Mission-Oriented in Geodesign Experience: Teaching About Cultural Landscape Values

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Abstract. Citizens' inclusion in the process of urban planning brought innovative ways to produce, assess and make data available. The principle of voluntary geographic information was proposed to register people's activities and can result from motivation, as "mission-oriented". Processes emerged from the use of geospatial data by citizens, and geodesign is also presented, as a purposeful process of creating ideas, preferably in a collaborative setting. The presented workshop happened in areas of social vulnerability, whose landscape is composed of cultural values related to a historically used geodiversity. Participants had to complete tasks to design an intervention in a protected area. The objective was to motivate digital natives to think about the risks, vulnerabilities, and potentialities of the landscape. A geographic virtual environment was created from Minecraft using GIS and ETL for processing data, as a representation model. The model for dynamic interaction with the landscape was based on quests (missions) that participants had to accomplish. NPCs (Non-Playable Characters) presented contexts of restrictions and potentialities to be considered, which was the evaluation model. Once the participants had completed the step, the result considered the modification to the virtual landscape made by each pair of participants. In total, 22 design proposals met the established goals (change model). An evaluation of participants' experiences was carried out to track the increase in awareness of the subject of study. Future developments are focused on the implementation of stages for negotiation and voting for the best ideas, which can also be associated with the co-creation of proposals.

Keywords: Minecraft · Geogame · Geodiversity · VGI

1 Introduction

The possibility of people being sources of geographic data brought forth the concept of citizens as sensors [1]. It was made possible due to the many innovations in the geoinformatics field, as well as the reflection of internet popularization.

Once the possibilities of wider consumption and distribution of information were established, and the importance of citizen participation recognized, the applications turned to the VGI - Volunteered Geographic Information, which is associated with the

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term user-generated content [2], associated with the potential of web 2.0 [3]. Contribution is voluntary, but it can happen passively or actively. The passive mode, according to Davis et al. [4] happens when citizens have their data and behaviors captured in sensors embedded in mobile devices (such as cell phones). The active mode, according to the same authors, happens when the citizen consciously checks in on an information capture platform or deliberately collaborates in a VGI.

The possibility of including citizens in the process has also increased interest in using platforms as a basis for planning. This begins with actions called Critical GIS, Participatory GIS, Collaborative GIS, and Community Integrated GIS [5–8]. What they have in common is the possibility of involving citizens in discussions, expanding access to analysis and criticism of the place. But they are still very much associated with the principle of collecting and making available information created collaboratively by citizens.

To further explore citizens' listening, Davis et al. [4] propose the principle of mission-oriented, whose purpose is to improve the quality of collaborations, increasing records according to broadening interests, greater spatial coverage, validation and reliability activities information, and feedback on queries. The authors relate the actions as a volunteer-task relationship (identifying the most suitable citizens to fulfill a task, depending on their profile), volunteer-region (looking for those who have specific knowledge about a spatial area), and volunteer-theme (selecting the citizens who may have more knowledge about a subject and can give more reliable answers).

At an institutional level, the availability of geospatial information gained form through Spatial Data Infrastructures (SDI). The establishment of SDIs marked a change in geospatial data available to the general public [9]. The European regulations that instituted the SDI – Spatial Data Infrastructure, INSPIRE (Directive 2007/2/EC) was a milestone, which was a reference for the Brazilian regulations, the INDE – Infraestrutura Nacional de Dados Espaciais (Decree No. 6,666 of 11/27/2008) [10, 11].

Geographic information should promote the rise of awareness of the territory by integrating the different agents of society to participate in shared planning processes [12]. In the meantime, with the consolidation of shared geospatial data online on different styles of platforms, the concept of geodesign arose from both geospatial data analysis and public participation development. The expectation was to work as support to the collaboration of different agents of society in planning. Geodesign is preferably developed on a web-based platform, but it can also be carried out in an analogical way, as the fundamental principle is to plan "with" and "for" geography, in a shared process, by co-creation [13, 14].

Despite the many innovative ways of making geospatial data publicly available, including minorities in spatial and urban planning still remains a key issue to address. Among the underrepresented social groups are the elderly people and kids. These two groups come from completely different generations, so, they have different ways to communicate and engage with new ideas. The second generation, more specifically, falls into the group of digital natives, which are people that were born after 1995 and had to live their whole life dealing with digital technologies [15, 16]. This group of people shares the same interests and online communities, being active in online games, forums, social media, etc. Minecraft rises from this context as one of the most successful

videogames in history, selling hundreds of millions of copies, holding a very active and passionate community of players, and reaching more than 50 million online players every day [17].

Considering this new generation of citizens, what should be considered when demonstrating specific values of a cultural landscape to digital natives? How to ensure that they can access information to think about designing new interventions based on these values?

One of the solutions that have been used is the game Minecraft. It can serve as a base for reproducing the framework of geodesign, by adapting its complexity to a mission-oriented experience through the virtual environment of the game.

The game design approach in implementing game mechanics for players' interaction with the represented landscape gives space for designing mission-oriented dynamics. Based on this idea, the present study aimed to involve digital natives in the process of learning about landscape values and allow them to express their views of alternative futures in a well-known environment for them. The framework of geodesign was used to lead the stages of the gameplay. A geogame was created to present how Ouro Preto's geodiversity has been used for over three centuries (Fig. 1), as well as how it still functions as part of the culture of the place (Fig. 2).

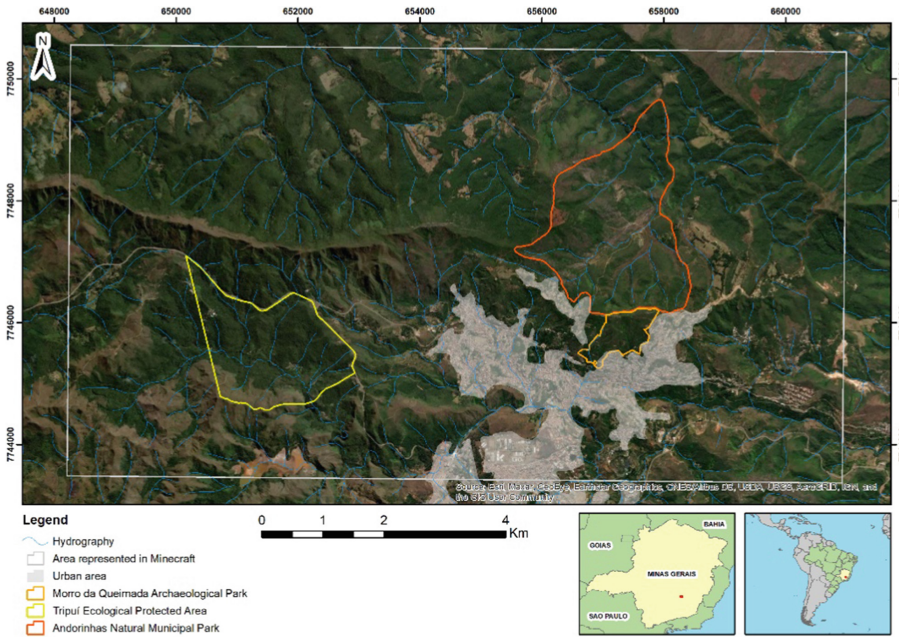


Fig. 1. Ouro Preto city and its protected areas and parks. Source: Sena, 2019 [29].

In this study, we show how Minecraft can be used as a medium for communicating the process of geodesign, by inviting kids to take part as people of the place. The proposed workshop used five out of the six models presented in the Steinitz framework. Each model is described concerning the game's virtual environment and processes that took



Fig. 2. General panorama of Ouro Preto's landscape: historical, cultural, and environmental values as part of the landscape. Perspective from the Serra de Ouro Preto area. Source: Danilo Marques Magalhães.

place based on it. The Decision Model, which consists of the process of optimizing the consensus among the participants of a workshop, was not considered in this study.

2 Geodesign and Minecraft

What stands out in geodesign is that it goes beyond the stages of analysis and evaluation of geography, and it focuses on the propositional stage, for the planning of an area [18–21]. Geodesign is based on the stages of applying group engagement methods in shared planning [13].

Among the frameworks in geodesign most used in workshops, the proposal by Steinitz [14] stands out, which establishes that a study must go through six models: three of them in the pre-workshop and three others during the workshop. The first model is the Representation one, which it is defined how the area should be described, resulting in the production of data about the case study. The second is the Process model, which assesses how the area operates, that is, how the data are distributed in the territory. It results in information on areas of influence, concentrations, and networks of relationships, among others. The third one is the evaluation model, which is a judgment based on the area's functions, drawing attention to its vulnerabilities and potentialities, and indicating where proposed changes should be placed. The fourth model, Change, is created during the workshop, as it is the design of proposals. The fifth model, Impact, is also used during the workshop as it verifies the consequences of proposed changes. Finally, the Decision Model results from the negotiation and selection of the best ideas by the participants.

All these models are adaptable considering the focal area, purpose, the public which will participate in the process, as well as the media that provide visualization options to

the participants. There are several examples of digital media being used for geodesign workshops. Considering the impact of the game industry on the new generations, and how virtual environments have been developed in the past few decades, there is a visible interest in absorbing such technologies and the public by using them. One notable case of it is the use of Minecraft for urban planning processes and public participation with kids and youth.

2.1 The Participatory Process Through Minecraft

Minecraft has been used as a virtual environment for spatial and urban planning since architects, urban planners and researchers started to explore its potential for real planning processes.

There are several published experiences where Minecraft was used as a tool for public participation. In many of them, the game was used primarily to collect opinions about what should be done with a specific place [22–25]. One of the most prominent experiences using Minecraft for the participatory process was developed by the "Block by Block Foundation", with support from UN-Habitat [26]. The initiative took place in more than one hundred countries and is based on a specific methodology of three main phases (planning, Minecraft co-designing workshop, and implementation) [27]. These phases consist of activities that start from selecting a site, creating financial planning, engaging citizens to co-create and design, and reaching a point where the best design is implemented in the real world.

Nowadays statistics about Minecraft show that the game's community has a common and shared language used by the players, almost exclusively digital natives. Another major factor for choosing the game for this study is its representativeness worldwide, reaching over 112 million monthly active players [28], and its impact on a whole generation of users who, for over ten years, interacted virtually in the game's environment, creating their way of communicating ideas and strategies to deal with a 3D virtual landscape.

In this sense, as communication and geovisualization are key conditions to construct a geodesign workshop, it was employed in the use of Minecraft as the digital environment for the practice. The design thinking followed the logic of the geodesign framework, bearing in mind that the goal was to plan "with" and "for" the geography. The expectation was to make players understand their reality as local citizens and develop critical and spatially aware thinking of the following concepts: geodiversity, cultural landscape, risks, vulnerabilities, potentialities, planning, protected area, land-use change, and impacts.

3 The Workshop

The GeoMinasCraft game was created to provide a virtual environment for digital natives to learn and participate in the landscape planning process. To reproduce the framework of geodesign, the game design played a central role since most parts of the workshop were performed in the game environment by the players. The game was designed to contemplate from the representation model to the change model in one single gameplay.

The impact model is the only one that was not experienced by the players. Here, we consider the virtual environment created using geospatial data as the representation model, while the design choices of what to emphasize in the landscape representation consist of the process model. The evaluation model is the combination of the players' exploration choices and the many dialogues that they can have with the NPCs, characterizing the mission-oriented approach.

As a synthesis of the geodesign models and designed stages of the gameplay: Representation model: Landscape representation in Minecraft; Process model: Information about geodiversity and cultural landscape in Minecraft; Evaluation model: Information and contexts provided by the NPCs (Non-Playable Characters) during the exploration journey; Change model: Players' designs for visitor center of Morro da Queimada Archaeological Park; Impact model: Analysis of the possible consequences of the proposals and considering the issues presented by the NPCs.

The game was designed to be played in pairs of players in the single-player mode in the game. The purpose of putting two players to share one single computer aimed to stimulate cooperation and the rise of different strategies to deal with the virtual environment and the addressed issues.

3.1 Preparing the Representation and Process Models

The representation of the landscape was based on principal elements of the geodiversity that shaped the way human activities developed in that place over three centuries. To represent the Serra de Ouro Preto area, a set of basic geographical inputs were considered: terrain, hydrography, vegetation cover, nodal points, streets, and roads. The process of using geospatial data to create a Minecraft virtual environment was discussed by Sena et al. [27], which presents the playtesting of a prototype that, after bug corrections and new implementations, was updated and validated to be used for the present workshop. This virtual environment created in Minecraft consists of the Representation model, considering that it supports the visualization of the main features that form and give character to the landscape.

The main data input was the topography, which was represented in the game by using the satellite digital elevation model (DEM) from the PALSAR sensor (Phased Array type L-band Synthetic Aperture Radar), on ALOS (Advanced Land Observation) satellite. The used DEM has a spatial resolution of 12 m and was transformed into a 3D representation of the terrain in Minecraft. From the DEM it was also possible to extract the hydrology. ETL tools (Extract Transform and Load) were applied to create an exaggeration of the vertical axis of the DEM, to provide better geovisualization of the steepness of the Serra de Ouro Preto ridge (Fig. 3). Also using ETL tools, the hydrological features were classified according to their hierarchical level, to select those that were more representative in the landscape and to insert different widths and deepness. After preparing the topography and hydrology data, both were combined in one single in Minecraft. It was the base for several other implementations of landscape features and components.

As part of the representation model, a vegetation cover layer was created to represent the importance of the forests in context to the landscape values. The NDVI – Normalized Difference Vegetation Index was used to extract the portions of the selected area which

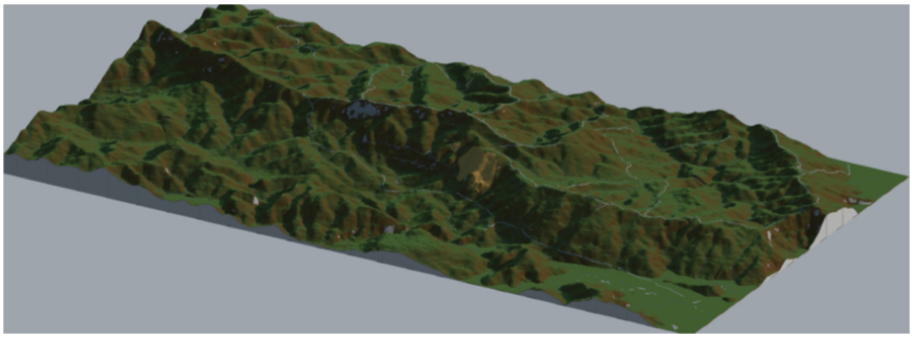


Fig. 3. DEM data was used as an input for recreating the city's terrain aspect, with a vertical exaggeration for the higher altitudes. Source: Sena, 2019 [29].

is covered by trees. The index is a normalized difference between the spectral responses of the red and the near-infrared bands. Sentinel-2 satellite imagery was used to calculate the index. The processing was also performed using ETL tools, in a way that it was possible to merge all the layers in one single Minecraft world file.

To create a realistic model of the area, it was also important to represent the main buildings that are landmarks on the landscape. A repository of simplified versions of common buildings was created to compose the landscape (Fig. 4). For the houses, a simple pattern of 3D buildings was produced and replicated. The main buildings were elaborate in detail, considering that those are mentioned by people of the place and recognized as landmarks when describing what they see. By having landmarks represented in their location, it would support participants in creating connections with their mental maps of the city (what they understand about the place), the reality (what the landscape is), and representation (the 3D models). This principle of connecting represented places in the game with reality was also applied to other kinds of sites and processes, like geology, land use related to mining activity, urban growth, nodal points, etc. (Fig. 4).

It was also important to represent the structure and composition of the underground, which is visible in the game when players access underground mines, as well as when they encounter a rock outcrop on steep areas. To recreate geological features a sequence of processing was performed using ETL tools that calculated the slope index from the DEM, extracting the high values of slope and transforming it into a vector layer. The vectors were used as a mask to change the terrain composition from blocks of dirt to blocks of stone, representing the rock outcrops. The underground was created using the software WorldPainter, to insert layers of blocks that represent real rocks that are found in the local banded iron formations (BIFs) (Fig. 4).

The creation of the virtual environment relied on the application of interoperability techniques between data and software, allowing the representation of landscape elements related to geodiversity aspects, such as the topography of Serra de Ouro Preto, its geology, a tailing dam, the historic gold mining sites, etc. These representations were essential to give an idea to the players of how this particular landscape works. These features, together with the NPCs dialogs, are part of the Process Model.

Considering that the purpose of the game is to explore the landscape of Serra de Ouro Preto from its aspects related to geodiversity and its uses, the choice of places of interest for geodiversity are important points for the functioning of game design. The locations were inserted considering the historical and current aspects of the formation of the cultural landscape from functions performed within the local geosystem,

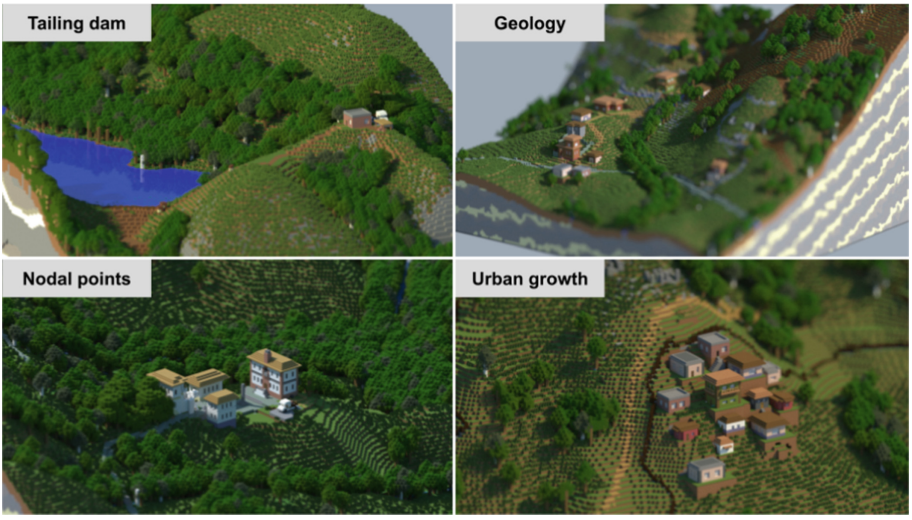


Fig. 4. Examples of sites where the players interact with representations of real places and processes in the city of Ouro Preto. Source: Sena, 2019 [29].



Fig. 5. Section of the virtual environment in which Morro da Queimada Archaeological Park is located. The brown line marks the park's borders. Source: Sena, 2019 [29].

in a way to evidence the connection between human activities and geodiversity. One example and focal area of the workshop is the Morro da Queimada Archaeological Park (Fig. 5). During the development of the process, fictional locations were inserted to represent phenomena related to aspects of geodiversity. For instance, a site was chosen to contextualize the occupation of steep terrain that generates a risk area due to how the geomorphological processes take place in that specific part of the area.

3.2 Evaluation Model to Be Used as a Base for a Mission-Oriented Design

During the gameplay, the participants had to accomplish a set of challenges to get permission to design and build a visiting center for Morro da Queimada Archaeological Park. On the road, they encounter NPCs that ask for help to accomplish tasks, that are designed to explain the sites they will find through their journey, as well as explain the cultural landscape's potentialities and vulnerabilities. The game intends to provide an environment for the players to learn about subjects related to the values of the landscape by visiting the places chosen to be represented in the Minecraft environment. These thematic lessons provided by the NPCs were evaluation synthesis about the place that they had to consider to go ahead (Fig. 6).

A total of 26 NPCs was in the game, each of them had a specific dialogue created to contextualize one aspect of the landscape, as well as to give players the directions to finish the quests. They were inserted in strategic positions to present information available in each specific stage of the game. There was, for example, an architect to explain about cultural landscape and the history of the place; a geologist to explain the geological structure that resulted in that landscape, a mining engineer to explain mining activities and resources; a resident to report about a sliding process after a rain period; and many others (Fig. 7).

The Change model was designed to be acquired as a result of the gameplay. A set of two quest/missions motivate the players to interact with the environment. By setting a clear objective for the players, they will collect all the resources needed to accomplish the designated task. In terms of game mechanics, the objective of the game is also the reward for finishing the landscape exploration (Fig. 8).



Fig. 6. Examples of NPCs. João, the archaeologist, Júlio, the merchant, Pedro, the geologist, Danilo, the Park Manager, Mônica, people of the place. Source: Sena, 2019 [29].

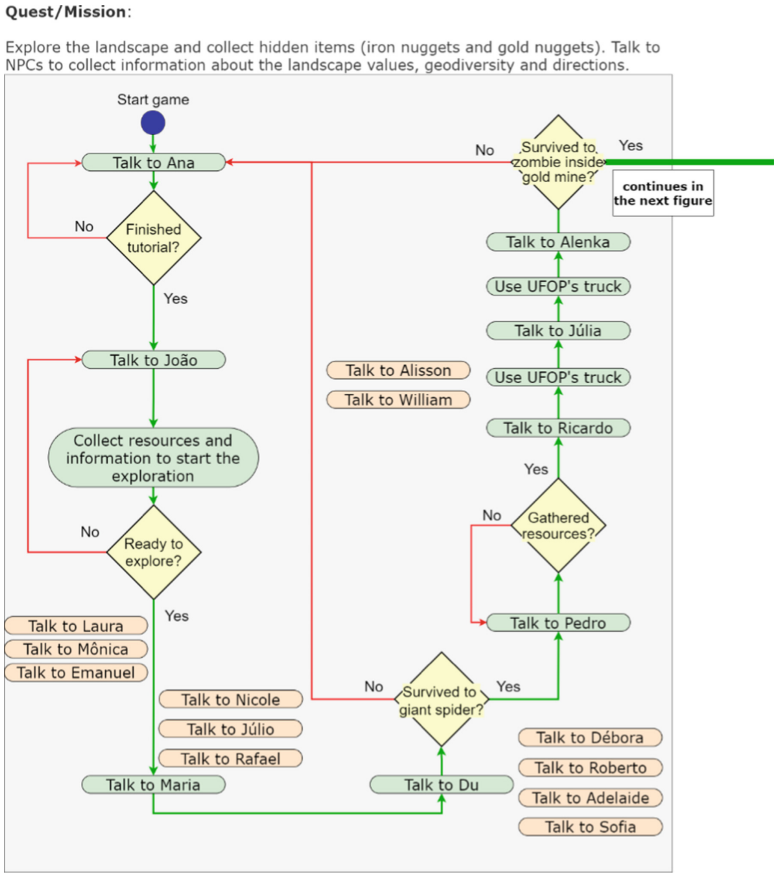


Fig. 7. Activity diagram of the first portion of the gameplay process. Green NPCs are linked to the main storyline. Light orange NPCs are secondary characters that give extra information and context. (Color figure online) Source: Created by the authors.

3.3 Post-workshop Assessment

The Impact model was created by assessing players' designs after the workshop. In this stage, the participants are not involved in the process. In combination with the proposed designs, each participant was assessed concerning their previous mental map of the landscape. This process aimed to assess the participant's perception of landscape values before and after the workshop.

One of the goals was to measure the spatial impacts generated by the players (the location of the proposed building), but also to measure the transformative learning of taking part in the experience. The locational assertiveness was analyzed by comparing the position of the buildings to the evaluation model of the area, verifying if the proposals were the within the suggested spots and if they considered the information provided by the NPCs about materials, the interventions on the field of view from the park, the risk areas and so on. The transformative learning was measured by applying questionnaires before

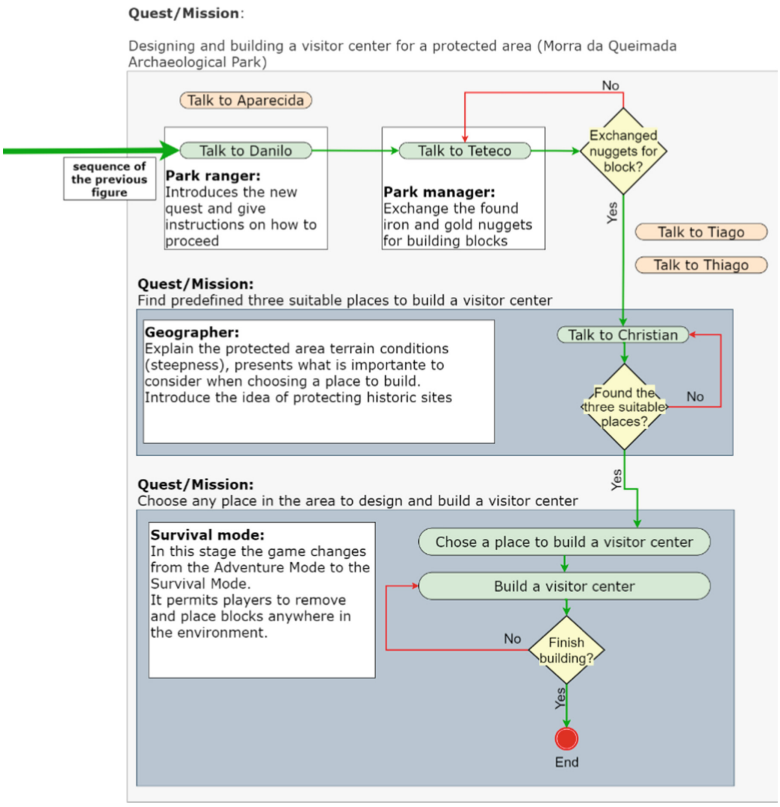


Fig. 8. Active diagram of the second portion of the gameplay process. It represents the stage when the change model is created. Source: Created by the authors.

and after the workshop, to know how much they care about the values of geodiversity before and after the experience. Together with the questionnaires, they were asked to draw the Serra de Ouro Preto area and its cultural landscape, also before and after the workshop. In the same drawing, they could add additional elements using different colors so that the organizers could evaluate the increment in information, spatial references, the score of elements represented, emphases on themes, and so on.

4 Results

The workshop took place over two days (the 6th and 7th of July), each day with one session of gameplay for kids from two neighborhoods of Ouro Preto. The invitation to play the game was made through the official program of Ouro Preto's Winter Festival of 2019. A total of 39 kids participated in the process, which was divided into two workshop sessions.

4.1 Change Model

A total of 22 designs for the visitor center were created after the two days of the workshop. Based on the mission-oriented design, all pairs of players had access to the same variety of materials (blocks). The design varies to some degree depending on which materials players 'purchased' from the Park Manager. Even though players could interfere in any part of the virtual environment, all designs were proposed within the Morro da Queimada Park limits.

The designs were assessed after the workshop by using ETL tools to perform a change analysis, comparing the original Minecraft environment with each of the modified ones. The analysis shows a preference to build in the preselected areas mentioned by the NPC, but the changes are not restricted to these spots only. There are some changes in the surroundings of the preselected places, mainly associated with changes in the terrain or removing the vegetation (Fig. 9).



Fig. 9. Change model. Visitor center designs proposed by the players. Source: Created by the authors.

4.2 Impact Model

The impact model was created by extracting data from the game environment and comparing it to the original environment. The main principle used in this approach was to subtract the original Minecraft world from the modified one. Two types of analysis were performed from the retrieved data, one concerning the location of the design proposal and one concerning its size and components.

For the first analysis, all the designs were transformed from a Minecraft world file to a CSV file with columns for each block location and its properties (type of block). From this data, we performed a density analysis, which shows that all the designs were located within the limits of Morro da Queimada Archaeological Park (Fig. 10).

The second analysis focused on the type of material and the size of the design. The total of blocks used for each design proposal was counted to calculate the average size of

the designs, which was 214 m^3. The most common blocks used by the players to design their visitor center were blocks of bricks (1089 in total), blocks of glass (465), wood plank blocks (450), and stone slabs (398). Blocks of bricks were put in the game as a product from the tailings dam, which is one of the visited places during the exploration. Glass blocks were used in almost all projects as windows or for detailing viewing spots or balconies, which shows some relationship between landscape visibility in the proposals. More than 5 billion blocks were analyzed to extract those metrics, considering all the Minecraft worlds generated after the workshop.

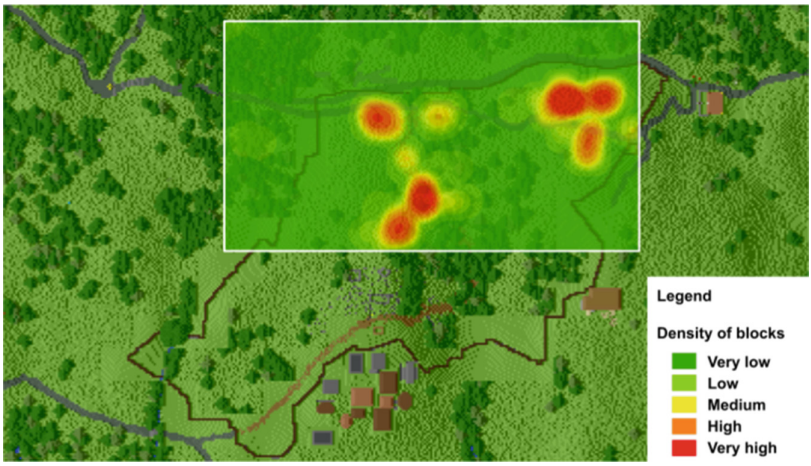


Fig. 10. Impact model. Analysis of the location of all designs. Source: Created by the authors.

5 Discussions

The case study was an example of the possibility of applying the geodesign framework to different digital media and different audiences. As the goal was to work with young people of the place, digital natives, it was selected a digital platform that is already used by them, to apply a shared language. The experiment took advantage of the immersive technologies and innovative ways to present spatial data to the general public. The goal was to support a transformative learning process, in which the participants could receive additional and organized information about their place, and were asked to use this information to design changes with and for the geography.

The participants in the GeoMinasCraft workshops are residents of Serra de Ouro Preto, with the image of Pico do Itacolomi in their daily field of vision. The mountain range is a traveled territory and not a contemplated landscape. Thus, the landscape of Serra de Ouro Preto, for some, is represented from the field of view that one has from the mountain, and not the visualization of the mountain itself, evidencing that for certain players the construction of the image is linked to landmarks. perceptible geographic features from the field of view favored by the lived space [30] (Fig. 9).

Through the designed gameplay and the stages that the participants had to complete, the Minecraft environment and its mechanics were employed to support the mission-oriented approach of the workshop. It enabled the creation of a target or main objective by the end of the process.

Limitations observed in the experiment are mostly related to representing specific aspects of the landscape and enabling design decisions (level of detail). The presented workshop shows that digital natives can perceive and communicate their thoughts through the game. On the other hand, the seriousness of the process stays on the second level of importance, since the aim was to support the learning about the cultural landscape's particularities, potentialities, and constraints.

The language used for the construction of the dialogues was adapted to favor the interpretation. The written text and the selection of key elements of the landscape presented to them were composed in capital letters, to draw the player's attention to specific textual elements. However, younger players with reading skills still in development faced some difficulties in performing the tasks given by the game, which made the monitors perform the reading of the dialogues and help them to interpret what the game asked for. Some other participants struggled to interact with the environment the fact of experiencing the game for the very first time using a keyboard and mouse as a user interface. Most of them had previous experience with Minecraft by playing the mobile edition or even only by watching gameplay videos on YouTube. These constraints can be overcome by converting the PC version of the game to the mobile version. It would make it possible for the players to experience the game outside, while they can walk through the real space.

Future research will focus on implementing the next stages of the geodesign framework, as well as improving the activity of designing and negotiation. For the presented workshop the participants were not able to visualize the Impact Model (done after the meeting by the coordinator), nor proceed with a voting/ranking stage about the best proposals. The results were composed of several ideas created in pairs or groups of participants, but they were constructed in parallel and not in a co-creation process. It is possible to use Minecraft to have a co-creation activity, by structuring an online server in which players can log in together and collectively visualize and decide about the Change Model, and negotiate towards a Decision Model. These are the future goals to be developed.

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References

1. Goodchild, M.F.: Citizens as sensors: the world of volunteered geography. GeoJournal **69**, 211–221 (2007). https://doi.org/10.1007/s10708-007-9111-y
2. Carrol, A.: Volunteered national geographic information? In: Workshop on Volunteered National Geographic Information, Santa Barbara, California, USA (2007)
3. Maguire, D.J.: GeoWeb 2.0 and volunteered GI. In: Workshop on Volunteered National Geographic Information, Santa Barbara, California, USA (2007)

4. Davis Jr., C.A., Moro, M.M., Matevelli, G.V., Machado, N.G.: ContribuiçõesVoluntárias: Impactos Potenciais dos Cidadãos Online e seus Dispositivos Móveis. In: Moura, A.C.M. (Org.). Tecnologias de Geoinformação para Representar e Planejar o Território Urbano. 1 edn, pp. 23–34. Editora Interciência, Rio de Janeiro (RJ) (2016)
5. Elwood, S.A.: Beyond cooptation or resistance: urban spatial politics, community organizations, and GIS-based spatial narratives. Ann. Assoc. Am. Geogr. **96**(2), 323–341 (2006)
6. Sieber, R.: Public participation geographic information systems: a literature review and framework. Ann. Assoc. Am. Geogr. **96**(3), 491–507 (2006)
7. Balram, S.; Dragicevic, S.: Collaborative Geographic Information Systems: Origins, Boundaries, and Structure. Idea Group Publishing, Hershey (2006)
8. Elmes, G., et al.: Local knowledge doesn't grow on trees. In: Fisher, P.F. (ed.) Advances in Spatial Data Handling, pp. 29–40. Springer, Heidelberg (2004). https://doi.org/10.1007/3-540-26772-7_3
9. Groot, R.: Spatial data infrastructure (SDI) for sustainable land management. ITC J. (3/4), 287–294 (1997)
10. Council and the European Parliament: Directive 2007/2/EC
11. Brasil, Presidência da República, Casa Civil, Subchefia para Assuntos Jurídicos. Decreto Nº 6.666 de 27/11/2008
12. Zhou, M., Nemes, L., Reidsema, C., Ahmed, A., Kayis, B.: Tolls and methods for risk management in multi-site engineering projects. In.: Arai, E., Kimura, F.; Goossenaerts, J.; Shirase, K. (eds.) DIISM 2002. IFIP, vol. 168, pp. 217–224. Springer, Boston (2002). https://doi.org/10.1007/0-387-23852-2_25
13. Li, N., Ervin, S., Flaxman, M., Goodchild, M.: Design and application of an ontology for geodesign. Revue Internationale de Géomatique **22**(2), 145–168 (2012)
14. Steinitz, C.: A Framework for Geodesign: Changing Geography by Design. ESRI Press, Redlands (2012)
15. Prensky, M.: Digital natives, digital immigrants, Part I. Horizon **9**, 1–6 (2001). https://doi.org/10.1108/10748120110424816
16. Prensky, M.: Digital natives, digital immigrants, part II: do they really think differently? Horizon **9**, 1–9 (2001)
17. Warren, T.: Minecraft still incredibly popular as sales top 200 million and 126 million play monthly. https://www.theverge.com/2020/5/18/21262045/minecraft-sales-monthly-players-statistics-youtube. Accessed 29 June 2020
18. Dangermond, J.: GIS: Designing our Future. ArcNews, Summer (2009)
19. Ervin, S.: A System for Geodesign. Keynote, pp. 158–167 (2011). Abstract
20. Miller, W.R.: Introducing Geodesign: The Concept. Esri Press, Redlands (2012)
21. Flaxman, M.: Fundamentals of Geodesign. Peer-Reviewed Proceedings of Digital Landscape Architecture 2010 at Anhalt University of Applied Sciences (2010)
22. Scholten, H., et al.: Geocraftas a means to support the development of smart cities, getting the people of the place involved - youth included. Qual. Innov. Prosper. **21**, 119 (2017). https://doi.org/10.12776/qip.v21i1.784
23. de Andrade, B.A., Poplin, A., de Sena, Í.S.: Minecraft as a tool for engaging children in urban planning: a case study in Tirol Town, Brazil. ISPRS Int. J. Geo-Inf. **9**, 170 (2020). https://doi.org/10.3390/ijgi9030170
24. Elmerghany, A.H., Paulus, G.: Using minecraft as a geodesign tool for encouraging public participation in urban planning. GI_Forum **1**, 300–314 (2017). https://doi.org/10.1553/giscience2017_01_s300

25. Opmeer, M., Dias, E., de Vogel, B., Tangerman, L., Scholten, H.J.: Minecraft in support of teaching sustainable spatial planning in secondary education - lessons learned from the Marker Wadden-project. In: Proceedings of the 10th International Conference on Computer Supported Education, pp. 316–321. SCITEPRESS - Science and Technology Publications (2018). https://doi.org/10.5220/0006764403160321
26. UN-Habitat: The Block by Block Playbook: Using Minecraft as a Participatory Design Tool in Urban Design and Governance (2021)
27. de Sena, Í.S., Poplin, A., de Andrade, B.: GeoMinasCraft: a serious geogame for geographical visualization and exploration. In: Geertman, S.C.M., Pettit, C., Goodspeed, R., Staffans, A. (eds.) Urban Informatics and Future Cities. TUBS, pp. 613–632. Springer, Cham (2021). https://doi.org/10.1007/978-3-030-76059-5_30
28. Gilbert, B.: Insider Newsletters, 14 September 2019. https://www.businessinsider.com/minecraft-monthly-player-number-microsoft-2019-9
29. Sena, I.S.: Visualização e valorização da paisagem a partir de geogame. Ph.D. thesis. Supervisor: Moura, Ana Clara M. Federal University of Minas Gerais, Geoscience Institute, Brazil (2019)
30. Lynch, K.: The Image of the City. MIT Press, Cambridge (1960)