GAME-BASED LEARNING AND MACHIZUKURI: GAMIFICATION IN YOUTH PARTICIPATORY URBAN PLANNING IN JAPAN

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This paper examines the intersection of machizukuri, Japan's collaborative, bottom-up approach to community planning, and the growing field of game-based learning in urban design. It traces the evolution of participatory planning methods in Japan, emphasizing how machizukuri has progressively incorporated digital tools and gamification to strengthen civic engagement. Drawing on international and domestic examples, the study analyzes how serious games and game engines, such as Godot, can enhance spatial literacy, collaborative learning, and youth empowerment in urban contexts. Building on this theoretical foundation, the paper proposes an open-source participatory workshop framework that integrates open-source GIS data, 3D modeling (Blender), and real-time simulation (Godot). This framework reinterprets machizukuri as a form of digital civic experimentation, bridging traditional community practices with contemporary digital infrastructures. The study concludes by discussing the framework's pedagogical, methodological, and social implications, highlighting its potential to foster spatial reasoning, civic responsibility, and inclusive urban co-design among younger generations.

Key Words : *serious games, gamification, machizukuri, game-based learning, spatial thinking, youth engagement, Godot Engine, PLATEAU*

INTRODUCTION

Participatory urban planning in Japan has long been shaped by machizukuri, a bottom-up approach emphasizing collaboration among residents, professionals, and public institutions. Similar to community development planning or participatory urbanism, machizukuri encompasses a set of collective processes through which citizens influence the built environment and the quality of everyday life. Originating in the 1960s as a counterpoint to top-down, state-led urban renewal, machizukuri has progressively evolved into a mature framework for civic co-design and community governance. Its methodological trajectory reveals a gradual incorporation of new instruments (from neighborhood assemblies and scale models to digital mapping and participatory simulations) reflecting an ongoing search for more effective and inclusive forms of local empowerment.

In recent years, this evolution has intersected with the broader global phenomenon of urban gamification, the application of game mechanics to planning, education, and civic participation. Defined as the use of rules, feedback systems, and challenges to stimulate learning and engagement, gamification in urban contexts provides structured yet playful environments for experimentation, dialogue, and decision-making. In Japan, its adoption within machizukuri reflects a convergence between traditional participatory culture and contemporary digital media. Game-based methods (ranging from analog design games to digital twins and open-data simulations) are increasingly recognized as powerful tools for fostering spatial literacy, empathy, and consensus-building across diverse publics.

This article investigates how the integration of serious games, game engines, and open-source technologies can enhance participatory urban practices rooted in machizukuri. It traces the conceptual evolution of gamification in urban design and examines the methodological developments of machizukuri that have progressively embraced playful and digital tools. Building on research in game-based learning and spatial cognition, it then explores how such approaches can be reinterpreted as pedagogical and civic instruments for youth participation. The final section presents an open-source participatory workshop framework, designed to operationalize these principles through the combination of MLIT's PLATEAU datasets, Blender's modeling environment, and the Godot game engine.

By situating this framework within Japan's longstanding tradition of community-based planning, the paper argues that the convergence of machizukuri and game-based learning offers new opportunities for civic education, spatial reasoning, and democratic innovation. It concludes by discussing the implications of this integration for the future of participatory urban design and for the broader field of digital civic engagement.

1. EVOLUTION OF JAPAN'S PARTICIPATORY PLANNING APPROACH

(1) Definition and Historical Background

The term machizukuri is a neologism composed of machi, referring to the street or the city, and zukuri, a suffix derived from the verb "to make" or "to build." It is often translated as "participatory urbanism" or "town making" and is associated with community development planning, which can be rendered as collaborative urban projects. Emerging in Japan in the 1960s, machizukuri originally referred to urban projects at the scale of neighborhood communities, frequently positioned in opposition to state-led urban design (Hein et al., 2006). The term gained widespread popularity in the 1990s and today encompasses a wide range of practices, from the promotion of social and solidarity enterprises to the preservation of traditional urban landscapes.

Machizukuri may be understood as a set of long-term activities aimed at improving quality of life by progressively enhancing the everyday environment, while strengthening the vitality and attractiveness of the community through the collaboration of diverse stakeholders (Satoh, 2020). This concept places particular emphasis on the role of the community and advocates for bottom-up experimentation, in contrast to the top-down visions characteristic of smart cities (Sorensen et al., 2007).

(2) The Three Generations of Machizukuri

Machizukuri has comprised three main types of activities: the preservation of historical heritage, neighborhood planning and land-use control to address the shortcomings of city planning laws.

Its methodological evolution can also be divided into three distinct periods. The first generation corresponds to the development of its philosophy from the late 1960s to the early 1970s. The second, beginning in the mid-1980s, was marked by experimentation and the creation of participatory models that led to new methods of action. The third, unfolding since the late 1990s, has focused on territorial management and community governance (Satoh, 2019). These successive experiences over the past decades have collectively shaped contemporary machizukuri.

(3) New Tools

In the machizukuri process, it is essential that all stakeholders develop a shared and grounded awareness of present conditions in order to collaborate meaningfully on future designs. Machizukuri generally avoids misleading or biased practices, instead advocating for creative processes of collaborative analysis and discovery that lead to urban design projects rooted in local consensus. Such processes can yield significant benefits not only for the built environment but also for residents themselves.

In this context, researchers have proposed a variety of models that adapt machizukuri practices to contemporary tools. Early approaches included the use of scale models enhanced with video simulation systems, enabling participants to explore proposed designs interactively (Shimura, 2007). These techniques have since become common in local assemblies, where they serve to foster shared understanding and dialogue (Horita et al., 2009).

Assemblies typically employ their own tools and objectives, which might begin with a neighborhood walk, during which participants document resources by taking notes and photographs along pre-defined routes. These findings are later aggregated on large floor maps, where printed photographs are placed at their respective locations and annotated with handwritten notes on adhesive sheets. Such assemblies usually conclude with group presentations, ultimately functioning as exercises in neighborhood memory work and knowledge transmission through the elaboration of scenarios. Importantly, these scenarios not only consider the built environment but also integrate social actors and institutional constraints, including financial and legal conditions of implementation (De la Peña, 2017). Rather than constituting fixed plans derived from isolated or individual reflection, these collectively constructed visions, when produced regularly and in multiple forms, can represent a genuine form of everyday social and intellectual capital.

Recent developments have further consolidated these practices through structured design games (Satoh, 2015). A range of workshop-based methods enables citizens and stakeholders to collaboratively and experientially envision the future of their communities. By integrating diverse participatory tools, such as scale models, collage techniques, role-playing, mapping, and goal-image games, into a coherent framework, the design game approach translates abstract urban visions into tangible, manipulable forms. This not only enhances communication among residents, professionals, and local governments but also facilitates consensus-building by making the planning process inclusive and concrete. Case studies presented by Satoh demonstrate how design games have been successfully applied in real projects, underscoring their value as practical methods for transforming complex urban issues into shared spatial visions.

Final presentations are usually conducted in the presence of local authorities, with the gradual inclusion of new actors such as police officers, firefighters, hospital staff, and neighborhood associations. In this way, the basic tools of observation and dialogue are reinforced by participatory game-based methods that expand the scope and accessibility of machizukuri. Together, they provide urban professionals with essential syntheses of the urban fabric while cultivating community ownership of future visions.

(4) The Gamification of machizukuri for enhanced engagement

In addition to observation and mapping workshops, another methodology can be introduced: the joint design and simulation of a future image of the urban environment, using a physical model with interchangeable components. Participants manipulate removable parts representing different urban and architectural elements, thereby giving material form to their aspirations. The exercise is enhanced through randomly drawn cards indicating various plausible future events, such as fires or the construction of high-rise buildings nearby. In this way, participants can easily initiate dialogue on potential transformations of their living environment (Thiel et al. 2017).

This role-playing approach allows participants to simulate and confront by themselves the conflicts likely to emerge throughout the machizukuri process. Their understanding of the impact of their decisions is thus enhanced. At the same time, participants often remain unaware of the complexity and importance of such collaboration, as well as of the compromises required to reach an acceptable consensus. Ideally, these citizen-led experiments are subsequently confronted with a panel of professionals, who can produce alternative versions, conduct various evaluations, and exchange their perspectives.

More recently, this logic of gamification has been consolidated and diversified through dedicated guides (Ando, 2024). Such catalogue systematizes the use of board games as tools for training sessions and participatory workshops, presenting selected games that address challenges ranging from communication and collaboration to environmental systems and urban planning. The catalogue identifies recurrent problems in participatory workshops such as limited engagement, low personal resonance of abstract content, or difficulties in fostering perspective-taking and proposes gameplay as a corrective mechanism. Through detailed sketches, narratives of participant experiences, and design advice, Ando demonstrates how games can reconfigure workshop dynamics, foster empathy, and stimulate collective imagination. Importantly, the guide not only showcases existing games but also advises facilitators and municipalities on how to adapt, deploy, and even design original games tailored to their communities.

In this sense, gamification in machizukuri does not merely introduce playful elements into otherwise technical exercises; it creates structured opportunities for deeper reflection, mutual understanding, and sustained engagement. By bridging play and civic learning, design games and catalogued board games together provide a flexible and evolving repertoire that transforms participatory urban planning from a procedural obligation into a lively, inclusive, and meaningful practice.

As with smart communities, the gamification of machizukuri appears to hold significant potential for mobilization (Sailer et al., 2017). Applying game mechanisms such as points, badges, challenges, or leaderboards can substantially improve student engagement in educational curricula (Kapp, 2013). To some extent, augmented reality video games can even help bring certain individuals out of social isolation (Tateno et al., 2016). The very nature of a game is to provide a field of action bounded by simple objectives and clear rules, designed to be fair and balanced. This contrast with the complexities of real life offers reference points and a sense of security to most players (Parker et al., 2021).

2. GAMIFICATION OF URBAN PLANNING

(1) Citizen Participation in Four Dimensions

Past studies suggest that planning should no longer be understood merely as a process, but rather as an act of mutual learning based on dialogue and interactions among individuals (Brown, 1985; Finn, 1994). An increasing number of scholars and practitioners indeed regard planning as a process of collective learning (Newman, 2008). Analyses of strategic planning have conceptualized planning processes in four dimensions: the first concerning vision, the second dealing with short and long-term actions, the third focusing on the participation of key stakeholders, and the fourth addressing a more permanent process that involves the broader public in major decision-making (Albrechts, 2004; Healey, 2006).

This fourth dimension asserts not only that citizen participation is necessary, but also that it must be embedded in permanent, empowerment processes where citizens learn from one another across a variety of topics, while also gaining perspective on their respective viewpoints. Such empowerment processes are conceived as spaces of continuous learning, engaging citizens without conferring specific decision-making authority, and privileging long-term dialogue over isolated, fragmented discussions or project-driven consultations.

According to these studies, this type of dialogue supports citizens in building sound argumentation, developing spatial reasoning, and acquiring the ability to present and defend concrete results before policymakers. Over time, it allows for the construction of mutual understanding as well as the accumulation of social and intellectual capital. While these four dimensions are intertwined, capable of reinforcing, challenging, or intersecting with one another. They also follow their own trajectories, each with its own rhythm, logic, and purpose.

This section will focus in particular on the trajectory of the fourth dimension, that of collective learning, while also briefly addressing planning procedures.

(2) Collective Learning and Urban Planning

Over the past few decades, many planners have experimented with games and playful approaches to support this process of collective learning. More recently, pervasive games, incorporating new digital tools to create an interface between the real and virtual worlds, have emerged in this field (Duncan, 2010). Games can be defined as systems in which players engage in artificial conflicts governed by clear rules, leading to measurable outcomes (Juul, 2011). They provide safe, bounded spaces conducive to experimentation and experience, thereby transforming them into powerful learning tools (Prandi et al., 2019). By playing, participants are able to explore a range of possibilities, observe the consequences of their various decisions, and do so without incurring real risks or damage. Through interaction with one another, players develop values, practices, and ways of knowing, acting, and being, thus creating the conditions of the fourth dimension of citizen participation (Brookfield, 2015). Encouraged by the growing popularity of games, particularly pervasive ones, learning games have recently been categorized under the label of serious games (Dörner et al., 2016).

Most of these serious games are developed with a specific planning objective in mind, such as the design of a public transportation system, the spatial appropriation of a neighborhood, or the elaboration of an energy plan for an urban district (Reinart et al., 2014). These types of serious games are generally played only within the framework of a given planning process. Considering that conventional planning processes are typically long and complex, involving multiple project phases and diverse teams, such games support and facilitate learning only at a limited scale. This limitation can legitimately be regarded as problematic, insofar as collective learning must progress through a significant number of steps.

(3) Serious Games and Urban Development Simulations

The use of computer-based urban simulations for educational purposes began in the 1970s (Dupuy, 1972), with "participant-observers" engaging in a "dynamic visual model of an urban environment through a system of visual simulation" (Kamnitzer, 1971). From the 1990s onwards, such simulations were used in the teaching of urban geography and planning concepts (Adams, 1998). The city-building simulation video game SimCity, released by Maxis in 1989, quickly became the most prominent example. Maxis, founded by Will Wright and Jeff Braun, described its origins as stemming from a long-standing interest in simple systems that give rise to complex behaviors (Martial, 2019).

Although SimCity was designed primarily for entertainment purposes, and thus cannot be considered a serious game, its later adoption in educational and utilitarian contexts has been framed as serious gaming (Alvarez et al., 2011). The use of SimCity to introduce students to urban planning carries both advantages and limitations (Lauwaert, 2007). On the positive side, regular computer use provides students with exposure to complex systems, stimulates creativity in planning and anticipation, and enhances problem-solving skills. Moreover, developing an integrated understanding of how different components of a city interact cultivates awareness of the short- and long-term effects of various urban decisions (Minnery et al., 2014). SimCity can also strengthen critical and adaptive reasoning, enabling more targeted approaches to problem-solving.

The most frequently noted drawback of SimCity is the unrealistic power of the mayor character embodied by the player, which does not reflect the institutional and political complexities of real-world governance. The game largely ignores the intricate elements of open societies and pressing contemporary issues such as citizen participation, voting rights, financing, or corruption (Lobo, 2005). The creators of SimCity never claimed to produce a realistic simulation, but rather a construction game; nonetheless, its use may distort players' understanding of actual urban environments. While simplification, condensation, and prioritization are often necessary in education and debate, where urban issues are typically divided into aspects such as legislation, history, sociology, or transportation, the simplification in SimCity is often considered excessive, even extreme. It can lead to a "technophile and empiricist fantasy, according to which the complex dynamics of urban development can be abstracted, quantified, simulated, and managed" (Friedman, 1999).

Despite these limitations, the global success of SimCity and other city-builders, sold in millions of copies, represents a vast potential for mobilizing citizens and fostering more dynamic and effective public debate.

(4) Global Simulations and Targeted Mini-Games

While the simplification of urban development in SimCity can be problematic, one of its strengths lies in its real-time digital interface, which provides a comprehensive overview of the city at a macroscopic scale, covering finances, pollution, energy, crime, fire risks, and more. These domains, which are often difficult to assess in everyday life due to the lack of long-term, open, and easily accessible data, become instantly available in most city-builders. This offers players the opportunity to make decisions that take into account the overall situation, albeit in a simplified manner (Kolson, 1996).

Nevertheless, the inherent complexity and length of planning processes necessitate the selective treatment of issues in order to address them adequately (Illanas et al., 2008). This has led to the creation of various experimental urban design mini-games, each aimed at a specific objective and guided by the pursuit of collective learning (De Jans et al., 2017). Instead of proposing singular serious games that encompass the entirety of urban reflection, these experiments offer a series of distinct exercises connected by a coherent learning trajectory (Lozano et al., 2017).

Existing research on these serious mini-games has so far focused primarily on their respective educational applications and instructional value, without incorporating genuine collective learning in real-world contexts (Poplin, 2012). It therefore appears necessary to move away from the pursuit of a single global consensual model and instead develop a toolbox that can assist architects and urban planners in designing serious mini-games for citizen collective learning, contextualized within complex and specific urban processes (Devisch et al., 2018).

These new tools hold potential for gamification within a bottom-up approach, whereas the concept of smart cities often provides ready-made, top-down gamified solutions without prior citizen consultation, a dynamic particularly observable in Japan.

3. GAME-BASED LEARNING AND SPATIAL THINKING

(1) Game-based learning

Game-based learning (GBL) has emerged as a significant field within educational research, premised on the idea that digital and analog games can serve not merely as tools for entertainment but as environments conducive to knowledge acquisition, skill development, and learner engagement. Early advocates (Prensky, 2003) argued that digital games represent not a threat to education but rather an unprecedented opportunity to capture learners' attention. He highlighted neuroscientific studies suggesting that action games can enhance visual selective attention, thus underlining the broader potential of games to foster cognitive capacities essential to learning.

Building on this perspective, subsequent research has emphasized that GBL must be understood through multiple theoretical and practical lenses. A comprehensive frameworks (Plass et al., 2015) insists that learning with games cannot be explained solely in cognitive terms, but rather through an integration of cognitive, motivational, affective, and sociocultural dimensions. They contend that games facilitate engagement at several levels, behavioral, emotional, and social, by embedding learning in contexts that are interactive, meaningful, and often collaborative.

Further research (Feliacia et al., 2015) explores the relationship between gameplay engagement and learning, demonstrating that well-designed game environments increase immersion, intrinsic motivation, and knowledge transfer. This work underscores the necessity of aligning game mechanics with pedagogical objectives, ensuring that the very act of playing sustains the learning process rather than distracting from it. Similarly, synthesized empirical evidence (Tobias et al., 2014) showing that learners can transfer knowledge acquired in games to external tasks, improve cognitive processes, and integrate curricular content when instructional design principles are respected. However, they also identified significant gaps, particularly in terms of standardized evaluation methods and design frameworks that reliably ensure measurable learning outcomes.

Beyond individual cognition, games also operate as mediating environments for collective reflection. An examination of the evolution of City Gaming (Tan, 2016) highlights how gaming transcends traditional pedagogical applications by serving as an interface between abstract decision-making and tangible urban development. In this context, games not only teach but also simulate the negotiation of conflicting interests, transforming serious societal challenges into playful yet rigorous explorations. City Games thus expand the scope of GBL, positioning it as a tool not only for instruction but also for collaborative planning, capable of bridging social, spatial, and design dimensions.

Taken together, these contributions point to several defining features of GBL. First, games offer structured yet flexible environments where rules and goals provide clarity while still allowing exploration and creativity. Second, they foster engagement through motivational design elements such as challenges, feedback systems, and role-play. Third, their iterative and interactive nature supports both individual reflection and collective intelligence. Nevertheless, the literature also warns against uncritical enthusiasm: while the motivational aspects of games are well-documented, the challenge remains to develop design processes and evaluative methods that ensure targeted knowledge and skills are systematically acquired.

Game-based learning represents a multidimensional approach that integrates cognitive, affective, and sociocultural theories into practice. Its potential lies not only in improving engagement and learning outcomes but also in shaping collective processes such as urban planning, where play can mediate between technical expertise, community participation, and policy-making.

(2) Digital placemaking

Digital placemaking refers to the use of interactive technologies and game mechanics to foster new forms of engagement with urban environments, enabling residents to co-construct meanings, practices, and narratives associated with place. While traditional placemaking emphasizes the design of physical spaces that nurture social life, its digital counterpart explores how virtual tools, mobile platforms, and location-based games can extend and transform these practices in hybrid urban contexts.

There are plenty of parallels between spatial design in video games and placemaking in urban contexts (Álvarez et., 2018). Although video games are primarily designed for temporary amusement, they nonetheless succeed in constructing complex artificial environments where human interaction and narrative meaning are central. By integrating storytelling, multi-perspectival design, and participatory practices, game developers have developed effective techniques to create immersive and engaging spaces. The authors argue that urban spatial design could benefit from incorporating these approaches, learning from game development how to engage users actively and flexibly in shaping environments.

Placemaking can be situated within the framework of "playable cities," contrasting this concept with the more instrumental model of smart cities (Innocent, 2018). Whereas smart cities often emphasize optimization, surveillance, and efficiency, playable cities explore how digital infrastructures can support playful interactions and bottom-up participation. Through a historical overview of playful urban interventions, Innocent demonstrates how game design can foreground cities as "always in the process of becoming" opening up spaces for citizens to negotiate the past, recognize the present, and imagine alternative urban futures. This approach shifts digital placemaking from a purely functional practice to one that actively mobilizes creativity and civic agency.

The development and evaluation of City Explorer (Pang et al., 2020), a location-based game designed to support city exploration and community awareness along a transit network, provides empirical insights into these dynamics, Their findings reveal that residents valued the enjoyment, competition, and rewards afforded by play in public spaces, which simultaneously created opportunities for placemaking through shared knowledge and interaction. Importantly, players expressed a desire for additional contextual information, such as ridership patterns and routines, which could further enhance their engagement with the city. The study illustrates both the potential and the challenges of digital placemaking: while playful technologies can activate community interaction and civic knowledge, they also raise questions of privacy, data management, and equitable access.

Taken together, these studies emphasize that digital placemaking operates at the intersection of entertainment, technology, and civic life. It leverages play to create hybrid environments in which urban residents not only consume space but actively participate in its meaning-making. By borrowing strategies from video games (storytelling, interactivity, and iterative design) digital placemaking fosters deeper engagement with urban contexts, while simultaneously pointing to the need for careful design choices that balance enjoyment with ethical considerations such as data protection, inclusivity, and long-term community value.

(3) Video games and spatial thinking

Spatial thinking refers to the cognitive processes by which individuals perceive, conceptualize, and manipulate spatial relationships at multiple scales. It is a foundational skill in disciplines such as architecture, geography, and urban planning, but also increasingly recognized as essential for education, digital literacy, and civic engagement. Research across cognitive psychology, education, and game studies has demonstrated that spatial abilities are not fixed traits but can be cultivated through targeted interventions, including the use of digital technologies and game-based environments.

Spatial abilities operates at different scales, from small-scale manipulations of objects to large-scale navigation through environments (Hegarty et al., 2006). While partially overlapping, these abilities are not identical, and their development depends both on direct experience and mediated representations such as maps or virtual environments. A classification of human conceptions of space (ranging from manipulable object space to geographic and map space) underscores the importance of aligning educational and technological tools with how people intuitively experience and conceptualize environments (Freundschuh et al., 1997).

Video games have emerged as powerful mediators of these abilities. Action video games for example can enhance core spatial capacities such as contrast sensitivity, visual attention, mental rotation, and visuomotor coordination (Spence et al., 2010). These effects not only improve performance on basic perceptual tasks but also transfer to more complex forms of spatial reasoning, illustrating the potential of games to generalize learning beyond the immediate activity. Similarly, video game level design provides architecture students with a unique opportunity to engage with the entire design-to-construction process (Valls et al., 2016). By building fully playable environments, students are able to test spatial layouts dynamically, a process often missing in traditional architectural education.

A broader examination of the interplay between game spaces and architectural practice highlights how virtual environments reveal alternative constructions of reality and foster new forms of spatial negotiation (Gerber et al., 2019). The simulatory nature of games, they argue, creates productive intersections between the design of virtual and real environments, offering alternative perspectives on how spatial logic can inform both domains.

Within education, spatial thinking has been framed as a critical competency for addressing real-world challenges. The GI Learner project for example defined ten core competencies of geospatial thinking (Zwartjes et al., 2019), ranging from pattern recognition and visualization to the critical use of spatial information for sustainability-oriented problem-solving. This work provided structured "learning lines" that integrate spatial thinking into secondary education, using GIScience as a foundation. In parallel, the need to integrate geotechnologies and spatial reasoning is emphazised into teacher training as part of the 2030 Agenda for Sustainable Development (Puertas-Aguilar et al., 2021), arguing that fostering spatial literacy among teachers is essential to shaping future citizens capable of critically engaging with global challenges through a spatial lens.

Taken together, these studies underline that spatial thinking is a multidimensional construct encompassing perceptual, cognitive, and applied dimensions. It can be enhanced through educational frameworks, digital tools, and game environments that provide opportunities for exploration, visualization, and interaction at multiple scales. Video games in particular demonstrate the potential of immersive and interactive environments to cultivate spatial cognition, bridging the gap between abstract reasoning and embodied experience. At the same time, the integration of geotechnologies and structured pedagogical models ensures that spatial thinking is not confined to entertainment or specialized fields, but becomes a transversal competency relevant to sustainability, citizenship, and urban design.

4. YOUTH PARTICIPATORY URBAN PLANNING

(1) From Marginalization to Empowerment

Youth participation has emerged as both a normative ideal and a practical necessity in contemporary governance, community development, and urban planning. Across disciplines such as sociology, education, urbanism, and public health, a growing consensus emphasizes that young people are not merely passive beneficiaries of decisions but active stakeholders whose voices, experiences, and creativity can significantly shape collective futures.

Traditional perspectives have often framed young people as social problems or as vulnerable populations requiring protection, leading to their exclusion from meaningful decision-making processes (Omar et al., 2016). Another approach argues for viewing youth as agents of community change, capable of influencing institutions and policies when provided with appropriate structures for engagement (Checkoway, 2012). This shift from marginalization to empowerment has been mainly defined by participatory models such as the Ladder of Participation (Hart, 1992), which differentiates between tokenistic involvement and genuine co-decision-making.

(2) Theoretical and Practical Approaches to Participation

Traditional Youth participation is not a monolithic concept but involves diverse practices ranging from community-based research and environmental stewardship to urban planning and placemaking. Children's rights and capacities are essential in shaping sustainable communities (Hart, 2013), particularly in environmental projects where their commitment is strong. Ethnographic work (Moore, 2017) illustrates how children, as "expert collaborators," creatively appropriate urban landscapes, underscoring the importance of outdoor play and self-organized spaces for developmental support.

In parallel, associations (UNICEF, 2018) and scholars (Loebach et al., 2020) highlight participation as both a democratic right and a vehicle for improved governance. Youth councils, advisory boards, and participatory workshops are framed as mechanisms to institutionalize youth input into local and national policy cycles, provided these processes adhere to principles of inclusiveness, feedback, and sustained engagement.

Urban space provides a crucial arena for youth participation, as access to and use of public spaces directly influence young people's sense of belonging and citizenship (Kinoshita, 2007). Research in both Western and Asian contexts demonstrates that youth often face barriers to occupying public spaces due to restrictive regulations, exclusionary design, or competing claims by adult users. At the same time, studies show that youth inclusion in the design of public environments can foster civic engagement, attachment to place, and healthier developmental outcomes.

Participation in community development has also been observed to vary across contexts, with low levels of youth integration in urban neighborhood decision-making, identifying structural marginalization as a recurring challenge. Conversely, initiatives such as Streets for People (Peacock et al., 2018) demonstrate that socio-technical processes combining digital tools, neighborhood walks and multi-stakeholder dialogue can successfully integrate children into ongoing design projects, while simultaneously surfacing the tensions surrounding their agency in political processes.

(3) Creative and Maker-Centered Approaches

The rise of the "maker" movement has contributed novel frameworks for youth participation by embedding creativity, experimentation, and material engagement into civic learning. Maker-centered learning fosters "maker empowerment" (Clapp et al. 2016) equipping youth to see themselves as active shapers of their worlds through open-ended exploration, tinkering, and design. These approaches align with participatory planning by cultivating critical capacities such as problem-finding, resilience, and collaborative innovation. Toolkits for youth engagement (Palacios, 2022) in planning further integrates such methods into urban contexts, emphasizing arts-based, intersectional, and youth-led strategies supported by feedback loops and sustained mentorship.

Collectively, the literature underscores several principles for designing effective youth participation frameworks. First, youth participation must move beyond tokenism toward genuine power-sharing, with clear mechanisms for influence and accountability. Second, it must be spatially grounded, recognizing that access to and co-design of public spaces are integral to civic identity. Third, it must integrate creative and maker-centered methodologies that empower youth to experiment, fail, and innovate within supportive environments. Finally, it requires sustained institutional commitment, including flexible governance structures and iterative feedback processes.

By situating youth not as passive recipients but as co-creators of knowledge, design, and policy, these approaches collectively provide the foundations for a workshop framework that promotes empowerment, civic responsibility, and spatial justice.

5. GAME-BASED PARTICIPATORY INITIATIVES

(1) International initiatives

Youth Digital game environments have increasingly been mobilized as platforms for participatory urban design and civic engagement. Among these, Minecraft-based initiatives such as Block by Block, launched by UN-Habitat in collaboration with Mojang, have become emblematic of how a popular commercial game can be adapted to support inclusive urban planning. By leveraging Minecraft's block-building mechanics, communities are invited to co-design public spaces and visualize urban transformations in accessible and engaging ways. Research confirms the pedagogical and cognitive benefits of such approaches. Minecraft-based workshops improve participants' spatial skills, particularly mental rotation abilities, which are essential for understanding urban form and three-dimensional geometry (Carbonell-Carrera et al., 2021). The platform thus not only facilitates participatory dialogue but also contributes to spatial literacy, making it particularly valuable for youth engagement in urban design.

Another example is the EquiCity game, developed as a mathematical serious game for participatory design (Nourian et al., 2024). Unlike Minecraft's intuitive and playful environment, EquiCity employs a sophisticated computational framework combining Markovian design models, fuzzy logic, graph-theoretical accessibility analysis, and automated solar-climatic evaluation. Implemented as a multiplayer online game, it allows participants to explore trade-offs between diverse and often competing urban development goals, such as heritage preservation, equitable access to sunlight, and compliance with environmental codes. By simulating iterative rounds of decision-making among stakeholders with varying interests, EquiCity fosters transparency, inclusion, and equity in the co-creation of spatial configurations. The novelty of this approach lies in its ability to combine rigorous mathematical modeling with participatory processes, bridging the gap between expert-driven and community-driven urban design.

Together, these two initiatives illustrate complementary directions in international practice: on the one hand, accessible and popular platforms that democratize participation by lowering technical barriers, and on the other, advanced computational frameworks that ensure fairness, rigor, and transparency in decision-making.

(2) Japanese initiatives

In Japan, youth-oriented and game-based participatory initiatives have multiplied in recent years, supported by a convergence of public, private, and civic actors. These initiatives range from grassroots workshops to national-scale open data projects, reflecting a dynamic landscape where digital tools are increasingly integrated into machizukuri.

Private initiatives are driven both by start-ups and large corporations. Start-ups experiment with the use of 3D city models to address urban challenges, often in hackathon or innovation-lab formats (ASCII STARTUP) [Note 1]. Established companies such as Nikken Sekkei have also organized student workshops (2040 Future City Making) [Note 2], encouraging young people to imagine long-term scenarios for urban futures.

Public initiatives include a growing number of workshops led by municipalities and public institutions. Examples include:

- Digital Twin Machizukuri Workshop 2024 in Toyohashi, focusing on participatory design using digital twin technologies. [Note 3]
- Citizen and Student Machizukuri Workshops in

Kōtō Ward, linked to the revision of the master plan. Note 4

- High School Machizukuri Workshops in Kumagaya City, centered on 3D city modeling. Note 5
- Creating a Sustainable Tokyo through 3D Models at the Miraikan (National Museum of Emerging Science and Innovation). Note 6

Hackathon-style events also play a central role in fostering innovation and youth engagement. The 2024 Toyohashi PLATEAU Challenge Note 7 exemplifies how competitive, time-bound events can stimulate creative uses of digital city models for local problem-solving.

Following the global success of Minecraft in participatory planning, Japan has developed its own Minecraft-based initiatives. The 2024 Saitama Minecraft Award Note 8 rewarded innovative student projects using the platform for sustainable city design. Other initiatives such as Minecraft for Machizukuri Note 9 have been organized by research labs and local governments to experiment with playful co-design processes (Nishi et al., 2022).

A distinctive feature of the Japanese context is the integration of PLATEAU Note 10, a large-scale national project led by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), which provides open-source 3D city model data as a public digital commons. PLATEAU enables new forms of urban analysis and simulation (Saito et al. 2022) while serving as an open digital commons that fosters transparency and citizen-driven innovation (Seto et al., 2023). Educational pilots have also explored how PLATEAU data can be mobilized as a teaching tool for spatial literacy and participatory workshops.

Taken together, Japanese initiatives illustrate an ecosystem where youth participation is encouraged not only through playful approaches such as Minecraft, but also through integration into national open-data infrastructures such as PLATEAU. This combination of grassroots creativity and institutional support suggests a promising model for scaling participatory urban design in ways that are both inclusive and technically robust.

(3) Game engines and urban planning

The use of game engines for planning and visualization is not a new idea. As early as the early 2000s, the potential of computer game technology for environmental and landscape planning has been identified (Herwig et al., 2002). While the rapid evolution of game engines was driven by the entertainment industry, their ability to simulate synthetic landscapes in real-time at low cost made them valuable tools for collaborative landscape visualization. This early recognition framed game engines as accessible alternatives to costly CAD or GIS systems, particularly in contexts where participatory planning and visualization were critical.

Subsequent research (Friese et al., 2008) extended these insights to scientific and educational applications, with several projects that appropriated game engines for serious purposes, demonstrating both their flexibility and the challenges of repurposing entertainment technologies for scientific visualization. They argued that despite limitations, such as the lack of dedicated functionalities for spatial analysis, the affordability and accessibility of game engines positioned them as powerful platforms for non-traditional applications.

With the democratization of tools like Unity and Unreal, game engines accessibility further increased and could be reappropriated for architectural design through the development of “design games” playful software tools that replicate design processes (Westre, 2013). By combining architectural logic with interactive coding, these platforms enabled architects and designers to “play” their design tasks, encouraging experimentation and broadening participation. The growing ecosystem of engines and frameworks used for serious games, underlining that while no single tool was specifically tailored for serious applications, game engines remained central to bridging entertainment-oriented design with educational and civic purposes (Cowan et al., 2017).

Also, the integration of geospatial data has marked a significant step forward. Unity can also be used for interactive visualization of large-scale topographic datasets, incorporating both terrestrial laser scanning and map data via platforms like Mapbox (Laksono et al., 2019). This work illustrated the capacity of game engines to handle real-world georeferenced data and to support multiple viewpoints, from first-person walk-throughs to aerial drone perspective, thus enhancing the immersive experience of urban and environmental planning.

Finally, contemporary approaches increasingly integrate gamification, open data, and participatory co-creation through a low-cost methodology that combines open datasets, user-generated content, and game engines to minimize time and costs in urban planning while enhancing citizen involvement (Kavouras et al., 2023). Applied in case studies in Greece and Denmark, their framework demonstrated how game engines can decentralize and democratize planning by allowing non-experts to actively engage in co-creation and co-evaluation processes. The results highlighted not only the efficiency gains of these tools but also their ability to foster broader acceptance and legitimacy of urban interventions.

Taken together, this body of work demonstrates the evolution of game engines from peripheral visualization tools to central instruments for participatory, data-driven, and gamified urban planning. By lowering technical barriers, supporting interactive engagement, and integrating with geospatial datasets, modern game engines provide a unique interface between expert-driven design and citizen participation. This trajectory suggests that future participatory frameworks in urban planning can effectively harness game engines not merely as representational tools, but as collaborative environments where co-creation, learning, and decision-making converge.

(4) The open-source value : Godot

The emergence of open-source game engines has been a critical step in democratizing the use of interactive 3D environments beyond the commercial game industry. Already in the early 2010s, open-source platforms such as OGRE or JMonkey offered opportunities to model real-world scenarios for training and serious games, especially when linked to geospatial data (Navarro et al., 2012). Yet, these tools were often limited to specific functions (2D-only development or incomplete 3D features) and lacked the usability, community support, and comprehensiveness of commercial engines.

It is in this context that Godot, released in 2014, has become the first truly ambitious, comprehensive, and accessible open-source game engine. Light, powerful, free, and extensible, Godot represents a major shift in the landscape of digital design tools. Unlike previous open-source engines, it provides a complete environment for both 2D and 3D development, with integrated scripting, scene management, and cross-platform deployment. Godot's popularity has grown rapidly, especially among independent developers publishing on platforms such as Steam and itch.io, where it has established itself as one of the leading engines in the indie game industry (Holfeld, 2024). Its success is driven not only by its technical capabilities, but also by its ethos: a collaborative, community-driven project independent of corporate interests, aligned with the open-source philosophy.

Beyond games, Godot has also proven relevant for serious applications. Game engines enable immersive environments for geographic and planning purposes, particularly when combined with open geospatial datasets (Keil et al., 2021). Godot, by virtue of its lightweight architecture and adaptability, is increasingly positioned as a viable alternative for such uses. For example, a prototype educational game in Godot trains spatial navigation strategies in vocational learners and demonstrates how the engine can both host playful experiences and foster measurable cognitive and pedagogical outcomes (Egg, 2022). Such initiatives underline how Godot bridges entertainment, education, and applied research.

The open-source value of Godot is twofold. First, it offers technical accessibility: anyone can download, use, and adapt the engine without financial barriers, making it particularly attractive for youth-oriented, educational, or experimental projects where resources are limited. Second, it ensures epistemic transparency: unlike proprietary engines, its source code is available for inspection and modification, which fosters trust, extensibility, and critical engagement.

Compared to earlier open-source engines, Godot constitutes a significant step forward: it combines the comprehensiveness of commercial engines with the openness of community-driven development. By encouraging spatial thinking, supporting geospatial and virtual reality applications and enabling the flourishing of independent creative projects, Godot demonstrates that open-source tools can stand at the forefront of both technical innovation and participatory digital culture.

6. METHODOLOGY: OPEN-SOURCE WORKSHOP FRAMEWORK PROPOSAL

This research proposes an open-source methodological framework for participatory urban co-design that integrates national geospatial infrastructures, collaborative 3D modeling environments, and interactive simulation tools. Grounded in the Japanese tradition of machizukuri and inspired by open innovation practices, the framework combines datasets from the Ministry of Land, Infrastructure and Transport's Project PLATEAU, the modeling environment Blender, and the open-source game engine Godot. Its purpose is to provide a reproducible and adaptable workflow for youth and citizen engagement in spatial planning, structured in five interrelated phases.

(1) Phase 1 : Data Acquisition

The first phase, establishes the geospatial foundation of the project. A target site is selected according to its representativeness and relevance for the community, with the goal of encompassing diverse typologies of land use, public spaces, and environmental conditions. The MLIT PLATEAU dataset (three-dimensional models of buildings, terrain, vegetation, and infrastructure) constitute the primary data source. Data pre-processing includes the extraction of relevant categories, conversion from CityGML or 3D Tiles formats into Blender-compatible standards such as FBX or GLTF, and the normalization of coordinate systems. This phase also defines the appropriate level of detail (LOD) of the models to accommodate varying degrees of complexity in the subsequent design exercises. The visual language of the models (ranging from realistic to conceptual low-poly representations) is determined according to the workshop's pedagogical objectives and the participants' technical proficiency.

(2) Phase 2 : 3D Modeling and Data Preparation

The second phase consists in transforming the processed geospatial data into editable and meaningful spatial assets. The imported PLATEAU models are cleaned, reorganized, and optimized in Blender to ensure both legibility and real-time performance. The process involves correcting geometric irregularities, simplifying meshes, and structuring the model into semantic layers such as terrain, buildings, vegetation, and public space. At this stage, the data shift from an abstract GIS format to a spatially expressive environment suitable for collaborative design. Additional contextual or hypothetical elements (street furniture, vegetation types, or alternative land-use scenarios) may be introduced. The models are then exported in standardized formats that preserve coordinate alignment and metadata compatibility with the Godot engine, ensuring seamless interoperability between the software environments.

(3) Phase 3 : Collaborative Co-Design

The third phase represents the core of the workshop framework. It translates the traditional machizukuri assembly into a digital and participatory process where community members, students, and planners engage collectively in envisioning spatial transformations. Participants are divided into small teams, each responsible for exploring a specific mission or theme, such as mobility, comfort, or landscape quality.

Given that the target participants of the workshop are junior high school students, the co-design activities are structured around clearly defined missions. This pedagogical framing aims to encourage and reassure participants by providing tangible objectives while fostering creativity within explicit spatial and environmental constraints. Each mission specifies a design goal accompanied by several conditions or challenges that guide the design thinking process. For example, a mission can consists in designing a space that provides shade, another involves creating a bench or seating arrangement that invites people to linger and socialize. Additional missions may include improving visibility, enhancing accessibility, or creating playful or sensory experiences within the neighborhood.

The co-design process is mission-based and structured according to the LOD of the digital models. Participants can select among three levels of engagement depending on their profile, prior experience, and the time available:

- at the introductory level, participants manipulate pre-existing assets (a curated collection of prefabricated 3D models of urban furniture distributed under a Creative Commons CC0 license) to explore fundamental notions of spatial composition, proportion, and scale relationships.
- the intermediate level involves greyboxing, a rapid spatial prototyping method that employs simple, untextured geometries to test and compare urban morphologies and functional layouts.
- the advanced level introduces full 3D modeling within Blender, allowing participants to experiment with materials, textures, and environmental parameters in order to articulate more complex and contextually sensitive design intentions.

The workshop is preceded by fieldwork through collective neighborhood walks during which participants document the urban environment through photography, sketches, and annotations. Their observations are subsequently classified by theme and reintroduced into the digital workspace to inform the design process. These hybrid interactions between field observation and digital modeling foster a more situated understanding of the territory, enabling participants to connect concrete experience with abstract design representation. Through this iterative alternation between exploration, reflection, and simulation, the workshop seeks to cultivate spatial thinking and to facilitate the articulation of shared values and local priorities within a collaborative, open-source environment.

(4) Phase 4 : Game Engine Integration and Interaction

With the spatial compositions developed collaboratively in Godot, this fourth phase activates them as playable environments. It marks the transition from design-time manipulation to experiential simulation, allowing participants to “inhabit” and evaluate their creations through interactive engagement.

In Godot, participants can explore their designs through multiple embodied perspectives (first-person, third-person, or aerial) thereby gaining a richer understanding of scale, proportion, visibility, and spatial sequencing. This interactive immersion enables them to perceive the sensory and functional consequences of their design decisions more directly than static visualization tools allow. Walking virtually through the streets they have imagined, participants can observe sunlight filtering between buildings, assess pedestrian accessibility, or evaluate the legibility and comfort of open spaces.

The open-source architecture of Godot affords considerable flexibility for pedagogical and participatory extensions. Beyond visualization, this phase situates participants within their own design, encouraging them to interpret spatial relationships dynamically rather than abstractly. The act of “playing” the model strengthens spatial cognition by integrating perception, movement, and reflection, thus bridging the gap between digital modeling and lived urban experience.

(5) Phase 5 : Implementation and Evaluation

The final phase focuses on the implementation, evaluation, and dissemination of the workshop outcomes. Once the co-design sessions have been completed, the resulting 3D models and interactive environments are consolidated into a playable prototype developed in Godot. This phase includes participatory testing sessions during which stakeholders (students, residents, and planners) experience the virtual environment collectively, simulating and discussing the implications of the proposed interventions. These sessions serve both as validation exercises and as opportunities for reflective learning, enabling participants to observe how their design decisions affect spatial qualities, accessibility, and the overall atmosphere of the modeled environment.

Feedback is systematically collected through questionnaires, debriefing discussions, and observation of participant interactions. The data obtained informs both the refinement of the virtual models and the evaluation of the workshop’s pedagogical and social outcomes. Continuous improvement is ensured through iterative revisions, with version-controlled updates integrating new GIS data, design adjustments, and user feedback.

Documentation and dissemination are integral components of this phase. All datasets and 3D models are archived under open licenses, ensuring transparency and reproducibility. The interactive games created with Godot are exported in web format and made publicly accessible through itch.io, an open platform widely used by independent creators. This online publication enables participants to play, showcase, and share their creations directly from any browser, without installation or technical constraints. Beyond its practical accessibility, this dissemination strategy fosters a sense of ownership and pride among participants, particularly younger ones, by transforming their digital productions into visible contributions to the collective project. In this way, the framework not only facilitates collaborative learning but also extends the participatory spirit of machizukuri into the digital public sphere.

7. CONCLUSION

The proposed workshop framework introduces a distinctive approach to participatory urban design by integrating open-source technologies, mission-based learning, and the traditional machizukuri. Combining field observation, 3D modeling, and gamification, it bridges the gap between conventional community workshops and contemporary digital design environments. Whereas many initiatives focus primarily on idea generation, and municipal projects often treat digital tools as peripheral, this framework emphasizes hands-on spatial production and iterative simulation through the Godot engine. The use of game-like missions introduces a motivational dynamic accessible to junior high school participants while maintaining the analytical rigor of collaborative design.

In contrast to Minecraft-based competitions where creative freedom is high but spatial realism limited, the proposed method employs real geospatial data from MLIT’s PLATEAU project and professional-grade modeling tools such as Blender and Godot. This ensures both precision and transferability, allowing participants to engage with the urban fabric as it exists while envisioning possible transformations. This method explicitly links neighborhood observation to digital co-design, enabling local perceptions and narratives to directly inform 3D representations and interactive prototypes.

Methodologically, the open-source philosophy is a central innovation. By relying exclusively on freely available software and datasets, the workshop establishes a reproducible, transparent, and scalable model of participatory education. The Godot engine enables direct online publication of playable prototypes through platforms such as itch.io, promoting public dissemination, visibility, and civic dialogue. This not only enhances motivation and self-efficacy among participants but also supports a broader culture of civic pride and digital literacy.

Beyond its pedagogical function, the framework serves as a research platform. The systematic analysis of design outputs and reflective questionnaires will help assess the cognitive and social impacts of spatial simulation on younger participants. Core research questions include the adaptability of professional digital tools to educational settings, the reproducibility of the GIS-to-engine workflow, and the qualitative dynamics of collaborative spatial reasoning.

Expected outcomes encompass the identification of site-specific issues through student observations, visualization of spontaneous design ideas, and cultivation of critical awareness toward public space. Structured missions ensure that even basic manipulations lead to meaningful reflection on comfort, safety, and inclusiveness in the urban realm.

Ultimately, this open-source, gamified, and data-driven model redefines machizukuri as a process of digital civic experimentation. It transforms participation into iterative learning grounded in observation, creativity, and accessibility, laying the foundation for a new culture of collaborative spatial design and urban literacy among younger generations.

The workshop's implementation constitutes the next phase of this research. Data collected from initial sessions (design proposals, participant reflections, and questionnaires) will be analyzed to evaluate both pedagogical and technical performance. Particular attention will be given to the development of spatial reasoning skills, participants' ability to articulate design intentions, and their evolving understanding of community and cooperation.

Subsequent publications will report these outcomes systematically, integrating quantitative indicators (engagement rates, task completion, software usability) with qualitative insights into how open-source, game-based tools mediate civic learning. Comparative analyses across missions and participant groups will provide empirical grounding for refining the methodology and assessing its transferability to other age groups and urban contexts.

Future work will explore the long-term potential of this framework as a sustainable civic infrastructure for participatory design. In sum, this research represents a step toward bridging open-source technologies and community-based urban practice. Through continued implementation and analysis, it aims to establish a participatory design model that is both educational and emancipatory where learning, making, and sharing converge to nurture a new generation of spatially literate citizens.

NOTES

Note 1) https://ascii.jp/elem/000/004/235/4235998
Note 2) https://www.nikken-ri.com/ideas/20241015.html
Note 3) https://www.city.toyohashi.lg.jp/62112.htm
Note 4) https://www.city.koto.lg.jp/390110/kuse/shisaku/torikumi/documents/dai4syou_3.pdf
Note 5) https://www.city.kumagaya.lg.jp/smartcity/service/plateau/zenntaihappyoukai.html
Note 6) https://www.tokyobayesg.metro.tokyo.lg.jp/event/old/250222_pendemy.html
Note 7) https://www.city.toyohashi.lg.jp/62113.htm
Note 8) https://www.city.saitama.lg.jp/001/010/014/007/p115940.html
Note 9) https://prtimes.jp/main/html/rd/p/000000022.000124068.html
Note 10) https://www.mlit.go.jp/plateau/

REFERENCES

1) ADAMS, Paul C. Teaching and learning with SimCity 2000. Journal of geography. Taylor & Francis, 1998, vol. 97, no. 2, pp. 47–55.
2) ALBRECHTS, Louis. Strategic (Spatial) Planning Reexamined. Environment and Planning B: Planning and Design. SAGE PublicationsSage UK: London, England, 2004. DOI: 10.1068/b3065
3) ALVAREZ, Julian and Damien DJAOUTI. An introduction to Serious game definitions and concepts. Serious Games & Simulation for Risks Management [online]. 2011 [accessed 01.10.2025]. Available at: https://hal.science/hal-04675725
4) ÁLVAREZ, Ricardo and Fábio DUARTE. Spatial Design and Placemaking: Learning From Video Games. Space and Culture. 2018, vol. 21, no. 3, pp. 208–232. ISSN 1206-3312, 1552-8308. DOI: 10.1177/1206331217736746
5) ANDO, Tetsuya. Game Catalogue for Community Design (まちづくりゲームカタログ: 研修・ワークショップが進化するボードゲームガイド). Kyōto: 学芸出版社, 2024. ISBN 978-4-7615-2917-8.
6) BROOKFIELD, Stephen D. The Skillful Teacher: On Technique, Trust, and Responsiveness in the Classroom. John Wiley & Sons, 2015. ISBN 978-1-119-01986-2.
7) BROWN, L. David. People-Centered Development and Participatory Research. Harvard Educational Review. 1985, vol. 55, no. 1, pp. 69–76. ISSN 0017-8055, 1943-5045. DOI: 10.17763/haer.55.1.r07478n215287101
8) CARBONELL-CARRERA, Carlos et al. Minecraft as a block building approach for developing spatial skills. Entertainment Computing. Elsevier, 2021, vol. 38, p. 100427. ISSN 1875-9521. DOI: 10.1016/j.entcom.2021.100427
9) CHECKOWAY, Barry. Youth Participation and Community Change. New York: Routledge, 2012. ISBN 978-0-

203-05172-6. DOI: 10.4324/9780203051726
10) CLAPP, Edward P. et al. Maker-Centered Learning: Empowering Young People to Shape Their Worlds. John Wiley & Sons, 2016. ISBN 978-1-119-25970-1.
11) COWAN, Brent and Bill KAPRALOS. An Overview of Serious Game Engines and Frameworks. In: BROOKS, Anthony Lewis et al., eds. Recent Advances in Technologies for Inclusive Well-Being: From Worn to Off-body Sensing, Virtual Worlds, and Games for Serious Applications. Cham: Springer International Publishing, 2017, pp. 15–38. ISBN 978-3-319-49879-9. DOI: 10.1007/978-3-319-49879-9_2
12) DE JANS, Steffi et al. Using games to raise awareness: How to co-design serious mini-games? Computers & Education. 2017, vol. 110, pp. 77–87. ISSN 0360-1315. DOI: 10.1016/j.compedu.2017.03.009
13) DE LA PEÑA, David et al., eds. Design as Democracy: Techniques for Collective Creativity. Washington, DC: Island Press/Center for Resource Economics, 2017. ISBN 978-1-61091-922-7. DOI: 10.5822/978-1-61091-848-0
14) DEVISCH, Oswald et al. Mini is beautiful: Playing serious mini-games to facilitate collective learning on complex urban processes. Interaction design and architectures. 2017, no. 35, pp. 141–157. ISSN 1826-9745.
15) DÖRNER, Ralf et al., eds. Serious Games. Cham: Springer International Publishing, 2016. ISBN 978-3-319-40611-4. DOI: 10.1007/978-3-319-40612-1
16) DUNCAN, Sean C. Gamers as Designers: A Framework for Investigating Design in Gaming Affinity Spaces. E-Learning and Digital Media. SAGE Publications, 2010, vol. 7, no. 1, pp. 21–34. ISSN 2042-7530. DOI: 10.2304/elea.2010.7.1.21
17) DUPUY, Gabriel. Les jeux urbains. L'Actualité économique. 1972, vol. 48, no. 1, p. 85. ISSN 0001-771X, 1710-3991. DOI: 10.7202/1003681ar
18) EGG, Rachel Ursula. Comment encourager l'utilisation de stratégies de navigation spatiale. Développement et évaluation d'un prototype de jeu vidéo avec Godot. 2022, Université de Genève.
19) FELICIA, Patrick and Azita Iliya ABDUL JABBAR. Gameplay Engagement and Learning in Game-Based Learning. [online]. 2015 [accessed 05.07.2025]. Available at: https://journals.sagepub.com/doi/abs/10.3102/0034654315577210
20) FINN, Janet L. The Promise of Participatory Research. Journal of Progressive Human Services [online]. Taylor & Francis Group, 1994 [accessed 01.10.2025]. Available at: https://www.tandfonline.com/doi/abs/10.1300/J059v05n02_03
21) FREUNDSCHUH, Scott M and Max J EGENHOFER. Human conceptions of spaces: Implications for GIS. Transactions in GIS. 1997, vol. 2, no. 4, pp. 361–375. ISSN 1361-1682, 1467-9671. DOI: 10.1111/j.1467-9671.1997.tb00063.x
22) FRIEDMAN, Ted. The Semiotics of SimCity. First Monday. 1999, vol. 4, no. 4. ISSN 13960466. DOI: 10.5210/fm.v4i4.660
23) FRIESE, Karl-Ingo, Marc HERRLICH and Franz-Erich WOLTER. Using Game Engines for Visualization in Scientific Applications. In: CIANCARINI, Paolo et al., eds. New Frontiers for Entertainment Computing. 279. Boston, MA: Springer US, 2008, pp. 11–22. IFIP International Federation for Information Processing. ISBN 978-0-387-09700-8. DOI: 10.1007/978-0-387-09701-5_2
24) GERBER, Andri and Ulrich GÖTZ, eds. Architectonics of game spaces: The spatial logic of the virtual and its meaning for the real. 1. ed. Bielefeld, Germany: transcript Verlag, 2019. Architekturen. ISBN 978-3-8376-4802-7. DOI: 10.14361/9783839448021
25) HART, Roger A. Children's Participation: From Tokenism to Citizenship. Innocenti Essays No. 4. UNICEF, International Child Development Centre, Piazza S, 1992. ISBN 9788885401051.
26) HART, Roger A. Children's Participation: The Theory and Practice of Involving Young Citizens in Community Development and Environmental Care. London: Routledge, 2013. ISBN 978-1-315-07072-8. DOI: 10.4324/9781315070728
27) HEALEY, Patsy. Transforming governance: Challenges of institutional adaptation and a new politics of space1. European Planning Studies. 2006, vol. 14, no. 3, pp. 299–320. ISSN 0965-4313, 1469-5944. DOI: 10.1080/09654310500420792
28) HEGARTY, Mary et al. Spatial abilities at different scales: Individual differences in aptitude-test performance and spatial-layout learning. Intelligence. 2006, vol. 34, no. 2, pp. 151–176. ISSN 01602896. DOI: 10.1016/j.intell.2005.09.005
29) HEIN, Carola and Philippe PELLETIER, eds. Cities, Autonomy, and Decentralization in Japan. Routledge, 2006. ISBN 978-1-134-34150-4. DOI: 10.4324/9780203358498
30) HERWIG, Adrian and Philip PAAR. Game Engines: Tools for Landscape Visualization and Planning? Trends in GIS and virtualization in environmental planning and design. 2002, vol. 161, no. 10. ISSN 978-3-87907-386-3.
31) HOLFELD, Julian. On the relevance of the Godot Engine in the indie game development industry. arXiv, 2024. DOI: 10.48550/arXiv.2401.01909
32) HORITA, M and H KOIZUMI, eds. Innovations in Collaborative Urban Regeneration. Tokyo: Springer Japan, 2009. cSUR-UT Series: Library for Sustainable Urban Regeneration, ED. BY . ISBN 978-4-431-99263-9. DOI: 10.1007/978-4-431-99264-6
33) ILLANAS, Ana Isabel et al., eds. Conceptual mini-games for learning [online]. Valencia, Spain, 2008. ISBN 978-84-612-0190-7. Available at: http://hdl.handle.net/10045/8495
34) INNOCENT, Troy. Play about Place: Placemaking in location-based game design. Beijing China: ACM, 2018. ISBN 978-1-4503-6478-2. DOI: 10.1145/3284389.3284493
35) JUUL, Jesper. Half-Real: Video Games between Real Rules and Fictional Worlds. Cambridge, Mass: MIT Press, 2011. ISBN 978-0-262-51651-8.
36) KAMNITZER, Peter. Computers and urban problems. Atlantic City, New Jersey: ACM Press, 1971. DOI: 10.1145/1479064.1479185
37) KAPP, Karl M. The Gamification of Learning and Instruction Fieldbook: Ideas into Practice. John Wiley & Sons, 2013. ISBN 978-1-118-67443-7.
38) KAVOURAS, Ioannis et al. A Low-Cost Gamified Urban Planning Methodology Enhanced with Co-Creation and Participatory Approaches. Sustainability. Multidisciplinary Digital Publishing Institute, 2023, vol. 15, no. 3, p. 2297. ISSN 2071-1050. DOI: 10.3390/su15032297
39) KEIL, Julian et al. Creating Immersive Virtual Environments Based on Open Geospatial Data and Game Engines. KN - Journal of Cartography and Geographic Information. 2021, vol. 71, no. 1, pp. 53–65. ISSN 2524-4965. DOI: 10.1007/s42489-020-00069-6
40) KINOSHITA, Isami. Children's Participation in Japan: an Overview of Municipal Strategies and Citizen Movements. Children, Youth and Environments. 2007, vol. 17, no. 1, pp. 269–286. ISSN 1546-2250. DOI: 10.1353/cye.2007.0127

41) KOLSON, Kenneth. The Politics of SimCity. PS: Political Science & Politics. 1996, vol. 29, no. 1, pp. 43–46. ISSN 1049-0965, 1537-5935. DOI: 10.2307/420191
42) LAKSONO, Dany and Trias ADITYA. Utilizing A Game Engine for Interactive 3D Topographic Data Visualization. ISPRS International Journal of Geo-Information. 2019, vol. 8, p. 361. DOI: 10.3390/ijgi8080361
43) LAUWAERT, Maaike. Challenge Everything?: Construction Play in Will Wright's SIMCITY. Games and Culture. 2007, vol. 2, no. 3, pp. 194–212. ISSN 1555-4120, 1555-4139. DOI: 10.1177/1555412007306205
44) LOBO, Daniel G. A city is not a toy: How simcity plays with urbanism. 2005.
45) LOEBACH, Janet et al. The Routledge handbook of designing public spaces for young people : processes, practices and policies for youth inclusion [online]. Routledge, 2020 [accessed 05.07.2025]. Routledge handbooks. Available at: https://cir.nii.ac.jp/crid/1130580129921010614
46) LOZANO, Rodrigo et al. Connecting Competences and Pedagogical Approaches for Sustainable Development in Higher Education: A Literature Review and Framework Proposal. Sustainability. 2017, vol. 9, no. 10, p. 1889. ISSN 2071-1050. DOI: 10.3390/su9101889
47) MARTIAL, Léo. A city is not a game, urban development approaches and challenges by video games and smart cities. Géographie et cultures. 2019, vol. 109, pp. 55–72. ISSN 1165-0354, 2267-6759. DOI: 10.4000/gc.9986
48) MINNERY, John and Glen SEARLE. Toying with the city? Using the computer game simcity™4 in planning education. Planning Practice & Research. 2014, vol. 29, no. 1, pp. 41–55. ISSN 0269-7459, 1360-0583. DOI: 10.1080/02697459.2013.829335
49) MOORE, Robin C. Childhood's Domain: Play and Place in Child Development. London: Routledge, 2017. ISBN 978-1-315-12189-5. DOI: 10.4324/9781315121895
50) NAVARRO, Andres, Juan VICENTE and Octavio RIOS. Open Source 3D Game Engines for Serious Games Modeling. In: ALEXANDRU, Catalin, ed. Modeling and Simulation in Engineering. InTech, 2012. ISBN 978-953-51-0012-6. DOI: 10.5772/29744
51) NEWMAN, Peter. Strategic spatial planning: Collective action and moments of opportunity. European Planning Studies. 2008, vol. 16, no. 10, pp. 1371–1383. ISSN 0965-4313, 1469-5944. DOI: 10.1080/09654310802420078
52) NISHI, Shotaro and Shin AIBA. Town planning workshop using Minecraft (Minecraft を用いたまちづくりワークショップの開発). AIJ Journal of Technology and Design. 2022, vol. 28, no. 68, pp. 430–435. ISSN 1341-9463, 1881-8188. DOI: 10.3130/aijt.28.430
53) NOURIAN, Pirouz et al. EquiCity game: a mathematical serious game for participatory design of spatial configurations. Scientific Reports. Nature Publishing Group, 2024, vol. 14, no. 1, p. 10912. ISSN 2045-2322. DOI: 10.1038/s41598-024-61093-4
54) OMAR, Dasimah et al. Youth Participation in Urban Neighbourhood Community. Procedia - Social and Behavioral Sciences. 2016, vol. 234, pp. 309–316. ISSN 1877-0428. DOI: 10.1016/j.sbspro.2016.10.247
55) PALACIOS, Federico. Cities for youth : Toolkit for youth engagement in planning. Urban Minds: School of Urban & Regional Planning, 2022.
56) PANG, Carolyn et al. The role of a location-based city exploration game in digital placemaking. Behaviour & Information Technology. 2020, vol. 39, no. 6, pp. 624–647. ISSN 0144-929X, 1362-3001. DOI: 10.1080/0144929X.2019.1697899
57) PARKER, Hamieda and Earle DU PLOOY. Team-based games: Catalysts for developing psychological safety, learning and performance. Journal of Business Research. 2021, vol. 125, pp. 45–51. ISSN 0148-2963. DOI: 10.1016/j.jbusres.2020.12.010
58) PEACOCK, Sean, Robert ANDERSON and Clara CRIVELLARO. Streets for People: Engaging Children in Placemaking Through a Socio-technical Process. Montreal QC Canada: ACM, 2018. ISBN 978-1-4503-5620-6. DOI: 10.1145/3173574.3173901
59) PLASS, Jan L., Bruce D. HOMER and Charles K. KINZER. Foundations of Game-Based Learning. Educational Psychologist. Routledge, 2015, vol. 50, no. 4, pp. 258–283. ISSN 0046-1520. DOI: 10.1080/00461520.2015.1122533
60) POPLIN, Alenka. Playful public participation in urban planning: A case study for online serious games. Computers, Environment and Urban Systems. 2012, vol. 36, no. 3, pp. 195–206. ISSN 01989715. DOI: 10.1016/j.compenvurbsys.2011.10.003
61) PRANDI, Catia et al. Gamifying cultural experiences across the urban environment. Multimedia Tools and Applications. 2019, vol. 78, no. 3, pp. 3341–3364. ISSN 1380-7501, 1573-7721. DOI: 10.1007/s11042-018-6513-4
62) PRENSKY, Marc. Digital game-based learning. Computers in Entertainment. 2003, vol. 1, no. 1, pp. 21–21. ISSN 1544-3574. DOI: 10.1145/950566.950596
63) PUERTAS-AGUILAR, Miguel-Ángel, Javier ÁLVAREZ-OTERO and María-Luisa DE LÁZARO-TORRES. The Challenge of Teacher Training in the 2030 Agenda Framework Using Geotechnologies. Education Sciences. 2021, vol. 11, no. 8, p. 381. ISSN 2227-7102. DOI: 10.3390/educsci11080381
64) REINART, Bärbel and Alenka POPLIN. Games in urban planning – a comparative study. REAL CORP 2014 – PLAN IT SMART! Clever Solutions for Smart Cities. Proceedings of 19th International Conference on Urban Planning, Regional Development and Information Society. CORP – Competence Center of Urban and Regional Planning, 2014, pp. 239–248.
65) SAILER, Michael et al. How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. Computers in Human Behavior. 2017, vol. 69, pp. 371–380. ISSN 07475632. DOI: 10.1016/j.chb.2016.12.033
66) SAITO Seiichi et al. What will the 3D city model "Plateau" change? (3D 都市モデル「PLATEAU」は何を変えるか). Journal of the Japanese Society for Artificial Intelligence. 2022, vol. 37, no. 4, pp. 446–452. DOI: 10.11517/jjsai.37.4_446
67) SATOH, Shigeru. Evolution and methodology of Japanese machizukuri for the improvement of living environments. JAPAN ARCHITECTURAL REVIEW. 2019, vol. 2, no. 2, pp. 127–142. ISSN 2475-8876, 2475-8876. DOI: 10.1002/2475-8876.12084
68) SATOH, Shigeru. Japanese Machizukuri and Community Engagement: History, Method and Practice. Routledge, 2020. ISBN 978-0-429-51395-4.
69) SATOH Shigeru, ed. Machizukuri Design Games (まちづくりデザインゲーム). Gakugei Editions (学芸出版社), 2015.
70) SETO, T., T. FURUHASHI and Y. UCHIYAMA. Role of 3D city model data as open digital commons: A case study of openness in Japan's digital twin "Project PLATEAU." The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Copernicus GmbH, 2023, vol. XLVIII-4-W7-2023, pp. 201–208. ISSN 1682-1750. DOI: 10.5194/isprs-archives-XLVIII-4-

W7-2023-201-2023
71) SHIMURA, Hideaki. Developing Machizukuri Design Conference Tools for Community DevelopmentA Case Study of Nihonmatsu City. Journal of Asian Architecture and Building Engineering. 2007, vol. 6, no. 1, pp. 79–86. DOI: 10.3130/jaabe.6.79
72) SORENSEN, André and Carolin FUNCK, eds. Living Cities in Japan. 0. ed. Routledge, 2007. ISBN 978-1-134-14319-1. DOI: 10.4324/9780203961728
73) SPENCE, Ian and Jing FENG. Video Games and Spatial Cognition. Review of General Psychology. 2010, vol. 14, no. 2, pp. 92–104. ISSN 1089-2680, 1939-1552. DOI: 10.1037/a0019491
74) TAN, Ekim. The Evolution of City Gaming. In: PORTUGALI, Juval and Egbert STOLK, eds. Complexity, Cognition, Urban Planning and Design. Cham: Springer International Publishing, 2016, pp. 271–292. Springer Proceedings in Complexity. ISBN 978-3-319-32651-1. DOI: 10.1007/978-3-319-32653-5_15
75) TATENO, Masaru et al. New game software (Pokémon Go) may help youth with severe social withdrawal, hikikomori. Psychiatry Research. 2016, vol. 246, pp. 848–849. ISSN 01651781. DOI: 10.1016/j.psychres.2016.10.038
76) THIEL, Sarah-Kristin and Peter FRÖHLICH. Gamification as Motivation to Engage in Location-Based Public Participation? In: GARTNER, Georg and Haosheng HUANG, eds. Progress in Location-Based Services 2016. Cham: Springer International Publishing, 2017, pp. 399–421. Lecture Notes in Geoinformation and Cartography. ISBN 978-3-319-47288-1. DOI: 10.1007/978-3-319-47289-8_20
77) TOBIAS, Sigmund, J. Dexter FLETCHER and Alexander P. WIND. Game-Based Learning. In: SPECTOR, J. Michael et al., eds. Handbook of Research on Educational Communications and Technology. New York, NY: Springer, 2014, pp. 485–503. ISBN 978-1-4614-3185-5. DOI: 10.1007/978-1-4614-3185-5_38
78) UNICEF. Model of youth participation. UNICEF, 2018.
79) VALLS, Francesc et al. Videogame Technology in Architecture Education. Cham: Springer International Publishing, 2016. ISBN 978-3-319-39513-5. DOI: 10.1007/978-3-319-39513-5_41
80) WESTRE, Aaron. Design Games for Architecture: Creating Digital Design Tools with Unity. New York: Routledge, 2013. ISBN 978-0-203-75017-9. DOI: 10.4324/9780203750179
81) ZWARTJES, Luc and María Luisa DE LÁZARO Y TORRES. Geospatial Thinking Learning Lines in Secondary Education: The GI Learner Project. In: DE MIGUEL GONZÁLEZ, Rafael, Karl DONERT and Kostis KOUTSOPOULOS, eds. Geospatial Technologies in Geography Education. Cham: Springer International Publishing, 2019, pp. 41–61. Key Challenges in Geography. ISBN 978-3-030-17782-9. DOI: 10.1007/978-3-030-17783-6_3