Geodesign Teaching Experience and Alternative Urban Parameters: Using Completeness Indicators on GISColab Platform

Ashiley Adelaide Rosa[1(✉)], Ana Clara Mourão Moura[2], and Beatriz Maria Fernandes Araújo[2]

[1] Programa de Pós-Graduação em Geografia, Instituto de Geociências da UFMG, Universidade Federal de Minas Gerais (UFMG), Av. Antônio Carlos, 6627 Belo Horizonte, Brazil
ashileyrosa@ufmg.br

[2] Escola de Arquitetura, Laboratório de Geoprocessamento, Universidade Federal de Minas Gerais (UFMG), Rua Paraíba 697, Belo Horizonte, Brazil
anaclara@ufmg.br

Abstract. This paper aims to introduce a teaching experience using geodesign as a method that favors the co-creation process and the use of alternative urban parameters, in an academic graduate course about urban planning at a local scale, in Architecture and Urbanism School. In the current scenario, cities growth is oriented by the perspective of cars, by land speculation and urban sprawl. As a result, it is observed the progressive loss of the human dimension in the urban space. The students were stimulated to think about the street functions and on the possibility of measuring urban quality with alternative parameters: the Completeness Indicators. Thus, aiming to develop solutions more adapted to the reality of the area and according to the collaborative contemporary practices urban planning the methodological approach was divided into two steps. In the first step, urban parameters and urban designs were elaborated, without using Completeness Indicators, and for the second step the participants used the indicators to support and describe the ideas. Both steps were conducted in a workshop format using the web-based Brazilian geodesign platform, the GISColab. The need for changes in the urban planning paradigm highlights the need for citizen participation and the role of the urban planner as a decoder of the collective goals. Finally, the results showed that there was a maturation of the students' critical thinking about the proposals made, as well as the impacts of the proposals considering the human dimension and the quality of urban space.

Keywords: Urban spaces · Landscape quality · Environmental assessment · Co-creation process · Geovisualization · Complete streets

1 Introduction

The logic of city growth, supported by modernist and highway precepts, led Brazilian cities to growth based on the need for automobiles and the sprawl of the urban fabric. This logic is about an individual solution to the detriment of supplying collective needs.

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Thus, progressively, city planning ignored the human dimension [1, 2]. Although the majority of the population needs to intensively use public urban space, such as streets, for many daily activities, as Gehl [3] classifies as "necessary, optional and social", cities are not thought of from this point of view - to people. Consequently, as car traffic, parking and congestion increase, the competition for urban space intensifies, and thus conditions for urban life and pedestrians become increasingly worse. The streets lose their function as a living space and are reduced to the displacement, directly affecting the quality and urban vitality. Such disregard for the street as a public space for people to socialize, leads to the latent need for teaching approaches in the field of architecture and urbanism that discuss issues about the quality, scale and demands of these spaces.

The predominant use in the planning of Brazilian cities of traditional urban parameters, mainly morphometric aspects (e.g., floor area ratio, volumetric coefficient, setbacks), has generated a scenario that reproduces more of the same massive constructive pattern of the urban landscape - with constant loss of environmental and cultural quality, uninviting people – and not evaluating performance or encouraging a change of mind and scenery. These parameters reproduce the interests of the real estate market, but do not manage the quality of the place based on environmental, social or cultural values.

In response to this traditional planning model, Complete Streets are an emerging concept in urban and transport planning discourse that arises to expand the focus of street design from the automobile to the safe accommodation of all modes of travel and users [4]. When approaching this concept, it proposes the democratization of the street space through a new design and a paradigm shift. Thus, arrangements are established between spaces intended for permanence, circulation, afforestation, active facades, among other aspects, which can make cities more vivid, comfortable and sustainable. There is no single Complete Street solution, that is, this approach is not replicable. Thus, better urban design alternatives can be incorporated as long as they respond to the local context of the area where they are located, reflect the street identity and the priorities of that community [5].

Therefore, the values applied to urban planning are constantly changing and are moving towards safe, living, sustainable and healthy cities [1]. This process highlights the role of the urban planner as a decoder of the collective demand, who provides the technical support and expertise for this transposition the necessarily in a collaborative way, and the need for citizen participation in urban planning process [6, 7].

The Completeness Index for Complete Streets appears as a possible solution to change the models practiced in city planning, in the design process and also in urban parameters [8]. The index consists of a set of indicators that help to assess the quality of free and public spaces in the city - especially on the streets, based on their planning functions: environment, place and movement. The "environment function" consists of the one destined to mitigate anthropic actions in the urban space, and can be measured from indicators such as efficient drainage, street afforestation and landscape quality. Meanwhile, the "place function" is one that encourages people to stay and carry out their daily activities; it is related to identity and social interaction, and can be measured through indicators of mixed use, permanent spaces, urban furniture and the flow of people. Finally, the "movement function" is linked to the street's ability to allow the

movement of people, vehicles and products, and can be measured by indicators of road capacity, multimodality, and access to public transport.

The geodesign proposal presented by Steinitz [7] and Miller [9] meets the need to overcome the modern form of planning. Geodesign has a methodology designed to support opinion and the creation of ideas with the help of geographic information, in a systematic and shared way. For this reason, Dangermond [10] points out that the possibility of geovisualization enables and favors the involvement of different actors in the geodesign process, while supported by the geographical conditions of the territory, the actions simulate better and more compatible possibilities.

In general, the design of plans and projects involves a very complex technical and legislative language that does not dialogue with citizens. Geodesign can act as a connecting element of participation to actually promote broad debate among users or experts. Thus, geodesign promotes a more collaborative and equitable scenario of participatory planning. In this context, Geodesign proves to be a creative and projective process with the potential to transform consensus, as stated by Forester [11], not necessarily as a support for decision, but primarily as a support for opinion. In other words, as a support for the construction of knowledge and citizen awareness about a place.

Geoinformation technologies are undergoing a significant paradigm shift related to the use and production of georeferenced data and information - largely based on geovisualization and access through the world wide web - with as main objective supporting the construction of opinions and decision-making. In this sense, the geodesign process, when incorporated into the fundamentals of SDI (Spatial Data Infrastructure) and Web-GIS (Web-based Geographic Information System), can be a robust supporting structure for the creation of opinions and decision-making through participatory planning, taking advantage of geoinformation technology [12].

Additionally, Wilson [13] points that the join of geodesign and web create opportunities for using these platforms of geoinformation technologies, with the potentiality to transcend scales, involving more people in the discussion, to encourage spatial thinking and the use in collaborative decision making. The author also highlights the importance of geodesign education on graduation degrees, preparing future professionals to work with real problems and possible solutions around the world.

In this scenario, the architect and urban planner play a very important role. As one of the professionals trained to carry out the reading of the space, he must perform as the decoder of the collective desire, considering the social and cultural aspects of each location. Such an attitude allows exploring a truly collaborative experience, where participants visualize the impacts generated by their proposals and actions. This is a relevant factor defended by Arnstein [14] in the stages of evolution of the participatory process and the performance of the technical staff. According to the author, the emphasis is often on unilateral information, from the technicians to the citizens, without there being a communication channel that allows the return, and even less, with negotiation power for the citizens.

From this point of view, this article aims to present a didactic and methodological experience using geodesign as a process. It also presents the web-based platform as an instrument that facilitates the construction of citizen awareness. Moreover, it presents the use of alternative urban parameters, the Completeness Indicators, in a course on

urban planning at the local scale, of the Architecture and Urbanism graduation course. Students learn the process of collective construction of ideas while being informed about values that favor the condition of completeness of the collective urban space. The article is structured as follows: (i) detailing of the methodological steps used in the course; (ii) presentation and description of the case study area; (iii) report on the development of activities and experiences with the virtual geodesign platform, GISColab; (iv) results and analysis of the experience, and finally (v) considerations about the experience, processes, methods, and tools explored.

2 Methods, Tools and Methodological Steps

This paper reports a methodological and teaching experience, with alternative or non-traditional urban parameters, in the course "Urban Planning: Local Scale Problems", that was held on the Architecture and Urbanism graduation, Federal University of Minas Gerais. The course was taught from October 2021 to February 2022, applying the Geodesign process as a methodology and the Brazilian web-based platform, the GISColab.

The GISColab platform, as an SDI service, was initially developed by GE21 Geotechnologies. Using this first structure, it was adapted to be used as Brazilian geodesign and co-creation platform, developed by Moura and Freitas [12]. The platform presents a map collection (layers) and tools to assist in the geovisualization, analysis, and proposition of ideas for a given place. All maps are georeferenced and are placed on the platform with pre-established legends, or can be uploaded using the connection with other SDIs.

It is up to the user to control the overlap, transparency and visualization of the layers to better qualify the relationship between the phenomena observed in the territory under study. The content of the layers can encompass phenomena of different aspects such as hydrography, vegetation, slope, distribution of roads, protected areas, slums, among others, which interfere in the perception of space. They are used as reference layers to the proposition of ideas and in the voting of a proposal. The set of maps can be customized by the workshop organizer according to the demands of each territorial context and the participants.

The tools present in the GISColab platform support the stages of the geodesign workshop. The "Annotation" tool supports the initial stages, where aspects of the territory are being identified and has points for demarcating these characteristics. This first step is called "Reading Enrichment". The "Dialogues" tool involves the propositional stage and is used to build ideas through more resources such as points, lines and polygons. This tool also has a comment feature, where participants can leave their impressions about the proposals. It is still possible in the "dialogues" tool to use the "likes and dislikes" mechanism, counting votes and recording the opinion about the ideas. Dialogues are used to the steps "Creation of Ideas", "Discussion of Ideas" and "Voting of Ideas".

Before the beginning of the workshop activities, the students attend to classes about the "traditional" and "non-traditional" urban parameters. In Brazil, the traditional ones, presented in all Master Plans, are the morphometric parameters, and the non-traditional are presented as assumptions related to cultural values, environmental studies and land

use. The idea of Completeness Index for Complete Streets by Rosa [8] and about the functions of the street. They are presented to the students at this moment as non-traditional urban parameters that increase the quality of the urban space.

In the first step, the students developed their ideas in a collaborative and broader way, that is, in the form of plans of ideas for the territory, and with the aid of the digital platform GISColab. The didactic-pedagogical dynamics was established through the following sub-steps (which took place both in asynchronous and synchronous ways): (i) an introduction to geodesign, with emphasis on the Steinitz framework [7] (since this design process was unknown to most students); (ii) reading enrichment about Pampulha individually; (iii) division of students into three groups (environment, movement and place) and preparation of the first design suggesting. In the next, more detailed step, the sub-steps were: (iv) assumptions about the twelve indicators of completeness of the streets; (v) a design review including the completeness indicators, negotiation and voting of the final design, resulting in a single and collective proposal (Fig. 1). The groups worked in a "circle" logic, in which each group worked first on its own context, and then, the groups changed the contexts adding ideas in the proposal.

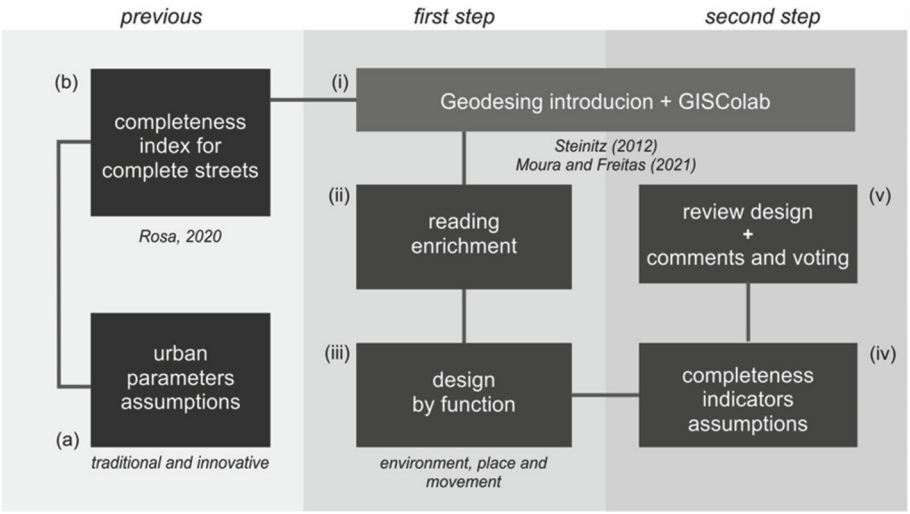


Fig. 1. Workshop activity flow. Source: the authors.

In the second step, the students were encouraged to consider twelve Completeness Indicators of the streets (e.g., street afforestation, efficient drainage, flexibility of uses, active mobility and modal connectivity) and to propose urban designs for the studied area. The idea of using these indicators is related to stimulating the use of innovative urban parameters and, consequently, resulting in more attractive urban spaces and landscape. In addition, the use of the indicators aims to facilitate the construction of ideas in line with the place, and also facilitates the gradual understanding of new concepts, such as the vocation, completeness, and planning functions of the street. This logic supported the dynamics of geodesign and was supported by it. From the description of the proposals,

the use of the completeness indicators was computed, and dynamically presented in widgets on the platform, demonstrating which indicators were the most or least impacted positively/negatively, thus allowing the development of more assertive and qualified proposals.

2.1 The Study Area

The Pampulha District is located in the northern vector of the municipality of Belo Horizonte, capital of the state of Minas Gerais (Brazil) (Fig. 2). This administrative region has as its main landmark a dammed river of the same name, which originated the Pampulha Reservoir. The dam is part of the local landscape along with other landmarks such as the Governador Magalhães Pinto Stadium (Mineirão), the Mineirinho Gym, the Pampulha Airport, the São Francisco de Assis Church, the Ecological Park, the Zoo and the Botanical Garden, among others.

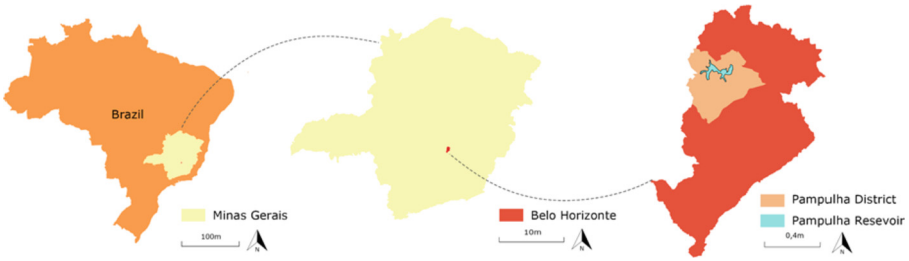


Fig. 2. Location map of the Pampulha District. Data source: PBH. Organization: the authors.

Due to the difficulty of accessing the center of the capital, the Pampulha District, which was once part of the rural area formed mainly by farms, had its urbanization process later than that of the capital, starting in the 40s. With the development of highways and of urban transport in the city, the region became accessible mainly by automobiles, in a context of modernization of the then mayor Juscelino Kubitschek, through Fernão Dias Highway and Presidente Antônio Carlos Avenue.

The Pampulha Ensemble represents a milestone in modern architecture, receiving in 2016 the title of Cultural Heritage of Humanity by the United Nations Educational, Scientific and Cultural Organization (UNESCO). The ensemble turned exceptional by the innovative way in which the formal and technological resources of its repertoire were used. Thus, the experience of Pampulha expresses the following fundamentals: innovations in form, especially in curves; the technological innovations provided by the use of the plastic potential of concrete; and innovations in landscaping, represented by early ecological interest, appreciation of native flora and botanical compositions of strong plastic expression [15].

Pampulha is an area that houses, in addition to leisure facilities and parks, regions with a lot of residential use. It is a place where the real estate pressures of densification and verticalization collide with the specific care established by the heritage protection policies for the landscape and environmental values. Thus, a conflict of interest

is established in the area over the fate of the cultural and environmental landscape of Pampulha, resulting in a challenge for the dialogue between the different actors and the possible alternatives for the future of the region. This stage makes the discussion and learning about the region enriching, as it favors different analyzes and still requires new approaches and instruments to deal with these impasses. These impasses can be analyzed under the scope of the functions of movement, environment and place of the region.

Thus, the "movement function" deals with the street's ability to accommodate displacement, enable access and active mobility, and minimize travel time. In the region of Pampulha, there is an articulating character, connecting the center to the north vector by means of rapid transit intended mainly for the car. It can also observe long routes with cycle lanes and little availability of public transport, resulting in a challenge for modal connectivity, active mobility and road safety in the region.

The "environment function" also brings great discussions when observed in Pampulha, according to (Fig. 3). There it has great arboreal expressiveness that contributes to the allocation of spaces for recreation, sport, leisure and tourism and also to the maintenance of the climate, air quality, landscape quality, water drainage, among others. This function clashes with issues related to the urban parameters applicable to the area, since, in understanding its landscape as a cultural and environmental heritage, it is necessary to adapt and propose new alternatives for sustainable development.

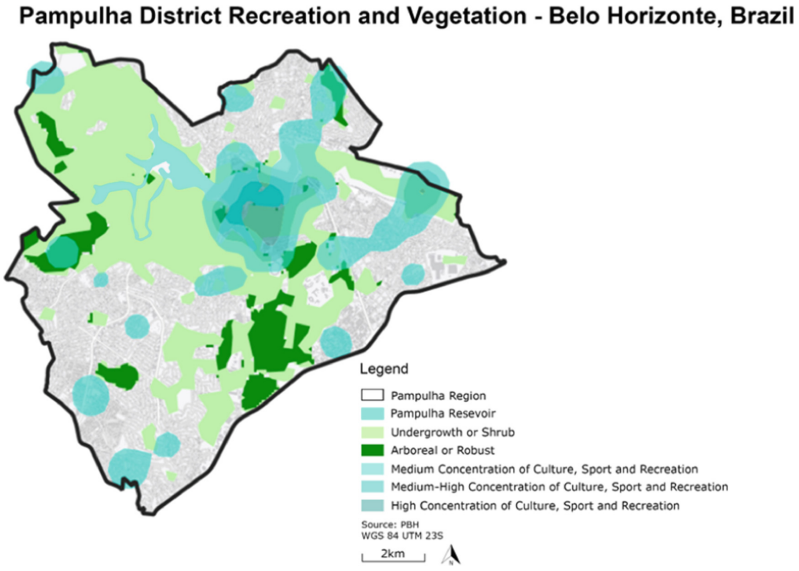


Fig. 3. Vegetation and Recreation activities map of the Pampulha District. Data source: PBH. organization: the authors.

And finally, the "place function" is evidenced in the region through the options for living there. The public space in Pampulha is attractive to the most varied people and leads to different recreational activities. However, currently, it is quite restricted to equipment present in the vicinity of the lake The concentration of commerce in Regional

Pampulha has been established outside the architectural and environmental heritage in the region (Fig. 4).

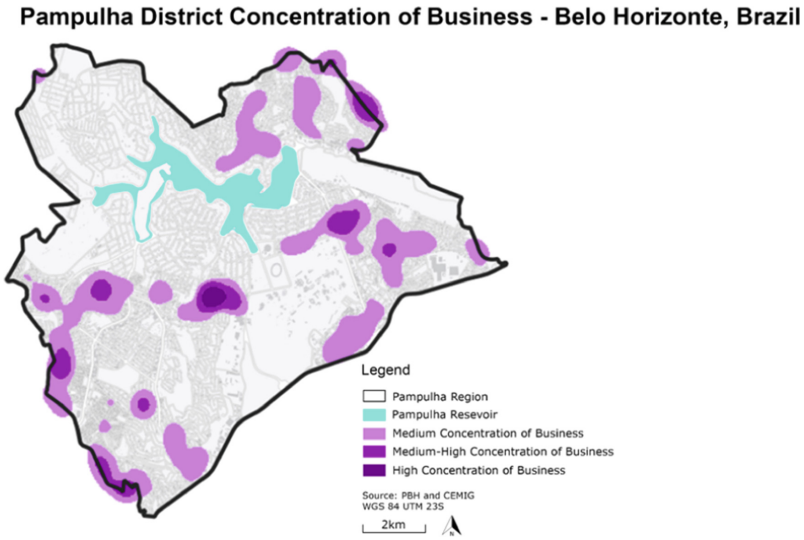


Fig. 4. Trading concentration map of the Pampulha District. Data source: PBH/CEMIG. organization: the authors.

3 The Development of the Case Study

Assuming that the students performed the previous activities: classes on traditional parameters and on alternative parameters and about completeness index and street functions (movement, environment, place), the workshop was held from January 20, 2022 to February 8, 2022, totaling six (6) meetings (synchronous/asynchronous).

For the first meeting, the students were instructed to previously watch the recorded classes about geodesign concept and about the Brazilian geodesign platform, GISColab. Thus, on January 20, 2022, they performed the reading enrichment individually, exploring the maps available on the platform and adding the observations through the "Annotation" tool (Fig. 5).

On January 25, 2022, students were separated into three groups (environment, movement and place) and the elaboration of ideas began through urban parameters (preferably represented by polygons) and urban drawings (preferably represented by points or lines), each in its own context (working windows) at GISColab.

As mentioned, the students were divided into three groups with 4 students each: environment (group 1), movement (group 2) and place (group 3). The idea was for each group to make proposals for their own context. For example, Group 1 thought about ideas of urban parameters and urban designs for the "environment function", based on what was explained in the conceptual class on the Completeness Index for Complete Streets. To

make their contributions, the students used the "Dialogs" box (Fig. 6), with the author's information and description of the proposal. On January 27, 2022, students worked in the other two contexts. In the first round, group 1 worked in the "movement" context, group 2 worked in the "place" context, while group 3 worked in the "environment" context. In the second round, group 1 worked in the "place" context, group 2 worked in the "environment" context, while group 3 worked in the "movement" context. At the end of the circle, the three groups had performed in the three contexts.

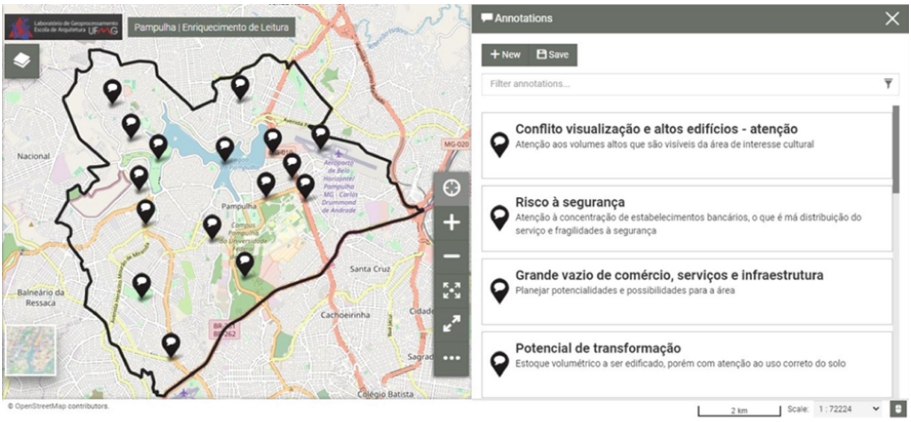


Fig. 5. GISColab interface showing the "Annotations" box (right) with the name of the idea and an explanatory text about the contribution or observation. Source: the authors.

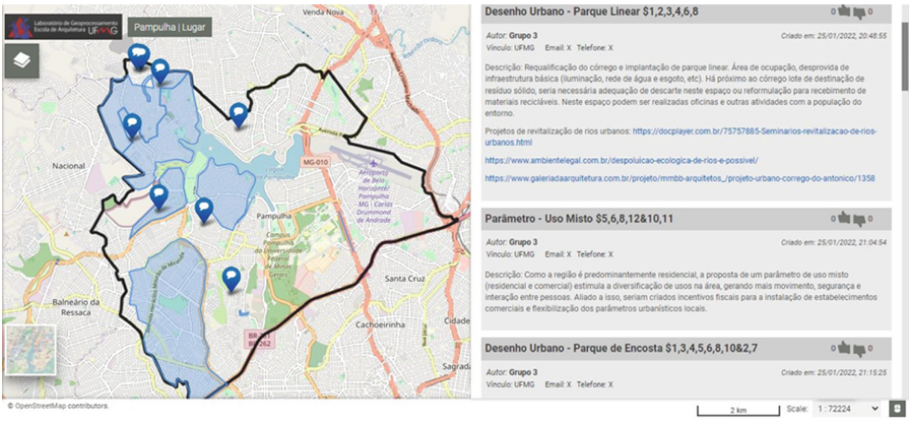


Fig. 6. GISColab interface showing the "Dialogs" box (right) with the name of the proposal, an explanatory text about the proposal, the identification of the group and the description of the completeness indicators. Source: the authors.

In addition, on February 2nd, students watched a video about the twelve indicators before class, which describes each one and exemplifies how they can be applied. The

purpose of the day was to edit the proposals taking into account the Completeness Indicators. Each group in its context of origin edited the initial proposals, analyzing one by one and informing in their description to which indicators the idea could contribute positively or could cause negative impacts. For this description, the students followed the logic: Proposal Name $(comma-separated numbers from positive indicators) & (comma-separated numbers from negative indicators), for example: Permeable Sidewalks $2, 7, 9 & 3, 10, in which 2, 7 and 9 are positive contributions to the mentioned indicators, while 3 and 10 are the negatively affected indicators ones (Figs. 7, 8 and 9).

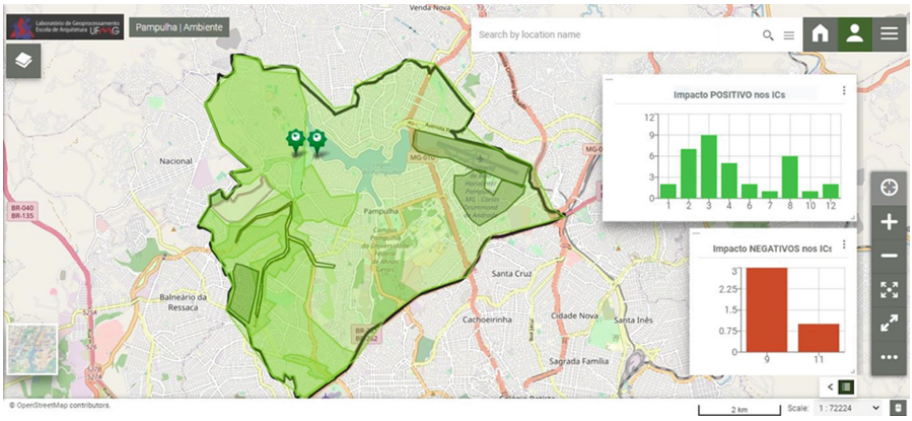


Fig. 7. GISColab interface showing the "Environment" context working window after the completeness indicators description. Source: the authors.

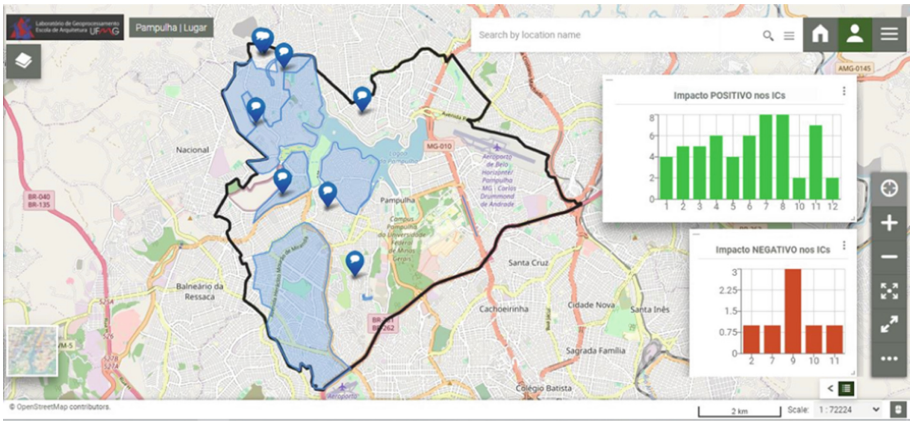


Fig. 8. GISColab interface showing the "Place" context working window after the completeness indicators description. Source: the authors.

On February 3, through video and script guidelines, students used the "Dialogues" tool to write comments for each proposal, as a discussion or debate. For example: whether

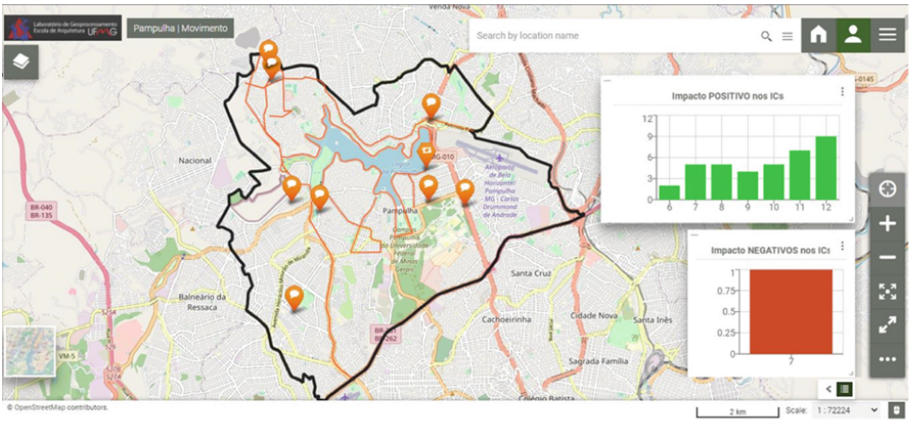


Fig. 9. GISColab interface showing the "Movement" context working window after the completeness indicators description. Source: the authors.

or not they agree with the idea/location, what could be improved and suggestions in general. Also following a cycle for the activity, avoiding simultaneous access to the same context and loss of information. Finally, the group entered the context itself, analyzed the comments left by colleagues and adjusted the proposals that it considered pertinent.

Finally, on February 8, 2022, the proposals were added together in the same context, called "Synthesis" (Fig. 10). The objective was to analyze the proposals made, their comments, keeping in mind the votes (individual opinion) that was carried out immediately afterwards in a synchronous way conducted by the workshop coordinator. The result was a unique and collectively constructed design.

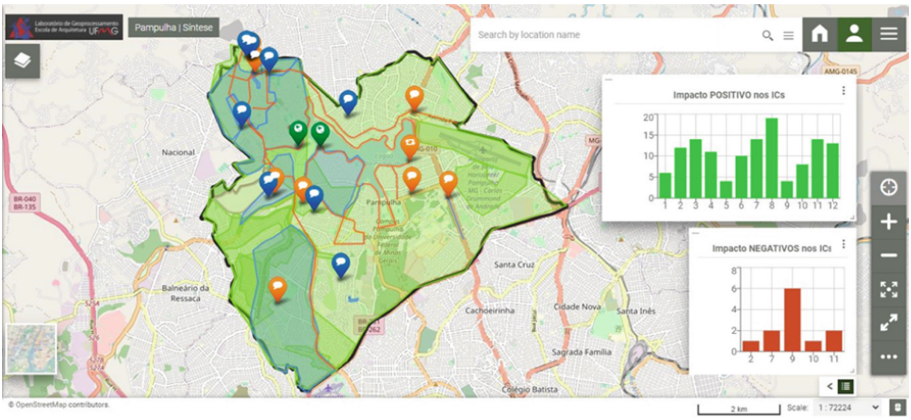


Fig. 10. GISColab interface showing the "Synthesis" context working window. Source: the authors.

4 Results and Discussion

The results were organized in an impact matrix (Fig. 11). The goal was to understand which indicators were more contemplated or not so well considered in the selected ideas. It was also a way to elucidate possibilities of representation of the results and diagnoses for the students. As can be seen, the indicator "permanence spaces" was the most contemplated, that is, with positive impacts. On the other hand, the "road capacity" indicator was identified as a negative impact at the end of the experiment. This panorama showed it was easier to the students to understand and create proposals about "place", to the detriment of proposals on "environment" and "movement".

	environment	movement	place	sum
1. street afforestation	2	0	4	6
2. efficient drainage	7	0	4	11
3. environmental comfort	9	0	5	14
4. landscape quality	5	0	6	11
5. active facades	0	0	4	4
6. flexibility of uses	2	2	6	10
7. universal accessibility	1	4	7	12
8. permanence spaces	6	5	8	19
9. road capacity	-3	4	-3	-2
10. road safety	1	5	1	7
11. mode connectivity	-1	7	6	12
12. active mobility	2	9	2	13
sum	31	36	50	117

5 Most benefit
1 Benefit
0 Neutral
-1 Detriment
-3 Most Detriment

Fig. 11. Impact matrix of completeness indicators. Source: the authors.

After the end of the workshop, the performance of the proposals was evaluated, considering thematic, locational and priority assertiveness (Fig. 12). Thematic assertiveness is related to the theme of the proposal, if it is good and appropriate to the context, in short, if it is "a good idea". Priority assertiveness is related to the workshop's objective of incorporating new concepts and alternative urban parameters, the indicators of completeness. Thus, a proposal with priority assertiveness has correctly incorporated the indicators in its description. On the other hand, locational assertiveness is related to the appropriate location of the proposal, based on the observation of the map collection offered and prior knowledge of the place.

From this analysis, it was possible to observe that most proposals achieved all the three criteria (58.40%), followed by proposals that achieved at least two criteria (34.88%). There were no proposals without some level of assertiveness. Although there is still room for further analysis on the factors that led to this situation, the first impressions show that the dynamics and methodological process incorporated in the workshop fulfilled its teaching and consensus building objectives.

Priority assertiveness was the least recurrent (69.76%), followed by locational assertiveness (88.37%), while thematic assertiveness was the predominant one (92.03%) (Fig. 13). Such a picture shows that the use of geovisualization tools and geotechnologies may have contributed positively to the understanding of the place, that is, to the locational

assertiveness of the proposals. When analyzing the result of the priority assertiveness of the proposals, it became evident that the non-assertiveness was due to errors in understanding the indicators and new concepts for the students. Therefore, priority assertiveness can be improved with a previous and more in-depth approach to the indicators, adding more technical and conceptual details to the assumptions.

	proposals	thematic	priority	locational
moviment	bicycle path	1	1	1
	bus stop: bandeirantes II	1	0	1
	bus stop: vila paquetá	1	0	1
	road capacity increase	0	0	1
	road and pedestrian safety increase	0	0	1
	increase in the number of buses	1	1	1
	road improvement	1	0	1
	medium and high capacity mobility corridor	1	1	1
	medium capacity mobility corridor	1	1	0
	pampulha cultural tram	1	1	1
	tram central station and Info center	1	1	1
	bicycle racks	1	1	1
	crosswalk	1	1	1
	crosswalk	1	1	1
	interventions in unsafe stretches	1	1	0
environment	free grant benefit to increase permeability	1	1	1
	flood park	1	1	0
	shaded bus stop	1	1	1
	tax incentive to decrease surface temperature	1	1	1
	basic sanitation program	1	1	1
	green connection	1	1	0
	shaded bus stop	1	1	1
	sanitary sewage treatment and urban stream recovery	1	1	1
	water support and preservation center	1	1	1
	brazilian spotted fever monitoring center	1	1	1
	permeability parameter review	1	1	1
place	mixed use	0	0	1
	zone of sustainable urban density	1	1	1
	incentive to active facades and trading	1	1	1
	zone of restricted sustainable urban density	1	1	1
	zone of sustainable urban density	1	1	1
	slope park	1	1	1
	streets closed on weekends	1	1	1
	bus stops that encourage staying	1	1	0
	linear park	1	1	1
	bus stop	1	0	1
	bus stop	1	0	1
	bus stop	1	0	1
	bus stop	1	0	1
	bus stop	1	0	1
	bus stop	1	0	1
	bus stop	1	0	1
	basic urban infrastructure	1	1	1

number of criteria achieved
3 (58,14%)
2 (34,88%)
1 (6,98%)
0 (0%)

Fig. 12. Performance of the proposals analyzed by thematic, locational and priority: green (3), yellow (2), orange (1) and red (0). Source: the authors. (Color figure online)

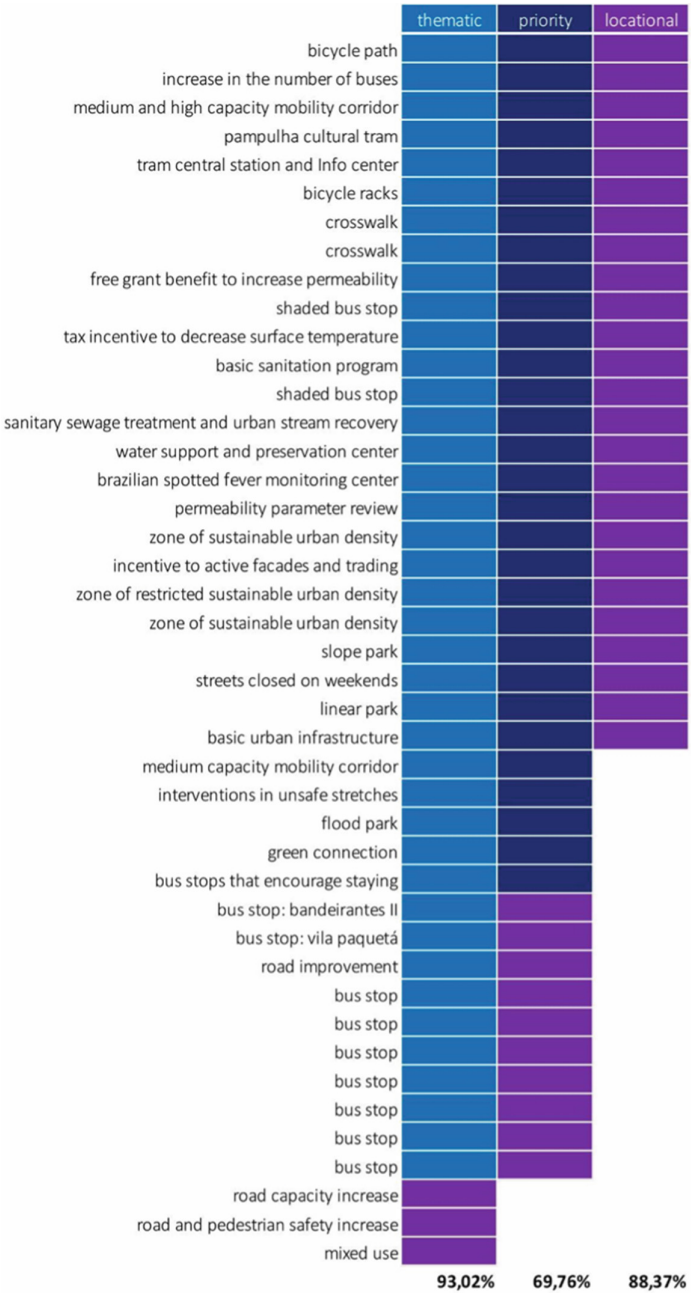


Fig. 13. Assertiveness of the proposals by thematic, locational and priority. Source: the authors.

5 Conclusions

Geovisualization and geoinformation played an important role in this experience, as it was carried out entirely remotely (online). It allowed knowledge about the place to be aggregated and built collectively. In addition, the use of digital tools facilitates communication and the consolidation of the main concepts. The use of geoinformation technologies, such as the GISColab digital platform, has shown that they have great potential on the teaching, since the undergraduate students (mostly, with 20 years old) are mostly digital natives. In this reported experience even the platform's unproven tools were explored.

The use of Completeness Indicators in urban planning course encouraged students to research innovations and other projects for reference, that is, to think about professional practice beyond what is posted. It also worked as an exercise that led students to think about the positive and negative impacts of their proposal on the place and considering the people of the place. Finally, the use of geodesign as a methodology for teaching Architecture and Urbanism proved to be a maturing process of building consensus.

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