

Geogames' Environments as Hosts for the Collective Expression of Emotions in Urban Space

Jan Szot , Edyta Sobieraj , and Franciszek Krysztofiak 

Faculty of Architecture, Poznan University of Technology, Poland

Correspondence: Jan Szot (jan.szot@put.poznan.pl)

Submitted: 30 April 2025 **Accepted:** 20 October 2025 **Published:** 21 January 2026

Issue: This article is part of the issue “Geogames: The Future’s Language of Urban and Regional Planning” edited by Bruno Andrade (Federal University of Bahia), Alenka Poplin (Iowa State University), David Schwartz (Rochester Institute of Technology), and Marta Brković Dodig (Swiss Federal Laboratories for Materials Science and Technology - EMPA), fully open access at <https://doi.org/10.17645/up.i451>

Abstract

Urban space is perceived by users on many different dimensions. One important aspect of spatial perception is the emotions that users associate with it. Mapping the emotions associated with specific spaces can make an important contribution to urban design processes. The conclusions drawn from their graphic representation can form the basis for specific spatial actions, leading to the creation of places that users can and want to become attached to. Geogames, which combine high usability with a pleasant and engaging form of interaction, are an effective tool for supporting processes related to the expression of spatial needs and opinions of inhabitants. There is a noticeable lack of easily accessible and engaging tools for mapping people’s emotions in urban space. This article describes a case study in which the game Minecraft was used as a tool for aggregating data on emotions associated with a given space. Based on GIS data, a digital model of a university campus was created in the game, where the study participants placed graphic representations of their emotions. An important issue addressed in this work was whether and how multiplayer and single-player modes can influence the expression of different emotions. The map of participants’ emotions in multiplayer mode was a spatial sequence, while in single-player mode, it was a series of scattered points. Multiplayer mode was characterised by a greater number of negative emotions, but this could have been caused by the mutual influence of the other participants. The information collected provides important insights into the subjective perception of space, which can be used for further planning activities. A tool was created, the availability of which facilitates the repeatability of the experiment and thus enables further research.

Keywords

emotion mapping; geogames; place attachment; spatial planning; urban space

1. Introduction

The perception of urban space is a multifaceted phenomenon, involving diverse dimensions and levels. In addition to the most basic conjunctural dimension, which allows for an immediate evaluation of the attractiveness of space (Brielmann et al., 2022), other sensory-based channels for reading spatial information can be distinguished (de Wit, 2023). The psychological layer is also extremely important, which, although strongly connected with the visual dimension, reaches much deeper, shaping a sense of security and well-being (Dai et al., 2021). Also significant in the psychological dimension are the emotions that a space evokes in users. Methods based on heart rate variability (HRV) readings make it possible to measure emotional responses to given spatial conditions (Paül i Agustí et al., 2019). Whether and how we respond to space and the emotions it evokes in us can provide important informational input for further planning efforts involving the search for patterns and regularities that underpin specific spatial interventions.

Mapping emotions in urban spaces involves a variety of different approaches and methods spanning from subjective surveys through objective wearable-based metrics up to crowd sourcing based on social media platforms. Subjective methods focus on the user's impression of the space. There is a number of different tools, such as surveys and interviews (Grazuleviciute-Vileniske et al., 2025) or feeling maps (Weinreb & Rofè, 2013) that allow for estimating how users feel about a given place. Objective methods work partially beyond consciousness and focus on biochemical microreactions of the human body. There are methods involving biosensors delivering information about physiological reactions connected with GPS data (Resch et al., 2015) as well as affective systems for researching emotions in public spaces for urban planning, providing data about emotional impressions of space in time (Kaklauskas et al., 2021). Going further, social media and georeferencing and geotagging functionalities (Grazuleviciute-Vileniske et al., 2025) and a sentiment layer stitched into posts, comments, and reactions, allow us to draw significant conclusions on how different places are perceived by users.

Currently, management, development, and education related to cities and urban areas involve the use of various digital tools and systems. Among the tools used are video games or elements of video games that support these processes. These are known as serious games. Their purpose is not only entertainment but also to illustrate and simulate real-life problems and situations occurring in built environments (Beattie et al., 2020).

A very specific kind of serious game used in urban processes is geogames. Their definition has significantly expanded over the years. First mentioned in 2005 as games involving real-life locations (Schlieder et al., 2005), geogames moved towards integrating GIS that started providing a basis for playful representations, which were considered to have GIS-specific high realism of depiction (Henry, 2018). As geogames refer to real places (Adanali, 2021), they focus on Earth and its parts (Poplin et al., 2022). Along with the development of open repositories such as OpenStreetMap, GIS data were utilised in geogames more and more widely, resulting in numerous productions (Antoniou & Schlieder, 2018). Nowadays, geogames take various forms, ranging from modified desktop products to mobile location-based game apps.

Geogames, such as a modified version of the Minecraft game, can be a valuable medium that makes the urban planning process engaging and inspiring for children and youth. As digital collaboration platforms enhance co-creation and raise awareness of the spatial context of everyday life, they generate agency in

shaping the future of urban space (Poplin et al., 2022). Combined with analogue games, Minecraft also provides potential in SDG-related green education that, through a scoring system, allows the role of green structures in urban design to be explored (Egusa et al., 2025). What is more, thanks to projects such as LillyPad, various states of environmental danger can be simulated in order to train spatial skills and raise natural disaster resilience (Tomaszewski et al., 2020). Besides educational gains, digital geogames are a significant element enhancing civic engagement in urban planning. By facilitating local community involvement, geogames may be tools used to improve quality of life and knowledge-building (Romano & Rogora, 2023). As a creative medium, these games are both created from scratch, such as B3 – Design your Marketplace!, or, a ready-made, adapted product like the aforementioned Minecraft delivers the potential of turning regular citizens into designers. Therefore, people can express their needs using the digital space of the game as a canvas for acts of creation (Delaney, 2022; Poplin, 2014). Geogames are also recognised as platforms supporting decision-making processes by delivering simulated scenarios that help improve understanding of the complexity of city structure (Adrienne & Nora, 2024). What is more, digital games that involve GIS data can serve as platforms for building spatial consensus among various stakeholders involved in the decision-making process (Poplin & Vemuri, 2018).

Even though both topics—emotional mapping and the use of geogames in urban-related processes—are important and dynamically developing research and practice fields, there is a significant lack of examples exploring how geogames can contribute to the process of investigating the emotions of people in urban space. Utilising GIS data in a game environment and then converting game output back into usable GIS data provides an interesting area of exploration and research. Games like Minecraft have proven flexibility in working with GIS data as well as being an attractive medium, especially for younger users. What is more, it provides single-player and multiplayer modes. Single players interact with the game world alone, encountering only prescribed in-game characters. In multiplayer mode, the user plays with other human gamers in the same environment and time, observing, affecting, and interacting with their actions.

The main goal of this study is to explore the potential of the Minecraft game as a tool for aggregating data about users' emotions in urban space, including the possibilities of converting game output into utilisable GIS data to be used by stakeholders such as local authorities and planners in the decision-making process. As the Minecraft game provides both single-player and multiplayer modes that allow individual and collective interactions with the game world, we consider the question of whether and how the game outcome may differ. Is there any bias for specific types of emotions? What emotions are more likely to be expressed when a game is played alone or with other players? Answering these questions may be helpful in determining which mode is preferable in implementing the presented method in practice. The article has the following structure: Firstly, a literature study is presented that outlines the current state of knowledge in the fields of geogames and emotions in urban space. The study method is shown with the process overview, data collection, and characteristics of participants. Results are then presented and discussed, including the context of other research. The article ends with a summary outlining the conclusions of the study and potential implementation in urban practice.

2. Literature Study

2.1. Geogames

Geogames are interactive applications that can be used for both educational and participatory purposes. They are location-based games with clearly defined temporal and spatial boundaries, whose activities are set in a specific geographic space (Heinz & Schlieder, 2019). Initially, games of this type were designed primarily for intense outdoor physical activity (Hall, 2010). Their advantage over traditional consoles was the player's ability to move freely in real space (Schlieder et al., 2005). In the beginning, they were based on board game mechanics, as exemplified by the GeoTicTacToe game (Schlieder et al., 2005). This feature—the ability to play outdoors, based on real-world locations—opened new perspectives, especially in an educational context.

Today's widespread use of smartphones as a platform for geolocation gaming creates unique opportunities, both in terms of in-game task design and location-based learning (Schaal et al., 2018). This allows us to augment reality with digital elements, which is the case in popular games such as Pokémon Go and Ingress. The point systems used in them can be an additional motivator for players to travel greater distances and extend gameplay time (Westerholt et al., 2020). Allowing the player to make choices during gameplay increases learning satisfaction (Kremer et al., 2013). However, it is important to be careful about using too much multimedia, which can contribute to cognitive load (Brosda et al., 2016).

Geogames are most often based on seek-and-find mechanics, while they rarely utilise simulation. Its use can enhance the enjoyment of gameplay, as well as make the issues raised within the game appear more real, thereby supporting learning in the environmental field. Simulation elements must not last too long, as this can reduce player engagement, with even a very simplified simulation still having a positive impact on gameplay (Schneider et al., 2017, 2020).

The use of novel technologies in educational contexts can be highly motivating and engaging for youth (Poplin et al., 2022). Incorporating familiar mechanics and environments from popular games, such as Minecraft, can further enhance youth interest by encouraging them to play, engage, and participate in the urban planning process (Andrade et al., 2020; Poplin et al., 2022). This type of activity can also contribute to the development of spatial thinking skills and geographic inquiry (Adanalı, 2021). Furthermore, the presence of educational elements in the games in no way diminishes the enjoyment of the game (Kiefer et al., 2006). The enjoyment and immersion described here resonate with the concept of flow—a state of optimal experience that arises when players feel both challenged and in control, particularly relevant in spatially oriented, participatory game environments (Aarseth & Günzel, 2019). Minecraft stands out as a unique platform for geogames due to its popularity and its ability to enable the process of co-creating space in an inclusive and cooperative manner, especially when numerous online users are involved. Its use can significantly improve the efficiency and quality of decision-making in urban planning and design (Delaney, 2022). At the primary school level, there is still a lack of practical tools for teaching spatial skills to children and young people. This problem is recognised by Bartoschek et al. (2018), while pointing out that there are technologies that can be effectively applied to educational outdoor games, an example of which is the OriGami game.

To fully reach the educational potential of games, their use should go beyond traditional didactic approaches. Meanwhile, teachers and designers often treat geolocation games merely as a tool for transferring knowledge, rather than creating a space for inquisitive, place-based learning (Mathews & Holden, 2018).

This problem also occurs at the university level, where most courses on GIS are rigid and straightforward in character. In this case, the use of gamification elements can improve the way the course is structured, even if there are no entertainment elements involved (DeMers, 2018). Using digital tools based on GIS and agent-based modelling (ABM) to engage young people in local spatial planning enables them to combine their personal experiences with systems thinking. This can lead to more accurate decision-making at both the neighbourhood and city-wide scale (Poplin et al., 2017).

Geogames use simplified models of real systems, focusing on selected issues or topics. Despite this simplification—or perhaps because of it—they allow a better understanding of the behaviour of complex systems in the specific context of the game (Ahlqvist & Schlieder, 2018). Although they do not fully capture the realities of the world, they can contribute to a deeper understanding of the interdependence between human and natural systems (Ahlqvist et al., 2018). An example of this approach is the Lily Pad project by Tomaszewski et al. (2020), in which a combination of serious games, GIS, spatial thinking, and disaster resilience knowledge can lead to increased adaptive capacity in communities. As a result, it can even contribute to saving lives when an actual disaster occurs.

Another example is *The Game of Peat* by Aditya and Laksono (2018), which aims to raise environmental awareness among peatland residents. At the same time, this game can be used to collect field data that will allow decision-makers to more effectively protect and manage these valuable ecosystems.

2.2. Emotions in Urban Space

Emotions are a key part of geogame users' experience, influencing their engagement, immersion, and the educational value of these applications. As Mauss et al. (2005) point out, emotions are multi-component responses, involving coordinated changes in subjective feeling, motor expression, and physiology. In the context of geographic games, which by definition combine physical and virtual space, it is crucial to understand the hierarchical organisation of affect, encompassing affective traits, moods, and emotions, where higher levels organizationally influence lower levels through threshold modulation. The distinction between emotions—brief, intense responses to specific environmental situations—and moods, which last significantly longer and may occur without apparent reason, is important for interpreting participants' affective reactions in games, as moods can modulate emotion elicitation thresholds, influencing their interpretation (Rosenberg, 1998). Emotional reactions in games are largely the result of subjective cognitive appraisal processes, in which players evaluate the personal relevance and adaptive implications of in-game events, which can lead to paradoxical emotions where seemingly negative actions evoke positive feelings. These reactions encompass a broad spectrum of experiences—from basic states such as fear, joy, or disgust, through higher-order forms like nostalgia or guilt, to complex mixed states in which different valences are simultaneously activated (Hemenover & Bowman, 2018). The emotions experienced by the player can influence their behaviour. The player's choices leading to immoral behaviour in the virtual world, if associated with feelings of guilt, can lead to an increase in sensitivity to moral violations (Grizzard et al., 2014).

Emotions significantly influence cognitive functions, including attention, memory storage and retrieval, as well as decision-making processes (Wilkinson, 2013). As such, they play an important role in shaping interactive experiences. These emotional states initiate motivational processes that can translate into action

depending on the characteristics of the emotional state and level of arousal (de Byl, 2015). In the context of educational games, both frustration and boredom can considerably weaken learning motivation. Simultaneously, increased emotional activation may enhance motivation and concentration during the learning process, regardless of whether this activation stems from enjoyment of the activity or concern about potential failure (Wilkinson, 2013).

While the use of real-time emotion detection in gaming can contribute to controlling the player's experience (Granato et al., 2020), similar technologies for recognising emotional patterns can be applied in a broader urban context, where residents' emotions can be mapped and used in spatial planning processes. As Li et al. (2016) point out, finding an objective and accurate method for assessing people's emotional responses to urban spaces is of fundamental importance for urban design practices and related policies. If the composition between space and user is not successfully achieved, a sense of unease may arise, which can escalate into anger or fear (Ansaloni & Tedeschi, 2016).

One method of mapping emotions is to use social media with geolocation. The data collected in this way can be used to support urban planning processes. An example of this approach is the study by Kovacs-Gyori et al. (2018), which analysed emotion mapping during the 2012 Olympic Games in London by utilising geotagged tweets, demonstrating the broad applicability of Twitter data analysis for urban planning in the context of large-scale planned events. Similarly, Kong et al. (2022) used an analysis of opinions published on social media concerning 99 parks in Beijing to support the assessment of the attractiveness and quality of various types of large-scale green areas. These strategies are complemented by the use of data collected by dedicated smartphone applications, which allow for the collection of subjective emotional declarations synchronised with the user's location (Neuner et al., 2025). Kołakowska et al. (2020) showed that smartphone sensors are a valuable source of information about users' emotions. Through the appropriate selection of sensors, the development of labelling protocols, and the design of features, it is possible to create practical applications for real-time emotion detection. Paül i Agustí et al. (2022) used HRV measurements for this purpose and then compared them with the participants' subjective assessments. A comprehensive integration of these approaches was proposed by Resch et al. (2015) by combining data from physiological sensors, mobile applications, and social media content analysis for multi-level mapping of emotions in urban environments, supporting the evaluation of urban projects and decision-making based on diverse sources of information about residents' well-being.

2.3. Playful Approaches in Urban Planning Besides Games

Several alternative approaches have been proposed to enhance the efficiency of spatial-planning processes. One method is the use of VR and AR technologies (Kavouras et al., 2025; Ng et al., 2024; Paraschivoiu et al., 2025). Game mechanics transferred to a non-gaming context, known as gamification (Deterding et al., 2011), have the potential to increase learning effectiveness (Dicheva et al., 2015). Badges and leaderboards increase motivation, while point collection encourages players to engage in more challenging tasks (Huang & Hew, 2015). However, it is essential to adjust the level of difficulty appropriately and to preserve the autonomy of participants in choosing their goals, as otherwise these elements may become demotivating (Abramovich et al., 2013; Sanmugam & Mohamed, 2020). Gamification can also serve as an effective communication tool in urban design. For example, Muehlhaus et al. (2023) showed that a mobile application incorporating game elements increased participants' motivation in a real-world planning project.

Incorporating playful elements into urban design can effectively engage and empower people without expert knowledge to actively co-create space. The use of a simple card game during workshops conducted by Huyghe et al. (2014) showed that a friendly and playful atmosphere encourages activity, promotes open exchange of ideas, and stimulates creativity, which ultimately translates into proposals for real solutions. Harriss (2010) found that using board games, narrative scenarios, and play-based prototypes within participatory sessions deepened engagement and led to more innovative, context-sensitive solutions. Applying card games in design can also be an effective tool in educating students, supporting a user-centred approach to urban space design (Mavros et al., 2022).

Location-based urban games and similar playful interventions foster more inclusive city design. Transforming existing infrastructure into a playground that encourages passers-by to interact, by utilising its natural potential, is the starting point for better design (Altarriba Bertran et al., 2022). An example of this approach is the workshop in Barcelona led by Hjorth and Lammes (2024), where field games were co-designed to sensitise participants to inequalities in the accessibility of urban space. Elements of play with the surrounding space can also be incorporated into the daily activities of both children and adults, which can inspire real architectural changes in residential spaces (Çetin Er & Özcan, 2024). Using playful elements in urban design, both to get the local community involved and to educate future and current designers, can really improve its effectiveness.

3. Materials and Methods

3.1. Process Overview

To achieve the stated research goal, a workshop was organised in which a group of participants navigated through a fragment of urban space recreated in the game Minecraft, based on GIS data. While Minecraft game mechanics are primarily based on placing box-like voxels, called blocks, of different types and materials (for example, grass, rock, wood, or glass), we have assigned specific types of blocks to certain emotions. Every block type in the game has an assigned ID number. The main aim of the participants was to place blocks with specific emotions assigned in places where these emotions are felt. The study took into account only outdoor areas. Participants were allowed to freely explore the environment. It aimed to provoke the natural course of movement that an individual could have in real space. There was no limit on the number of Minecraft blocks that could be placed.

For the study, Plutchik's wheel of emotions was used. Although it may raise some criticism due to its generality and superficiality, it was adequate for our study, which aims to create a method that may be commonly adapted for any type of user. At the same time, it remains more up-to-date than, e.g., Paul Ekman's basic emotion taxonomy. Figure 1 shows the Minecraft block types selected to represent specific emotions.

Anticipation/Vigilance	95:1		Orange Stained Glass (minecraft:stained_glass)
Astonishment/Surprise	95:3		Light Blue Stained Glass (minecraft:stained_glass)
Joy/Ecstasy	95:4		Yellow Stained Glass (minecraft:stained_glass)
Admiration/Trust	95:5		Lime Stained Glass (minecraft:stained_glass)
Loathing/Disgust	95:10		Purple Stained Glass (minecraft:stained_glass)
Sadness/Grief	95:11		Blue Stained Glass (minecraft:stained_glass)
Fear/Terror	95:13		Green Stained Glass (minecraft:stained_glass)
Rage/Anger	95:14		Red Stained Glass (minecraft:stained_glass)

Figure 1. Emotions and Minecraft block types that represent them.

The process of the study consisted of the following steps:

1. Area selection: For this study, the area of Poznan University of Technology's Warta Campus was selected.
2. Generation and post-production of the Minecraft world: Using GIS data from various sources, the campus space was generated and then manually curated in the Minecraft game.
3. Recruitment of participants: Using local communication channels, participants were recruited among Poznan University of Technology students.
4. Kick-off meeting with participants: During the single kick-off meeting, participants were informed about the goal of the study, all tasks, and process elements were listed and explained.
5. Survey walks: Participants were asked to perform individual survey walks to gather impressions and reflections on the subject space.
6. Grouping the participants: Participants were divided into two groups. Members of the first group were playing single-player mode, while members of the second group were playing multiplayer mode.
7. Distribution of Minecraft world copies: Files containing a prepared world were distributed among single-player group members, and a multiplayer session was arranged.
8. Gameplay: All participants conducted a 1-hour gameplay session to fulfil the task related to placing blocks assigned to specific emotions.
9. Gathering modified worlds: Modified world files were gathered from participants.
10. Data extraction and mapping: Using the FME Workbench (Safe Software) software, coordinates of blocks representing specific emotions were extracted, converted into operable GIS data, and subsequently mapped.

3.2. Participants

Participants of the study were recruited from the main users of the Poznan University of Technology's Warta Campus: students and academic staff. Using local communication channels, recruitment for the workshops was announced. During a kick-off meeting organised after the recruitment step, the study overview and main tasks were presented. Exact steps were presented along with study elements, including:

- Preparation for the workshop involving the survey walk;
- Method of dividing users into groups;
- Channels for distributing Minecraft world files;
- Main rules and guidelines for interacting with the Minecraft world;
- Emotion taxonomy used in the research;
- Submission due and channel for sending modified world files for single-player group members.

No data about participants were collected to provide anonymity for the study. After individual survey walks, participants were randomly divided into two groups, one of which had simultaneous and multiplayer gameplay while members of the other group conducted the gameplay individually on independent copies of the prepared game map. During the multiplayer session, participants had an audio connection with each other so they were able to see avatars and hear other players. After gameplay, all single-player world files were gathered from participants.

3.3. Study Area

The study covered the area of the Warta Campus of Poznan University of Technology, located in the central part of the city bounded by Kórnicka Street to the south, the Warta River to the west, Jana Pawła II Street to the east, and the Cybina River to the north. The main axis of the campus is Piotrowo Street, running in a north–south direction. The campus includes buildings of individual departments, a Lecture Center, and a Sports Center, as well as student dormitories. The exact location of all facilities is shown in Figure 2.

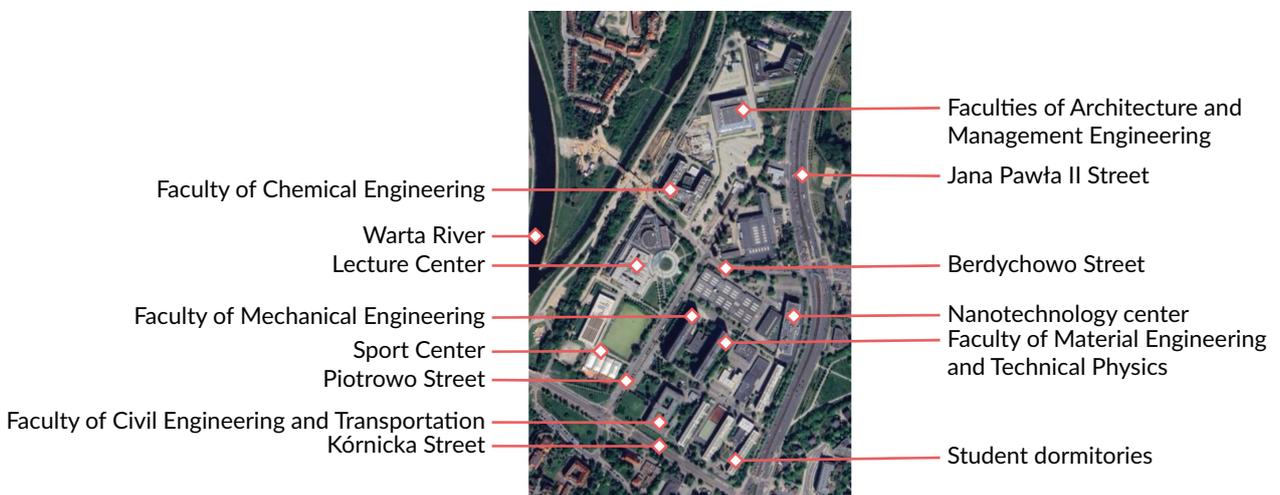


Figure 2. Map of Warta Campus with its main elements.

3.4. Data Preparation and Processing

The input data for generating the model of the campus was firstly prepared in the QGIS software based on geoinformatic data derived from sources such as OpenStreetMap (land use), the General Office of Geodesy and Cartography (numerical terrain model), the Spatial Information System of the City of Poznań (buildings), and the Geoportal service (tree stand). With the use of FME Workbench software, a Minecraft game level was generated. Next came the process of manual refinement and cleaning of the model, involving enrichment

of buildings with architectural elements and small architecture in the World Edit environment. Accurate and precise GIS data allowed the creation of an approximately 1:1 scaled digital copy of the campus within the game environment (Figure 3).

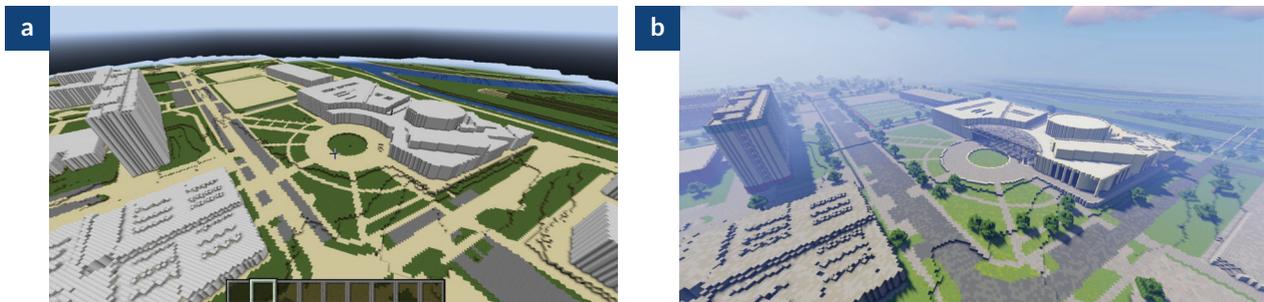


Figure 3. Campus site in Minecraft: (a) raw, GIS-based world; (b) world after postproduction.

The game environment was set up in the following way: Firstly, players were located in a closed room containing expositors with blocks and emotions connected to them (Figure 4), then, through a portal, they were transported to the campus (at the point shown in Figure 5).



Figure 4. Initial in-game view: blocks and emotions assigned to them.

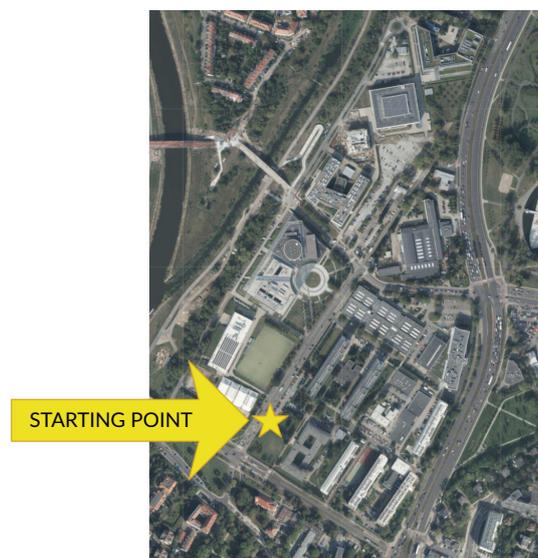


Figure 5. Starting point for each player on the campus.

After the workshop, the worlds collected from the participants, enriched with blocks representing the listed emotions, were re-read in the FME Workbench software environment and filtered based on block identifiers determining their types. This allowed us to separate segments consisting of blocks of a given type and then transform them into points described by coordinates from the local datum, and finally export the resulting data in CSV format to the QGIS software.

The research involved 10 participants representing both students and academic staff. The study took place in March and April 2025. For multiplayer mode, there was a single world accessible instantly after the workshop. Single-player participants sent back modified worlds. One of the single-player participants did not send her world.

4. Results

4.1. Single-Player Results

The total number of distributed markers was 2,654. Most markers were associated with Joy/Ecstasy (1,113 markers) and Vigilance/Anticipation (607 markers). The fewest markers were associated with Fear/Terror (39 markers) and Rage/Anger (48 markers). Markers covered the whole area of the campus, with a stronger presence in the centre, southeast, and northern parts (Figure 6).

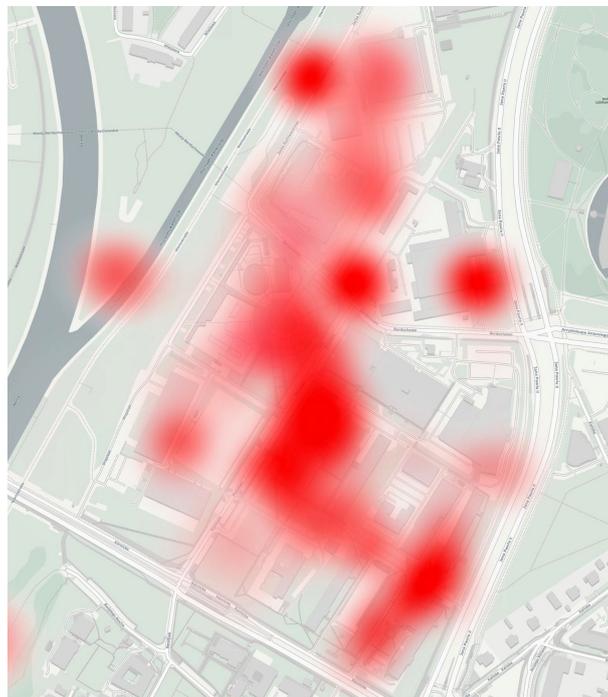


Figure 6. Heatmap for the distribution of all single-player markers.

In the case of nearest neighbor distance (NND), there is a significant bias between positive and negative emotions. While in the first group the NND value spans from 2.04 to 3.90, for negative emotions values range from 4.41 to 9.56. The considerably greater dispersion of the negative emotion values shows that single-player participants do not spend much time in places considered unpleasant, even when it is just a

virtual representation. The highest cohesion was observed for Admiration/Trust (NND = 2.04), while the highest dispersion was observed for the distribution of Fear/Terror markers (NND = 9.56). The average NND value is 4.82.

In most cases, the distribution of emotion markers was a combination of linear and clustering. There are two exceptions in the cases of Fear/Terror and Rage/Anger, with, respectively, dispersed and clustered distribution.

When it comes to placing markers for positive emotions, the most popular location was the Lecture Center, located in the centre of the campus. The space in front of the building can be considered to facilitate fostering relations between users. The other characteristic place for positive emotions was the riverside, showing a strong connection between the campus and the river. Table 1 contains detailed data about all emotions.

Table 1. Characteristics of marker distribution for single-player mode.

Emotion	# of markers (% of all markers in single-player mode) <i>n</i> = 2,654	NND	Distribution	Main locations
Amazement/Surprise	167 (6.3%)	3.90	Linear/Clustering	Lecture Center, Faculty of Mechanical Engineering, Faculty of Material Engineering and Technical Physics
Joy/Ecstasy	1,113 (41.9%)	2.11	Linear/Clustering	Central north–south core of the campus, riverside
Admiration/Trust	267 (10.1%)	2.04	Linear/Dispersed	Lecture Center, Faculty of Mechanical Engineering, Faculty of Material Engineering and Technical Physics, north part of the campus
Vigilance/Anticipation	602 (22.7%)	3.75	Linear/Clustering	Lecture Center, Faculty of Chemical Engineering
Fear/Terror	39 (1.5%)	9.56	Dispersed	None specific
Loathing/Disgust	336 (12.7%)	4.41	Linear/Dispersed	Student dormitories, Faculty of Chemical Engineering
Rage/Anger	48 (1.8%)	7.04	Clustering	Berdychowo/Piotrowo street crossing
Grief/Sadness	82 (3.1%)	5.75	Linear/Clustering	Sports Center, Faculty of Chemical Engineering

Single-player results show that participants from this group were more focused on positive impressions of the campus. This may be connected with the consistent order of presenting emotions, as the positive ones are always presented first, which may lead to the conclusion that players started with positive emotions and, towards the end of the session, they were accelerating the play and paying less attention to negative emotions. The lack of linear reduction of placed markers, however, speaks against this hypothesis.

4.2. Multiplayer Mode Results

A total of 3,904 markers were placed in multiplayer mode. Again, most were related to Joy/Ecstasy (1,410 markers), followed by Loathing/Disgust (608 markers). The fewest were recorded for Grief/Sadness (157 markers) and Fear/Terror (195 markers). Markers covered the whole campus area with a very strong presence in the north (Figure 7).

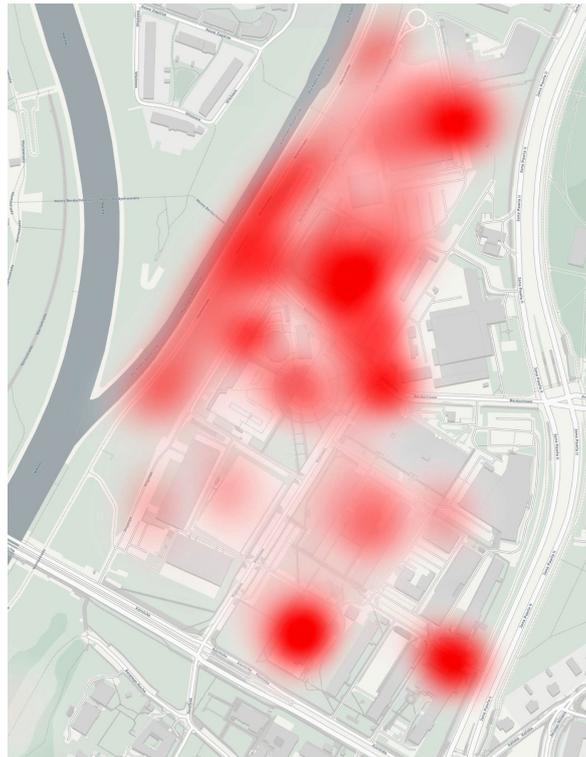


Figure 7. Heatmap for the distribution of all multiplayer markers.

When it comes to dispersion, there is no observable pattern, and all NND values are comparable spanning 1.64 to 4.02, with an average of 2.54. This indicates collective exploration and low player dispersion in the game environment. The lowest NND value was observed for Rage/Anger.

Multiplayer mode can be characterised by a more diversified distribution of types among different emotions markers. Amazement/Surprise and Joy/Ecstasy had linear distribution with a tendency to surround buildings in the case of the Amazement/Surprise. Linear and clustering can be observed for Admiration/Trust, Vigilance/Anticipation, Fear/Terror, and Loathing/Disgust. Clustering distribution was characteristic for Rage/Anger and Grief/Sadness. Positive emotion tends to have a linear distribution, while negative emotion tends to cluster. It may indicate that in a group, users are more eager to stop at spots that can be considered problematic.

For positive emotions, the Lecture Center seems to be most emblematic due to its open and relations-oriented form. The Sports Center and the riverside also can be outlined as places gaining positive perception. Negative emotions are specific to the Berdychowo/Piotrowo street crossing, and for the northern part of the campus. Negative emotions are also occurring around pedestrian crossings on Piotrowo Street.

For multiplayer mode, less bias for dispersion can be observed. Along with a clustering tendency for negative emotions, we can say that collectively, players are more confident in facing and reflecting on negatively perceived areas. Table 2 contains detailed data about multiplayer mode.

Table 2. Characteristics of marker distribution for multiplayer mode.

Emotion	# of markers (% of all markers in multiplayer mode) <i>n</i> = 3,904	NND	Distribution	Main locations
Amazement/Surprise	406 (10.4%)	2.53	Linear	Lecture Center, Faculties of Architecture and Management Engineering, Faculty of Chemical Engineering
Joy/Ecstasy	1,410 (36.1%)	1.90	Linear	Riverside, Sports Center, Piotrowo Street, walkway to the Faculties of Architecture and Management Engineering
Admiration/Trust	231 (5.9%)	4.02	Linear/Clustering	Riverside, Faculties of Architecture and Management Engineering, Sports Center
Vigilance/Anticipation	598 (15.3%)	2.33	Linear/Clustering	Northern part of the campus, Lecture Center
Fear/Terror	195 (5.0%)	3.42	Linear/Clustering	Sports Center, Faculty of Material Engineering and Technical Physics
Loathing/Disgust	608 (15.6%)	1.93	Linear/Clustering	Walkway to the Faculties of Architecture and Management Engineering, Faculty of Mechanical Engineering, Sports Center
Rage/Anger	299 (7.7%)	1.64	Clustering	Northern part of the campus, pedestrian crossings, Berdychowo/Piotrowo street crossing
Grief/Sadness	157 (4.0%)	2.56	Clustering	Front of Faculty of Civil Engineering and Transportation, Berdychowo/Piotrowo street crossing

4.3. Mode Comparison

As data from one of the participants were not obtained, there is no point in comparing the exact values of markers for both modes, so the percentage values were juxtaposed. Table 3 shows differences in percentage values for each emotion in both single-payer and multiplayer modes. There is no significant difference between modes; variance does not exceed 7%.

There is an important distinction in the average and distribution of NND values. Single-player mode is characterised by a much larger average and range of NND values. This observation leads to the conclusion that the collective experience of the game environment, when players can see and hear each other, may

Table 3. Percentage differences between marker amounts in single-player and multiplayer modes.

Emotion	Single-player	Multiplayer	Single-player/multiplayer difference
Amazement/Surprise	6.3%	10.4%	-4%
Joy/Ecstasy	41.9%	36.1%	+6%
Admiration/Trust	10.1%	5.9%	+4%
Vigilance/Anticipation	22.7%	15.3%	+7%
Fear/Terror	1.5%	5.0%	-4%
Loathing/Disgust	12.7%	15.6%	-3%
Rage/Anger	1.8%	7.7%	-6%
Grief/Sadness	3.1%	4.0%	-1%

cause organised and group-attracted actions, while individual experience seems to be more chaotic and unorganised. This can be observed especially in the case of a multiplayer-specific phenomenon of surrounding buildings with markers. What is more, the multiplayer mode tends to be more problem-oriented, which can be observed in clusters of negative emotion markers.

4.4. The Image of Warta Campus

This research allowed us to draw an emotional picture of the Warta campus of Poznan University of Technology.

In the case of positive emotions, one can primarily see an accumulation of Joy/Ecstasy points in the central part of the campus and also along the shoreline. Significant in this regard are the entrance areas in front of the Lecture Center, the Faculties of Architecture and Management Engineering, and by the building of the Faculty of Mechanical Engineering. Curiosity is aroused by the pending construction of the university's new rectorate building during the survey. Above all, the entrance area in front of the Lecture Center is admired, while a mixture of emotions are evoked around the buildings of the Faculty of Chemical Technology and the Faculties of Architecture and Management Engineering. The representation of positive emotion markers for both single-player and multiplayer modes is shown in Figure 7.

Negative emotions are mainly aroused by the intersection of Piotrowo and Berdychowo streets, and the area running north of this point constitutes the exit zone from the student parking lot. There is also a clear path associated with Fear/Terror in the southwest corner of the Sports Center indicating that this place is highly unpleasant. Similar, path shaped pattern may be observed among Student dormitories for Loathing/Disgust markers (Figure 9).

It should be noted that there is no uniform division of locations into those experienced unequivocally negatively and positively. Many locations, such as the intersection of Piotrowo and Berdychowo streets and the road to the building of the Faculties of Architecture and Management Engineering, arouse both positive and negative emotions in users. The only exceptions are the entrance area in front of the Lecture Center and the shoreline along the western part of the campus.

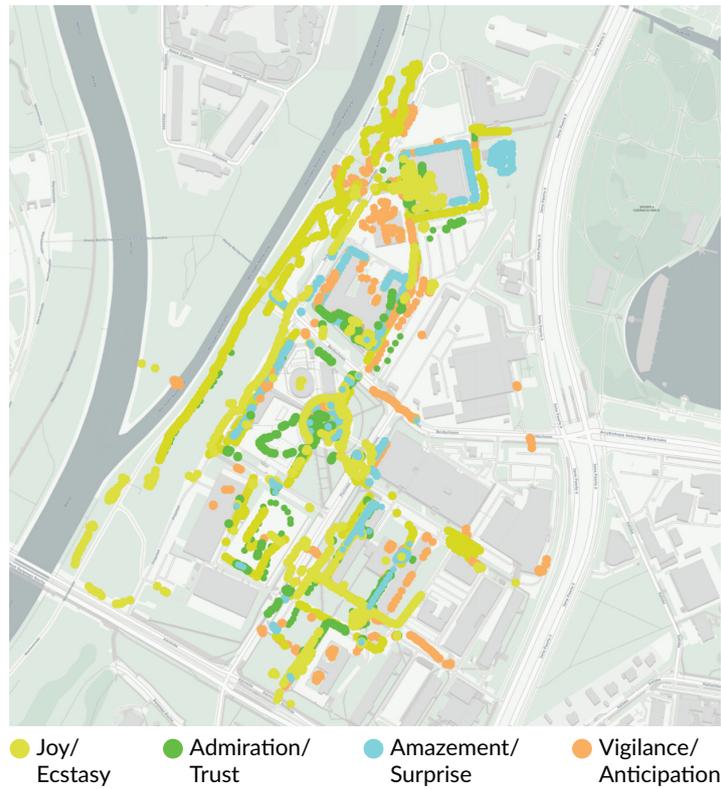


Figure 8. Positive emotion markers for both single-player and multiplayer modes.

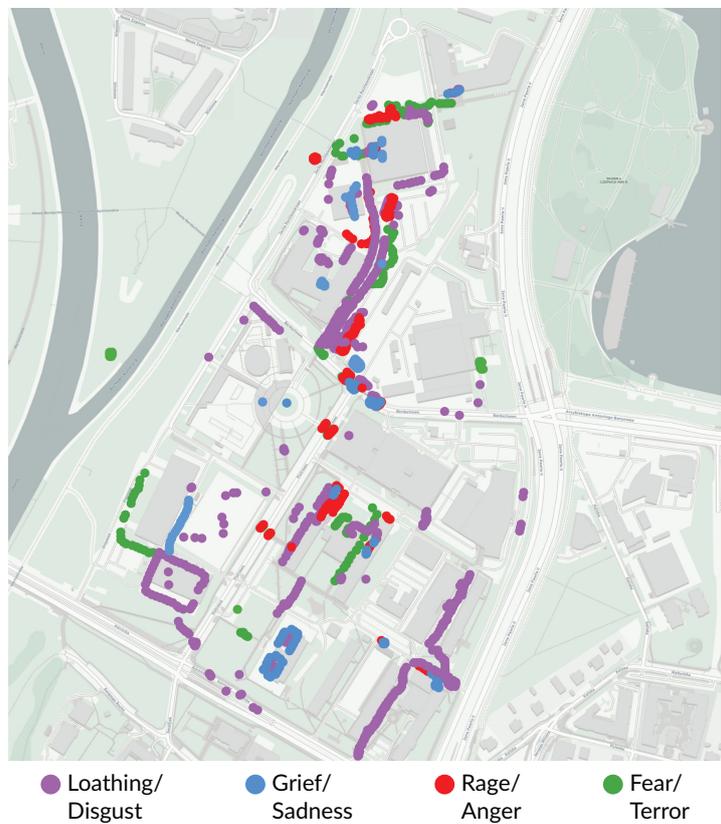


Figure 9. Negative emotion markers for both single-player and multiplayer modes.

5. Discussion

The study undertook to verify the applicability of geogames as a tool for collective emotion mapping using the Minecraft game as an example. An additional research goal was to determine if and how single-player and multiplayer modes affect the externalisation of emotions in the game. Plutchnik's emotion taxonomy was used here, which may contain some limitations, though. The essence of this study, however, was to create an accessible environment for all, devoid of complex nuances that can hinder or even block the experimentation of users.

In the context of geogames research, this article explores an as-yet-unaddressed issue related to the emotional value of space perception. Existing research undertakes to show geogames as tools utilised in urban-oriented processes such as education (Egusa et al., 2025; Poplin et al., 2022), civic engagement (Delaney, 2022; Poplin, 2014; Romano & Rogora, 2023), decision-making support (Adrienne & Nora, 2024; Poplin & Vemuri, 2018), as well as the issue of emotional mapping (Kaklauskas et al., 2021; Resch et al., 2015; Weinreb & Rofè, 2013). In these cases, voxel Minecraft elements are used to present physical elements of the built environment. There are no attempts to explore game environments to facilitate discrete aspects of the space, such as the emotions connected with the space. Mapping them and making it more engaging and potentially oriented to young users is also a research gap that needs attention. This work starts to fill it, creating a field for further studies. Firstly, this research does not take into account the interiors of the buildings, which, in many cases, are strongly connected with outdoor areas, especially in terms of people's movement. The research assumes participation of regular users who have more in-depth insight into the research area. It would be interesting to investigate the impression of new users, which could be useful for assessing the touristic attractiveness of given spaces. What is more, there is a significant aspect of narrativity that would provide more dispersion control and could make results more meaningful if the study is oriented to specific areas. Another issue that should be highlighted is the level of detail of the modelled space, which at first glance may be crucial in perceiving the space. Introducing a moderator of virtual experience appears to be especially interesting. Furthermore, it would facilitate the channelling of research results.

It has to be underlined that the in-game step is preceded by survey walks in real space, which is considered a stage that should always be present in such a process. This is important especially considering the simplicity of Minecraft game graphics. Another approach to this topic is to involve the use of mobile devices equipped with the Minecraft application. Shortening the time gap between spatial impression and its registration appears to offer the premise of greater data accuracy. Another question can be asked about how generic a model can be to successfully serve in the process. How does it relate to the size and complexity of the area? Nonetheless, the real space should always be the main reference, despite the game engine's attractive way of aggregating data that are easy to work with.

The above discussion is concluded in the following SWOT analysis, underlining the strengths, weaknesses, opportunities, and threats associated with the presented methodology and its results (Figure 10).

One of the main strengths of this method is its ability to efficiently identify problematic areas within the studied territory. In this case, the intersection of Piotrowo and Berdychowo streets should be mentioned. In addition, the data obtained in GIS format are ready for inclusion in spatial information systems. An additional

advantage often mentioned in the case of digital games is that they operate in a safe virtual environment free from physical barriers and threats. It is also worth noting that this is another step towards involving young people in city-building processes. The main weakness is the bias in the results caused by the distortion of spatial impressions by the influence of other group members. Another problem seems to be the lack of clear standardisation of the method, which would facilitate its wider implementation. The opportunities offered by using Minecraft to map emotions in urban space are related to the possibility of finding patterns and relationships between the characteristics of a given space and the emotions it evokes. In addition, the attractive formula can be a catalyst for engagement and building spatial awareness among young people and children. Among the risks that can be identified is the risk of digital exclusion if the issue of moderation and tutoring of participants is neglected. Additional risks are posed by the overinterpretation of collected data, which are considered in isolation from other spatial data. The final element that needs to be addressed is the simplification of real space in the game environment. It is important that this process is closely linked to the actual impression and appropriate representation of space in the game environment.

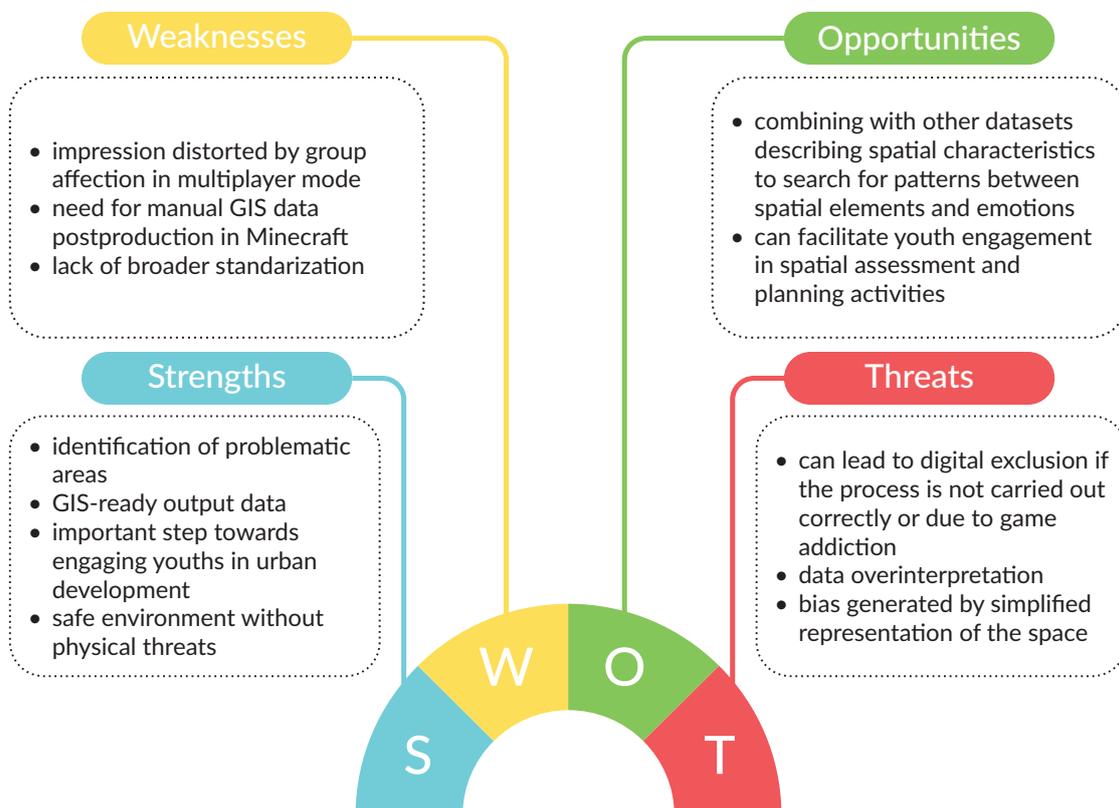


Figure 10. SWOT summary for the presented methodology.

6. Conclusions

This article demonstrates that games such as Minecraft, with the support of GIS data, can provide a useful environment for collecting spatial data—in this case, data on the emotions that users experience in urban spaces. This allowed us to provide valuable information on the emotional image of the Warta Campus of Poznan University of Technology. Concerning the differences between the impact of single-player and multiplayer modes on the results, the following conclusions can be pointed out:

- Multiplayer mode favours the expression of negative emotions, especially in the case of fear and anger. However, it is not known where in the range between the results of the two game modes lies the actual perception of the space.
- The data obtained from the multiplayer mode more often have the character of spatial sequences, while in the case of the single-player mode they have the character of scattered points. Regardless of the mode, positive emotions prevailed, testifying to the favourable character of the campus space for users.
- Results show that multiplayer may be more appropriate for further implementation due to more consistent results. What is more, this method is also easier to handle due to the fact that a single world file is produced during the process.
- The proposed methodology could be implemented during the formation of urban space development plans and interventions at the preliminary steps of such a process. Furthermore, it may provide interesting results for researching and evaluating the perception of modern real estate developments that are usually metrics-oriented.

Data provided by the presented method, connected with spatial characteristics of the space, seem to be valuable input for investigating more complex patterns of why certain spaces generate positive and negative emotions. These patterns can be useful for urban space diagnosis and implementation plans aiming to obtain certain impressions of a given place. This kind of emotionally oriented tailoring is a step toward creating city spaces that are more deeply connected with their users.

The study opens a space for further inquiries that are an extension of the subject matter dealt with here. This includes both the deepening of issues related to emotions and the application of the presented methodology of aggregation and transformation of spatial data to other layers of perception of urban space, such as a sense of safety and attachment, or the transitional character of the space.

Funding

Poznan University of Technology statutory funds funded this research, project number 0112/SBAD/2506.

Conflict of Interests

The authors declare no conflict of interests.

Data Availability

Data created during this study are available here: <https://github.com/jzszot/URBAN-PLANNING>

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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About the Authors



Jan Szot is an assistant professor at the Institute of Architecture and Heritage Conservation of the Faculty of Architecture, Poznan University of Technology. Scientific activities oscillate around digital support of design and planning processes. He pays special attention to the BIM methodology in terms of data integration, analytical aspects, as well as in the context of historic buildings. The relationship of architecture and urban planning to video games as an important cultural medium is also an important area of research. His research in this area specifically relates to participatory processes in urban planning. This is also the subject of his doctoral thesis on the implementation of video games as tools to support participatory processes. The guidance system developed as part of the work streamlines the process of selecting tools for process assumptions.



Edyta Sobieraj is an assistant in the Laboratory of Digital Technologies and Methods at the Institute of Architecture and Heritage Conservation of the Faculty of Architecture, Poznan University of Technology. Her main area of research interest focuses on BIM technology and its application in practice, computer-aided architectural design, and the use of 3D programs and graphics engines in architecture.



Franciszek Kryzstofiak is a student at the Architecture Department of the Poznan University of Technology. For several years, he has also been involved in the BuildTheEarth project for the Minecraft game, which focuses on replicating real locations in the game.