia, 2005). There is hardly any space for exploring the nuances of students’ experiences outside the “single narrative” in the chronology of events, which implies a distancing of the student as a historical agent. This factor leads to a motivational mismatch between the student's needs and the governing “forces” of history, which are camouflaged under a historical reality that is not always accessible to their experience. This paper aims to answer whether a more literal visualization, aligned with teaching methods, might be a mediation tactic for all involved.

Structuring a Graphic Space for Learning Historical Time

This research was conducted and rooted in the changing context of the Brazilian high school curriculum, which is considering demands for new linguistic perspectives for approaching information literacy. Based on information design and data visualization methods, the research revolves around the practical

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applications of time visualization within the field of social humanities, especially in the discipline of history. We considered these applications with teachers, students, and researchers and outlined a didactic tool for visual learning.

The proposed tool was shaped by user requirements, high school curricular demands, semantic use, and representation of data within the field of history, as well as historiographical visual models based on global history. In semantic terms, consolidated visual models, such as timelines, timetables, schematic maps, etc., acted as guiding points for cognitive models that might be more familiar to users when considering visual language. The proposal was also constructed from requirements extracted from similar initiatives of temporal visualization, as we previously described in Oliveira and Bueno (2021). In this particular paper, we investigate a diverse range of time-space visualization tools and extract patterns regarding the representation of information. Some of the investigated aspects comprise the configuration of the time axis, specific time scales, digital affordances for mediating usability, color schemes, pictorial patterns, etc. The study shows that, across the decades, representations of time and space have been improved by reducing the level of data complexity, which was especially impacted by the transition from print to digital devices, the latter supporting more graphic diversity and customization.

We highlight the fundamental contributions of Braudel (1990; as cited in Ribeiro, 2010), Jordheim (2014; 2012), and multiple authors to the conceptualization of a more concrete perception of historical time, considering its abstract nature. From a more structural standpoint, time might be illustrated as a complex system of layers (multi-temporalities) organized according to their duration. While long-duration occupies the structure's base, short-term events occupy the top and thus articulate comprehension of time according to its social time and transformation expression. From a narrative standpoint, this visualization might unveil the contradictions that emerge when applying physical time logic to human experience, as discussed further in this paper. Nevertheless, structural models, such as layered models, offer a solid visual approach from an information design perspective when confronting different areas of study.

As a matter of visual literacy in high school, special attention was necessary to reduce complexity when analyzing preferred models for time visualization. For that, Engelhardt's (2007) and Meirelles' (2013) constructs on the presentation of graphic language were fundamental to addressing the horizontality of diachronic time in a Western setting, considering the reading direction from left to right. In this case, Chavez and Garcia (2014) also highlight that Brazilian students tend to prefer a diachronic, sequential presentation of events in history since didactic books, booklets, and classes tend to be structured that way. Because of this Western tendency, a new vertical axis emerged after establishing horizontal diachrony as a starting point, along with layers of duration for adding a systemic dimension to time visualization. Estaville Jr. (1991) and Silva (2012) describe this verticality as the axis of simultaneities (synchronism) that cross sequential time in time frames to be specified by each context, which adds a third dimension for information.

Considering the low complexity of the tool, the final conceptualization of its graphic space allows two different diachronies since this is the minimum number for allowing a synchronic time frame. It also became imperative to consider that teachers, overall, do not feel comfortable producing diverse graphic language (Coutinho & Lopes, 2011) or utilizing complex graphic language in technological devices.

Therefore, structuring the graphic space of the tool followed a few practical-theoretical guidelines, which are described below:

- Establish the concept of diachrony as a horizontal axis and the concept of synchrony as a perpendicular or vertical axis. It is important to recognize the interdependence proposed here between the two axes and how systemic learning might be aligned with BNCC competencies;

- The graphic space is segmented into two diachronies, adding a fourth dimension of comparison: one for local/national contexts and one for global contexts. Although this option is deeply influenced by global history historiographic practice, this choice is also aligned with time-space delimitations for the humanities itinerary in BNCC. Timelines still might work as a system of layers of duration, hence displacing long duration to the bottom and events to the top;

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- Distortion of linearity is then considered as a method for delimiting the graphic space in a finite structure that revolves around itself, oriented from left-right reading, similarly to volvelles. As Helfand (2002) described and was complemented by Krzywinski et al. (2009), the circular model offers different levels of data resolution, which acts as a mediator for complexity. Distortion of horizontality (diachronism) also displaces the synchronic axis in a radial configuration.

Figures 1, 2, and 3 illustrate the proposed graphic space and its organization:

Figure 1
Organization of the tools graphic space according to national or global contexts and layers of time for each diachrony.

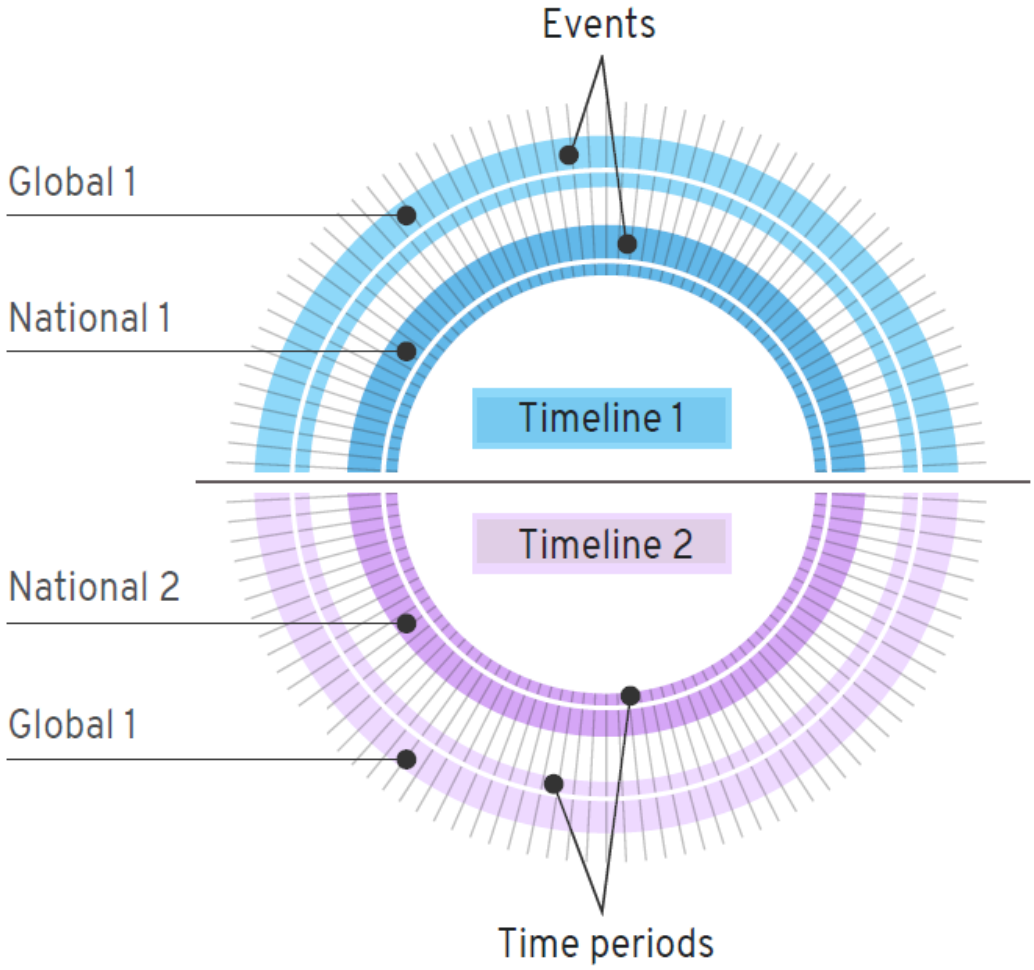

Figure 2
Placement of synchronic and diachronic axes in the tool's graphic space.

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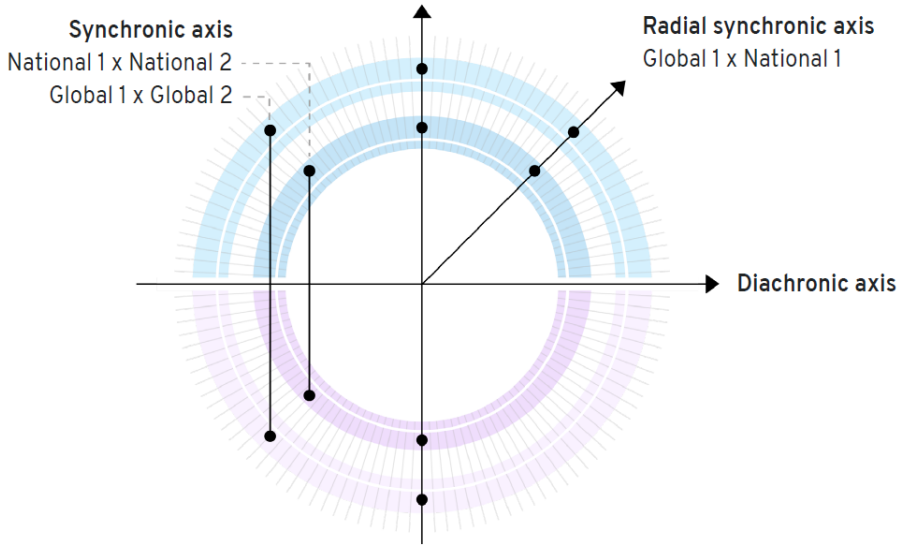
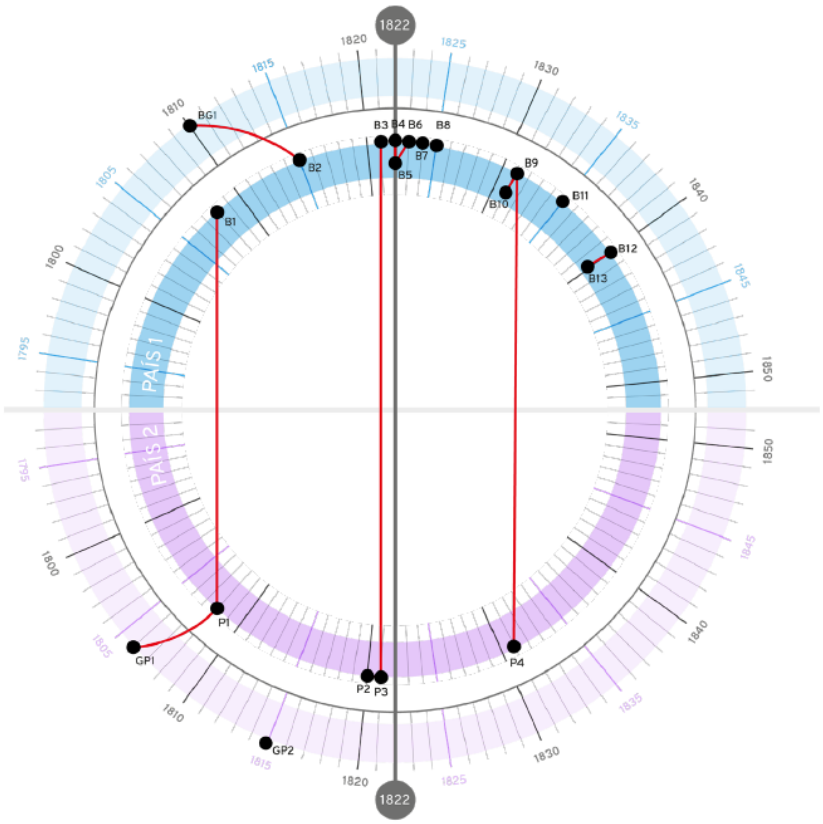


Figure 3
A preliminary version of the tool's use. Codified dots consist of events connected by red segments indicating relations between them.



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After structuring the graphic space, we proceeded to user evaluation in order to understand how teachers and students relate to this particular visualization tool in a school context. We describe the evaluation methods in the following section.

User Evaluation

Methods

Although aligned with consolidated models of time visualization, the layers of information in the graphic are also based on punctual interventions on linearity and placement of axes. This approach is complemented by curricular demands, including spatial frames of local and global contexts. However, while individually, each requirement is aligned with a particular approach to historical data, it was still unclear whether, altogether, the composition would operate on a significant logic for users. We conducted user evaluation with the target audiences, focused on two main objectives and dynamics:

- **Dynamic 1:** given basic instructions on the tool's functioning, investigate if teachers and students were able to read and interpret the information presented on the tool's graphic space through a set of comprehension questions;

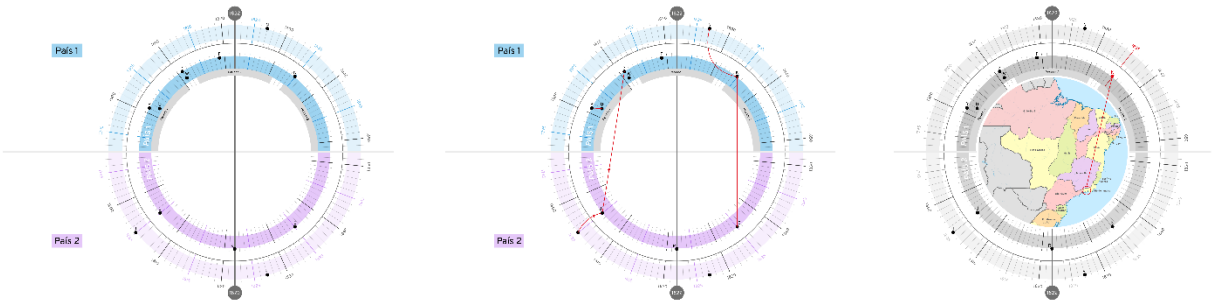
- **Dynamic 2:** from a given dataset, investigate if they can generate a graphic representation in the empty graphic space through a short task analysis.

Considering the pandemic as a limitation for interaction between researchers and users, we opted to evaluate with a control group consisting of three high school history teachers. To compare the dynamics with students, the control group also included one high school student.

Each participant was consulted individually through a one-hour online call. The provided datasets included random codified events around a specific time frame, revolving around 1822 (the year of Brazil's independence from Portugal). Each dynamic was conducted remotely through collaborative websites, such as Miro and MURAL, while participants were asked to verbalize their actions when completing dynamic 2. In the end, participants were invited to offer feedback and express specific moments of their experience. Figure 4 illustrates three different visualizations presented to the participants during the first dynamic:

Figure 4

Board with three different visualizations presented to participants during dynamic 1 for comprehension evaluation.



Preliminary Results

During the first dynamic, all teachers understood the overall purpose of the tool, mainly providing correct answers for each comprehension question. However, some challenges were directly associated with the visualization of simultaneity between events in two different situations, such as global and local in the same context or local and local in two different contexts.

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It is important to address that, although the dataset was composed of a set of codified, unnamed events and periods around specific dates, teachers were able to recognize real events that could be associated with each dot in certain time frames. In this case, it was interesting to observe how previous knowledge was a solid base for confronting new visual methods, considering how, in order to bring new languages to the classroom, especially non-verbal ones, teachers must often break a cycle of the languages they were confronted with during their own learning experiences.

During the second dynamic, teachers faced difficulties regarding text legibility and contrast, which were corrected in the following phases of the study. Aspects that required more attention included difficulties in comparing synchronic and diachronic axes, as well as reading date marks, which were prioritized when promoting final adjustments to the tool's space.

Once again, teachers immediately expressed how certain codified events felt familiar because of certain dates, considering the 1822 time frame. While marking spatially and temporally close events, participants often externalized that "something very interesting was happening" in a particular context. This expression may imply that, although they may not have had experience with the tool, graphic language offers an intuitive communication based on graphic variables offered by consolidated tools, such as maps. In this case, Bertin's (1967) contribution to the semantics of graphics representing spatiality allows us to wonder if the rupture with traditional timelining is more of an exercise of visual literacy as a pedagogical practice, rather than a radical, repetitive challenge of "reinventing the wheel", as Helfand's (2002) book title on volvelles might suggest.

When evaluating the student, the results were similar as they faced no significant difficulties while interpreting or constructing the visualization and addressed each question or task with agility. Unlike the previous participants, who experienced technical difficulties in the collaborative website, the student seemed familiar with the affordances of the digital devices, such as the ability to zoom in and out, despite not having previous experience with it. Conducting the process remotely presented challenges already mapped by authors such as Coutinho and Lopes (2011) regarding the insecurities of bringing digital technology to school.

Although more confident in mastering the graphic language of the tool and utilizing the digital devices available, this particular student also felt more confident in promptly interpreting the data and making sense of the connections between what was being presented. However, they could not make intuitive associations with actual events in the same way the teachers did. In this way, previous knowledge of visuality and digital technology might have acted as a mediator between the proposed model and the presentation of information for them, perhaps complementary to how teachers experienced these factors, and vice versa. In conclusion, for now, we question if the teaching-learning dynamic could be enriched by bringing teachers and students together to collaboratively create the visualization until developing enough familiarization with it. Otherwise, we could present a mutual obstacle for both parts and require a second mediation device, such as an explicative guide or a tool kit.

Time Visualization for the Learner: The Continuum Between Structural and Narrative

The early process of the tool's conceptualization required an approximation with historiographical practices to extract visual models already familiar to the visualization of historical time and space. However, this approach also required considering the challenges faced by history as social science, especially regarding how one might confront the perception of space-time. According to Burke (1992), temporal information can be treated as a narrative expression or a structural construct. The narrative expression is focused on a micro-frame, considering the narrative as an intrinsic dimension of the succession of events in social time (Burke, 1992). The structural construct is a more macro-frame, with the time of events (short-term) only becoming significant when inserted into the time of structures (long-term, hence the layer at the bottom of multi-temporalities) (Burke, 1992).

With that in mind, we highlight that, while the proposed didactic tool is deeply rooted in visual models with rather "crude" graphic language and thus promotes straightforward and structural connections between its graphic elements, we find it helpful to discuss visual learning on its own terms. In the tool, events are

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marked as dots, periods as thick lines, and connections between them are indicated through rigid lines that imply a cause-consequence relation. When compared to Burke's (1992) definitions of narrative and structure, we understand that the tool's visualization offers a simplistic representation of the complexity of events. While we find this simplification consistent for a mediation tool in the high school context, it might limit the creative interaction between the teacher or learner and the graphic language. The narrative becomes reductionist by delimiting rigid structures and elements, and users might understand that their interpretations are not relevant to the final visualization. Additionally, we understand that the different focuses, micro-, and macro-frames, are relative to the approach for the study of the past (Burke, 1992) but are not necessarily favored equally in the tool's graphic space.

Likewise, Burke (1992) also proposed that narrative and structure might act as two extremes of a continuum, with a wide margin for possibilities in the middle. Some teachers participating in the early phases of the study explained that there seems to be nothing wrong with the regular timeline as a tool for enriching the experience of historical learning. On the contrary, the challenge is utilizing it critically to allow students to ask why they face such a linear, arithmetic perspective of time when each individual conceptualizes time frames according to their own experiences as human beings (Pschetz & Bastian, 2018).

Although we find it counterproductive to map the exact intended uses of the tool expressed by teachers and students, the alternatives raised by the participants were surprisingly diverse. The range of ideas brought to us during and after the evaluation involves multimodal aspects of visual literacy, offering a visual alternative for learning and an experience of social expression and critical thinking. Expanding the discussion in this direction recognizes that visual language is widely open to cultural context.

Participants suggested that the graphic space should be projected or printed on more extensive surfaces to create a collaborative discussion space. While describing bringing students to write and draw on the chalkboard, one teacher found it interesting that a delimited space with clear rules and perhaps a graphic toolkit might help mediate the relationship with learners. In some sense, we speculate that a rigid time structure can provide more agency for users in developing visual literacy by defining a more direct path for constructing the visualization in accordance with linear, horizontal timelines present in didactic books in Brazilian high school. In this way, we might assume that by "intuitively" knowing how to fill in the data, teachers and students would be more comfortable interacting collaboratively with graphic language, but further investigations with the tool are necessary to address this hypothesis.

Based on the BNCC requirements, participants suggested remixing the timelines with their perceptions of lived experiences in order to historicize them. In the early stages of the research, while consulting a diverse range of alumni of different ages, we learned that, both in the private and public school system, at least a quarter of the participants could not understand themselves as part of a historical narrative. For them, the past occurred long ago and was far away from their realities. It is motivated by this premise that the duality between narrative and structure becomes such a critical approach since individuals' lives operate through the narrative lens (Burke, 1992).

Recognizing that a structural tool might not suit the critical learning challenge faced by teachers in a moment of curricular change is an important starting point for considering the next steps. Not only does positioning students' diachronies in the synchronic frame mediate critical learning through visuality, but it also triggers autonomous visual expression and metacognition.

As Padovani (2012) depicted, significant learning comes as a sum of active channels incognition. Mental models are not necessarily composed of straight lines, symmetric dots, standardized color schemes, or perfectly organized axes and layers of time. Indeed, it is necessary to expand the tool to other methods of visual representation of information and rupture with the rigidness of statistical visualizations. In this case, we glimpsed methods such as collective mappings (Risler & Ares, 2013) and line-expression drawing (Orland, 2002).

As described by Orland (2002), line-expression drawing reinforces the semantic potential of the line, a borrowed approach from psychology, in which individuals are invited to express their own journeys (e.g., professional, personal, academic journeys) as continuous lines. In the tool's case, dots, lines, and areas,

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as basic graphic elements, are then subject to this semantic potential, supporting the use of graphic variables (e.g., texture, form, opacity) to signify properties of visual language. The connection between events, for instance, symbolized as straight lines with arrows, might then be twisted, broken, braided, distorted, or rotated. Each author is free to interpret its symbolic meaning as a part of historical learning, thus utilizing visual language as a connector to their previous knowledge, which is also outlined by cultural learning (Boughton, 2007).

Another consideration is collective mappings, community-driven regional maps, which often foment social mobilization debates, as conceptualized by the Argentinian group Iconoclasistas (Risler & Ares, 2013). The process is mediated by visual resources, such as iconographic kits. The results are often dense with plenty of data and hand-drawn registers, which show the nuances of the debate among participants. Over printed maps, collaborators compose their own geographies of time and space, reinforcing debates over anti-colonial information models. In this particular case, we understand that expanding the collaborative nature of the tool and its semantic structure is an essential dimension for dealing with information inside the social humanities.

Finally, Pschetz and Bastiani (2018) argue that design dialogues with time visualization are based on the same assumptions raised by Jordheim (2012): that it is necessary to recognize time in its multiplicity in order to understand the complexity of different socio-cultural realities of human societies. Such a position can be understood as a reaction to globalization's universal and mechanical time, an imposition of impersonal time. Recovering social time while simultaneously discussing its universal nature "allows a more specific focus on issues of ethics, equality, power and social coordination" (Pschetz & Bastian, 2018, p. 170). Reaching such a transformative sphere with visual language is a challenge for contemporaneity.

Conclusion

The challenge of a holistic education is a broad, open question to which multiple answers seem to fit but to which few seem to function in reality. Although new curricular demands within Brazilian high schools reaffirm the compromise with the diversification of languages, structural and cultural aspects challenge their rhythms and implications of teaching and learning relations.

When proposing whether visual models would help mediate this transition for the humanities curriculum, we argue that no direct response is sufficient to address the full complexity of the question, albeit the promising results from this study might indicate optimism in reconciling historical literacy and visual literacy. Our research indicated that users were eager to use prior knowledge and experiences – with information, technology, etc. – to form a solid base for facing these challenges. Therefore, visual language might be rooted in intuitive learning because of consolidated models, and perhaps this learning can be redirected toward other sorts of data.

Finally, we expect to deepen our understanding of these preliminary observations and expand our experimentations with the proposed tool and graphic language as the shifting new curriculum is gradually and officially implemented in 2022.

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Footnotes

[1] *Au commencement était l’image* (Darras, 1996). Translated by the authors.

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