**Media and Communication**
2025 • Volume 13 • Article 8747
https://doi.org/10.17645/mac.8747

cogitatio

ARTICLE

Open Access Journal

# The Case of Cities: Skylines Versions—Affordances in Urban Planning Education

**Laura Cañete Sanz** [1], **Sjors Martens** [2], **and Teresa de la Hera** [3]

[1] Department of Information and Documentation, University of Murcia, Spain
[2] Academy of Built Environment and Logistics, Breda University of Applied Science, The Netherlands
[3] Erasmus School of History, Culture and Communication, Erasmus University Rotterdam, The Netherlands

**Correspondence:** Teresa de la Hera (delahera@eshcc.eur.nl)

**Submitted:** 27 May 2024 **Accepted:** 3 October 2024 **Published:** 13 February 2025

**Issue:** This article is part of the issue "Digital Games at the Forefront of Change: On the Meaningfulness of Games and Game Studies" edited by Felix Reer (University of Muenster), Teresa de la Hera (Erasmus University Rotterdam), and Salvador Gómez-García (Complutense University of Madrid), fully open access at https://doi.org/10.17645/mac.i460

## Abstract

Studies on city-building games as educational tools show positive results in addressing different learning objectives, but also identify a missing link to reality, as they are mostly computer-based. Given the differences between existing games and their capabilities, the exact function of these games in an urban planning curriculum is unclear. The city-building game Cities: Skylines currently has three different versions (Digital, Tabletop, VR). Through an affordance analysis of the game's three versions, this study analyses how the versions afford four primary knowledge dimensions, and in doing so identifies different educational applications for each version of Cities: Skylines in different planning disciplines. The results show that: (a) the board game is strong in fostering player participation and critical thinking more suited for the social and health studies, public policy, and citizen participation domains of urban planning; (b) the digital version functions as moddable simulator, ensuring familiarity with existing systems and monitoring their effects, useful in logistics and transportation planning; (c) the VR form viscerally involves players in the simulated processes, applicable in design-focused segments of urban planning, such as sustainable design theory, housing, and land-use management. The results of this study can help urban planning educators identify possible uses for different versions of Cities: Skylines.

## Keywords

affordances; city-building games; knowledge dimensions; urban planning; urban planning education

## 1. Introduction

In 2023, the Dutch municipality of Sliedrecht used the commercial computer game Cities: Skylines (hereafter C:S; Colossal Order, 2015) to inform the urban planning department about the impacts of the redevelopment of an urban neighbourhood (see Figure 1). A local urban planner recreated the entire city in the game to comprehensively visualise choices and directly involve stakeholders in discussions about area development, regardless of their knowledge (Monster, 2023). This example illustrates that C:S is a relatively cheap and accessible simulation tool with a potential function in urban planning education. To help urban planning educators identify applications for different versions of C:S, this study aims to understand how different affordances of the C:S versions facilitate different dimensions of knowledge.

**Figure 1.** Sliedrecht neighbourhood built in C:S. Source: Monster (2023).

Games in urban planning have mostly been studied from an ontological perspective—how and when are these games effective (Ashtari & de Lange, 2019). As the number and diversity of city-building games (CBGs) continue to grow across different platforms, the process of city building in games can take different forms, reflect various systems, and contain diverse educational perspectives on how cities function, impacting said efficacy. When studying the application of CBGs in a classroom, Bereitschaft (2021, p. 21) urges to "consider carefully which CBG is the most appropriate given specific learning objectives," indicating a need for a deeper dive into the capabilities of the games themselves. C:S now has three different versions—a computer game version (abbreviated here as C:S-C), a board game version (C:S-BG; Håkansson, 2019), and a VR version (C:S-VR; Fast Travel Games, 2022). When a game has three different versions, its formal characteristics will vary, resulting in different uses and effects. These formal elements that differ per type of game and platform used *afford* different playstyles. Affordances, as defined by Norman (2013, p. 11), stand for "a relationship between the properties of an object and the capabilities of the agent that determine just how the object could possibly be used." The afforded playstyles result in different applications in urban planning, such as the visualisation and discussion applications in the Sliedrecht case. To provide insights into how different CBGs can afford different urban planning competencies and facilitate urban planning educators in the application of CBGs in their classes, this article draws on the four knowledge dimensions framework of Anderson and Krathwohl (2001) as a lens for our analysis of C:S versions to provide an understanding of which disciplines of urban planning are best served by different CBGs. We do so by means of a case study on the game C:S, entailing an exploratory analysis—both comparatively and formally—of three existing versions of the game, and by answering the following research question: How do the formal characteristics of the computer, board game, and VR versions of C:S afford interaction with different dimensions of knowledge that can be used in urban planning education?

## 2. The Study of CBGs for Urban Planning Education

Games have been used as tools in urban planning since the 1940s. These games, mostly designed as board games, were initially used to educate players about existing systems (Light, 2008, p. 363), described by Shakeri (2022, p. 225) as "an educational or complete simulation of the future development or participation process, at times, at the expense of the player's experience and fun qualities." Over the years, games in planning have shifted attention from simulating a system to "communication and encouraging stakeholders' involvement" (Shakeri, 2022, p. 225). With increasing computing power, games in urban planning have developed along four trends, according to Shakeri (2022, p. 223): urban games initiated as entertainment focusing more on (participatory) play, serious games, simulation games, and full-on gamification relying on system simulation. Although all versions of C:S started out as playful entertainment, the three C:S versions have seen increasing use in urban planning as test grounds for urban systems. Shakeri's continuum of CBG trends gives an indication of possible uses, yet the versatility of CBGs like C:S complicates a clear positioning and consequently a straightforward idea of their use for game-based learning in an urban planning classroom.

Game-based learning is shown to have promising results both in academic and vocational education (Dahalan et al., 2024). Vlachopoulos and Makri (2017) and Sierra-Daza et al. (2024) found through a systematic literature review that cognitive outcomes help develop specific skills regarding deep learning, critical thinking, scientific reasoning, and perceptual abilities (especially with virtual experiences). Behavioural effects, such as teamwork, collaboration, and other soft skills such as leadership skills or project management, are facilitated through games. While these educational effects are positive, the importance of the context variables of the player as well as the game should not be underestimated, requiring special emphasis on the player's perceptions and the educator's attitudes (Khan & Zhao, 2021). It is therefore academically relevant to provide more knowledge on the specific application of CBGs and how this is connected to the concrete affordances of these games and the knowledge dimensions they can foster. While positive effects may be achieved with the game, the specific application in a curriculum and urban planning domain of each of these versions has not been studied in detail. In this study, we aim to fill this gap by providing a comparative formal analysis of the three different versions of C:S.

The majority of studies on game-based learning to date typically focus on a singular game. As such, a comparison of the various design dimensions across different games has yet to be addressed. When studying the application of the different versions of C:S, these design categories become particularly significant. Tsai et al. (2021), for instance, explain that a board game creates a space where students learn by trial and error, experiencing simulations of specific events that improve face-to-face participation by exploring the game mechanisms and worlds created, enhancing skills such as decision-making or cooperation. VR has been shown to boost student motivation (Shabalina et al., 2015), and it is deemed a more attractive learning tool by higher education students (Young et al., 2020), and students retain more information by engaging in VR activities (Krokos et al., 2019). Despite the prevalence of board games throughout the history of urban planning, comprehensive comparisons of different media used are scarce. Sousa (2024) compared the board game and computer game versions of C:S as tools to teach urban planning concepts through collaborative decision-making processes. The author stresses the differences between the C:S versions, in that "they propose a similar progression but use different game mechanisms, progression, and feedback loops" (Sousa, 2024, p. 269). Therefore, this study extends beyond the current state of the art by exploring the differences in formal C:S characteristics across various platforms. This exploration yields insights that enhance our understanding of the different applications of C:S in particular, and CBGs in general.

## 3. Learning Competencies in Urban Planning

Translating the platform-specific variables into the pedagogical use of games in urban planning requires an understanding of learning competencies in urban planning. This was studied by Bereitschaft (2021) through an in-depth literature review focusing on the use of commercial CBGs as learning tools. He found that although most of the revised studies do not follow a specific learning framework, these games have the potential to communicate four primary types of knowledge levels: factual, conceptual, procedural, and metacognitive. These levels of knowledge were derived from a revision of Bloom's taxonomy of learning by Anderson and Krathwohl (2001). This framework acknowledged the varying applicability of games in urban planning, depending on their capabilities. In our analysis, we built on these four knowledge dimensions in CBGs to examine how each dimension is afforded in C:S versions, highlighting potential applications of the different game versions in different disciplines of urban planning.

The first dimension is factual knowledge, in which students interact with terminologies and specific details of objects or events. Cuccurullo et al. (2013) discussed, for instance, how a CBG focused on waste management familiarises students with the correct terminology, while Yildiz and Yildiz (2011) identified improved attention to architectural specifics through CBGs. However, Pinos et al. (2020) stressed that a key consideration in the didactic potential of CBGs is that modding commercial games is often required to go beyond a gamified abstraction and foster the transfer of knowledge to real life, placing a limitation on the achievability of factual knowledge. Affording this factual dimension in a game helps teach students to understand the basic elements of physical, social, and economic urban issues.

The second dimension is conceptual knowledge, requiring students to understand interrelationships between elements and theories or classifications. Czauderna and Budke (2022) used different CBGs to make students simulate different geographical theories, ensuring an experiential understanding of conceptual challenges. Later, Jolly and Budke (2023) specifically studied how a conceptual sustainable city could be constructed using games. The conceptual dimension allows for increasing the tangibility of theories and system interactions, but the extent to which games can convey this themselves can vary.

The third dimension is procedural knowledge. This dimension focuses more on subject-specific skills and methods, as well as criteria for evaluation. Fernández and Ceacero-Moreno (2021) used C:S to train students in necessary procedures should a natural disaster occur. Both subject-related skills and soft skills like problem solving were successfully facilitated through the game. Dhatsuwan and Precharattana (2016) specifically explored logical thinking and the application of urban planning simulations to real-life actions.

This dimension of knowledge enables students to experiment with simulated urban planning processes and consider their further application.

Finally, the dimension of metacognitive knowledge deals with the possibility of self-reflection and knowledge about learning. Droll and Söbke (2021), for instance, studied the use of C:S when teaching water management but reflected on the lack of realistic modelling. Therefore, they resorted to modding the original game, explicitly including the shortcomings of CBGs in the student assignment. This dimension deals more with perspectives on CBGs themselves, and often critically assesses the applicability.

While games have been used in urban planning for a long time, the concrete use of a game like C:S in urban planning education defies positioning due to its three different versions. Despite the proven value of using games in education, there is a lack of curriculum use cases that demonstrate their general benefits. Furthermore, the differences between platforms are considered important but have not yet been studied in formal detail, leaving the application of different forms of C:S confusing. This study fills this knowledge gap by exploring how CBGs can be used to convey four primary knowledge dimensions in urban planning education, which differ depending on the tool used and the educational setting, providing a fruitful avenue to study the areas of application of CBGs.

## 4. Methodology

### *4.1. Case Study*

As C:S has held an average of 30 thousand players since its release (only sinking in 2024 due to the release of its sequel) it is likely to be known by many urban planning students (Steam Charts, n.d.). Since its release in 2015, C:S has been expanded with a variety of downloadable content packs that add new urban systems, such as public transport or sustainable design, and has enjoyed a strong modding community adding new assets to the game. In addition to these, a board game version and recently a VR version were released. All three versions place the player or players in the role of an omnipotent city official who must build a city by setting up a variety of urban systems and ensuring the population's happiness. The computer, board game, and VR versions of the game all require players to build a city and provide facilities on a geospatial grid. However, the different designs of each version afford different adaptations and uses in urban planning education.

The computer version of C:S is a single-player game on an externally visible screen where the player must build a city by setting up a variety of urban systems and making it run fluently. The VR version, also a single-player game, follows a similar playthrough as the computer version, only now seen through a private headset and the player can fly through the game area in a first-person perspective, rather than just hovering above it. The computer game (i.e., the template for the VR game) was designed to "feature deep micromanagement-based play that would also appeal to less experienced players, and [the designers] realised that the real-time, flow-y nature of traffic could be the key" (Wiltshire, 2017). Starting with a highway connection, players must build a road network along which housing, commercial zones, industry zones, or other facilities can be placed. More building and improvement options unlock with population milestones, attained when more inhabitants move into the city. The necessities of the population regarding health, waste, energy, water, education, transport, and leisure must be met to ensure growth. All these facilities can be selected from an access bar at the bottom of the screen in the computer version (see

Figure 2) or conjured from the handheld controllers in the VR version. Each facility building has an action radius and characteristics that define its properties. For a city to function, each facility has to be connected to its dependent systems through roads, as they are factored in the dynamic functioning and flow of the city, instead of being a static box being ticked (Wiltshire, 2017). The game comes with predefined buildings, facilities, and maps, although the computer version allows for modding and the addition of personalised downloadable content (the VR version has no such capabilities or expansions). The game ends when the city goes bankrupt, or if the player has built a functioning city and chooses not to build further.

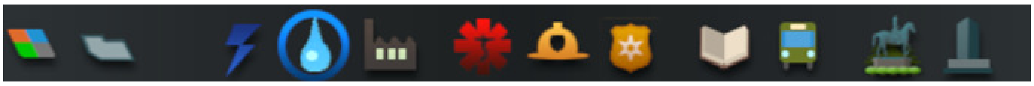

**Figure 2.** The possible building options the player can choose from in C:S. Note: While simulating different urban systems, such as water, healthcare, and public transport, the choices are predetermined.

The board game is different from the computer and VR versions. It can be played as a single-player game, but also as a cooperative game with multiple players. It consists of a set of base tiles with a road network on them that must be unlocked in specific manual-defined configurations with in-game currency. Each zone on the tiles bordered by roads is a district and can be built upon. At the start of a multiplayer game, each player picks a role, such as an architect or marketing expert, which grants that person special bonuses during their turn. During each player's turn, while deliberating with other players, they can play a construction card, swap cards, or end a milestone. Playing a card means processing its effect on the facility bar charts; an in- or decrease in money, energy, water, waste, pollution, traffic, crime, employment, or happiness. After this, an inefficiently shaped tile of the constructed building must be placed in a district (see Figure 3). While some service buildings have a proximity requirement, the constructions can be placed anywhere, if they do not overlap roads or each other. Policy cards or news cards impose new limitations on the gameplay, such as a rise in crime coinciding with a decrease in happiness. When districts have at least two buildings, players can end a milestone. This adds a happiness score to the milestone score bar based on the success of the city, after detracting happiness depending on the level of crime, traffic, and pollution, and costs money depending on the employment, energy, waste, and water bar. When the players run out of money or all tiles have been filled, the game ends. The final happiness score is read from the milestone score bar; the higher, the better the state of the city.


**Figure 3.** The building blocks of C:S-BG. Notes: Different resources are represented in randomly drawn cards and they have an impact on various other resources, such as population or pollution; they are subsequently placed on the board with inefficiently shaped tiles.

### 4.2. Method Outline

This study takes a qualitative approach to determine the differences between the three versions of C:S and identify the unique characteristics afforded by each, considering the game characteristics of each platform. Using observation, data collection, and data screening, this study formally analyses the use of C:S as a pedagogical tool by following two theoretical frameworks: Aslam and Brown's (2022) affordances framework and Anderson and Krathwohl's (2001) four knowledge dimensions framework.

Firstly, building on Aslam and Brown (2022), we conducted an affordance analysis, focused on exploring connections, lessons, rules, and interactions in the game without guidance. Unlike Aslam and Brown's fully associative playtest, we used the formal design characteristics of Fullerton (2014) as focal lenses to gauge affordances. An important caveat in this methodology is that the affordance analysis is delimited by a focus on using C:S versions as urban system simulators. This approach was used to keep the general use of the game clear, and thus we ignored alternative possible uses, such as building roads in the shape of letters. The use of C:S games to learn about urban systems and urban planning was opted for to limit the scope of this study.

The three games were played and analysed by two researchers—a game scholar and an urban planning educator with 60 hours of experience with the game—between April and November 2023. Following the distinction made by van Vught and Glas (2018, p. 214), the playthroughs sought to be instrumental—trying to identify all possible actions. Due to the complexity of C:S, this requires a shift from rational player—trying to optimise the achievement of milestones—to free play—pushing against the rules to identify possible alternative forms of play. Screenshots and pictures were taken in the three versions to collect relevant data and note version differences. During play, relevant information was collected in two tables—one for affordances per formal characteristic, and one for the knowledge dimension touched upon.

The digital version (base game without DLC) was played several times to explore different play styles. Each time, the game was played until every building option was unlocked and the city was profitable and happy. By discussing the choices, one researcher oversaw the data collection process while the other played the game. A total of eight hours were spent playing the game.

The board game version was played three times in single-player, cooperative mode with basic cards, and cooperative mode including roles and news cards. The main purpose was to play all the possible options from different perspectives until all the tiles were unlocked or the players ran out of money. A total of six hours were spent in gameplay.

For the VR version, one of the researchers experienced the immersive action through the Oculus Quest 2 VR headset, while the other researcher commented and coded the information by observing the gameplay on a television. The game was played until every building option was unlocked and the city was profitable and happy. A total of six hours were spent during the gameplay.

Secondly, the inventoried affordances of the formal characteristics were compared to the knowledge dimensions in urban planning education. This was done by comparing the playstyle and possible actions to the four knowledge dimensions of Anderson and Krathwohl (2001). The affordance of a knowledge dimension does not indicate the probability that a particular interaction with the game version will occur. Rather, it provides an overview of *possible* interactions that can be turned into use cases in the classroom.

### 4.3. Analysing the Formal Characteristics

Given the different affordances of different platforms, the list of formal elements we analysed should allow for multiplatform designs. To this end, we followed the list of formal characteristics introduced by Fullerton (2014) due to its focus on forms of play—an action occurring in each platform—instead of types of games. The general categories were further detailed with an indication of possible variables through Fernández Vara's (2015) identifiers for game overview and formal elements, as shown in Table 1. Although repetition of indicators across different formal elements is possible, these characteristics serve as focal points for analysing affordances in C:S, exploring possible play actions with each category in each version.

**Table 1.** Formal elements in games according to Fullerton (2014) and Fernández-Vara (2015).

| Formal Characteristics (Fullerton, 2014) | Description | Indicators (Fernández-Vara, 2015) |
|---|---|---|
| *Players* | The number and role of the players, as well as their position in the game | Single vs. multiplayer |
| | | Player(s) vs. game |
| | | Player vs. player |
| | | Mediation: how the player is placed in the game |
| *Objective* | The results that the players are trying to achieve | Rule driven: rules created endless conditions |
| | | Goal driven: an ultimate goal can be reached |
| | | Game dynamics: freedom in goal-oriented actions |
| *Procedures* | The actions and methods players are and are not allowed to perform, including the framework set by the system/narrative | Rules of the world: frameworks to obey |
| | | Procedural design vs. hard-coded content |
| | | Controls and controllers |
| | | Choice design |
| | | Representation and identity |
| | | Cheating and modding possibilities |
| *Rules* | Rules pose limits on actions but also define the characteristics of assets | Simulation rules: the stats of objects, etc. |
| | | Diegetic vs. extradiegetic elements |
| | | Rules of the fictional world (e.g., justice systems) |
| | | Game state control: save games possibility |
| *Resources* | Assets to be used to attain goals and the systems governing the exchange | Space of the game: available objects, etc. |
| | | Metagame support: communities or references |
| | | In-game economies |
| *Conflict* | Rules, procedures, and situations that hamper players from reaching a goal | Rules of the world |
| | | Player dynamics: how they play |
| | | Values: dilemmas or wicked choices |
| | | Game balance |

**Table 1.** (Cont.) Formal elements in games according to Fullerton (2014) and Fernández-Vara (2015).

| Formal Characteristics (Fullerton, 2014) | Description | Indicators (Fernández-Vara, 2015) |
|---|---|---|
| *Boundaries* | The rigidity of the difference between the game and the non-game setting | Game format and controller |
| | | Diegetic vs. extradiegetic rules |
| | | Spaces of the game and the magic circle |
| *Outcomes* | Possible end states of the game; this includes system end, but also possible serious use | Game communities: social engagement |
| | | Procedural rhetoric and message |
| | | Representation: how is it communicated |
| | | Choice design: what is rewarded and unlocked |

### *4.4. Assessing the Knowledge Dimensions*

As shown in the literature review, CBGs have been shown to teach specific learning competencies that are pursued in urban planning education, organised in Anderson and Krathwohl's (2001) four knowledge dimensions: factual, conceptual, procedural, and metacognitive. In the current study, the affordances of each version of C:S are interpreted by asking which knowledge dimension is engaged with when playing accordingly. While not every affordance of a formal characteristic will translate into a knowledge dimension, seeing which C:S version makes more use of which knowledge dimension gives direction to possible areas of application in urban planning education.

## 5. Results

The results of the analysis were structured per knowledge dimension. In Sections 5.1 to 5.4, for each dimension, the formal characteristics that afford exploration of the dimension are discussed. After the knowledge dimension overview, in Section 5.5, possible use cases of the three C:S versions in different domains of urban planning education are provided.

### *5.1. Factual Knowledge Dimension*

In this section, we discuss the results of our analysis that help us understand how the concrete affordances of the different versions of C:S facilitate the acquisition of factual knowledge. Factual knowledge is understood here as students' interactions with terminologies and specific details of objects or events. In our analysis, we established that factual knowledge is present when the players must engage with realistic planning terminologies or elements.

#### 5.1.1. Objectives and Procedures

In both C:S-C and C:S-VR, players must make choices about what to build where. In this process, the player has a large degree of freedom, as apart from space and money constraints, buildings can be placed everywhere as long as they are connected to roads, sewage, and energy, simulating urban systems. As the focus is on building and integrating urban elements into a larger urban system, the games afford familiarisation with key interactable elements in cities. The player is ultimately limited by the coded frameworks of the building requirements. As such, they are limited by the game systems more than the actual urban systems—like a toybox, players can choose out of semi-realistic toys. Key terminologies and elements of urban planning disciplines are highlighted in both the C:S-C and C:S-VR versions, as they are the main indicators of progress towards the objective. The importance of the resources and their interaction with procedures relies strongly on factual knowledge. However, the player is not bound by this, as multiple options are possible: it is possible to realistically place sewers under roads, but ultimately the game rewards realistic or unrealistic construction equally when the systems are connected.

Furthermore, C:S-C and C:S-VR are provided with stock-building representations that the player has no control over—what the city looks like is procedurally generated, limiting factual representations. However, C:S-VR affords the exploration of the city from a ground level in its procedures (see Figure 4), allowing for a more factual understanding of height and distance. However, the dependence on pre-made models reduces the aesthetic or realistic affordances of the computer version, leaving the representation often wanting. In contrast, C:S-C allows for modding, resulting in the possibility of adding realistic assets—such as copies of real buildings. As such, C:S-C affords the factual recreation of a city, allowing students to consider key buildings or elements of a city, albeit with a high technical requirement, while C:S-VR allows for the factual representation of realistic heights and distances.

**Figure 4.** First-person perspective in C:S-VR. Note: The ground-level view can familiarise the player with the scale of buildings and size of open space.

C:S-BG instead relies largely on interactions between elements, such as housing and urban management, based on predetermined costs as dictated on cards. Subjected to a gamified logic, C:S-BG does not familiarise players with the factual functioning of different elements through their choices, but instead subjects the procedures to an abstracted logic. Additionally, C:S-BG is more goal oriented, aiming for an arbitrary high score in the form of a happiness score bar. Here the objective is detached from factual terminologies or urban elements, instead opting for a gamified alternative wherein the terminology is explained in game terms instead of planning terms.

### 5.1.2. Rules and Resources

The formal characteristics of rules and resources are shared amongst all three versions. The resources of space, buildings, energy, water, waste, crime, pollution, traffic, health, education, happiness, and money—as important elements of urban systems—are present in all three versions, familiarising students with key terminologies. The rules surrounding these resources furthermore indicate the interrelationships between them, such as the resources needed for each building to function (e.g., schools need residential zones, and educated citizens need to go to office zones). While C:S-C and C:S-VR use semi-realistic rules to simulate and visualise the interrelationships due to the processing power of the digital devices, C:S-BG abstracts the relationships into relatively arbitrary rules (e.g., a dog park costs three money tokens and is only effective right next to a residential area). Instead, the rules of C:S-BG deal with permanent choices, as opposed to free experimentation in the other versions. The permanent choices confront players more with the factual dimension of city building—once the choice is made, it is set in motion—while free experimentation affords students to become more familiar with factual terminologies.

## *5.2. Conceptual Knowledge Dimension*

In this section, we discuss the results of our analysis that help us understand how the concrete affordances of the different versions of C:S facilitate the acquisition of conceptual knowledge. The conceptual knowledge dimension deals with a more abstract interpretation of the factual elements—classifications, generalisations, and theories (Anderson & Krathwohl, 2001). In our analysis, we established that CBGs can foster conceptual knowledge acquisition through the semi-realistic selection of factual elements and their interactions. However, the theoretical possibilities of CBGs are dependent on the focus on either the city building or the game itself.

### 5.2.1. Procedures, Rules, and Resources

Both C:S-C and C:S-VR simulate a semi-realistic urban system. In doing so, the relationships between different classifications of buildings are an essential part of the game. To make office zones work, for instance, the rules dictate that a higher-educated population is needed. For higher education to function, several procedures to establish housing, lower education, amenities, and transport must be followed. Some theories, such as the decaying catchment area of public transport stops (Andersen & Landex, 2009), are simulated in these games as well. In that sense, both C:S-C and C:S-VR, due to their simulation and processing power, encourage players to experience theories and classifications through mechanical action, albeit subjected to the limits of the system; theories can be experienced by understanding the coded logic, or visually in C:S-VR, but new theoretical logic cannot be easily added to be tested.

### 5.2.2. Boundaries and Outcomes

C:S-BG has a strict boundary with reality. While using the same elements as the other two versions, C:S-BG instead subjects these to a game logic within a structured game. The player is considerably limited in terms of available space (e.g., roads and board shapes cannot be moved) and building options, due to the random availability of facilities in the card decks and the shapes of the buildable elements. The game pursues a puzzle outcome, finding the best possible fit for your role-dictated turn with the resources available and the framework set by the news items and building cards (see Figure 5), rather than simulating city building.

**Figure 5.** Game board of C:S-BG. Notes: The building tiles must be placed next to a road; as such, getting all the amenities in place becomes a puzzle.

Instead of engaging with planning theories or classifications, players are focused on the game logic instead of urban planning theories. The outcome of the game is wholly determined in abstracted game terms (e.g., 18 happiness points or five money tokens), making even a conceptual understanding of a city difficult.

### 5.3. Procedural Knowledge Dimension

In this section, we discuss the results of our analysis that help us understand how the concrete affordances of the different versions of C:S facilitate the acquisition of procedural knowledge. The procedural knowledge dimension revolves around understanding and optimising the planning of a city using subject-specific skills or methods (Bereitschaft, 2021). Through our analysis, we established that this dimension is mostly present when players can use the game to dive into specific aspects of urban planning, such as sustainability, participation, and traffic flow, to reflect on best practices.

#### 5.3.1. Procedures, Rules, and Resources

C:S-C and C:S-VR afford conceptual knowledge dimensions in the simulation of the interrelationships between urban system elements. However, building a city for maximum profit and happiness does not directly constitute optimisation through subject-specific skills. Procedural knowledge is afforded by these two versions due to the transient nature of the simulation; players can undo their actions, pause the game to build different scenarios, and even freely experiment with no monetary costs in sandbox mode, while still receiving quality metrics of each specific resource. The interactable procedures, non-binding rules, and resources focused on the urban system allow students to optimise traffic, access to education, healthcare, etc., in an experimental setting, using the in-game feedback procedures. The experimental frameworks—the rules—within which the procedures must be optimised can be set during the lesson.

C:S-C can increase the complexity of procedural knowledge through its affordance of modification. Although they require programming or modelling skills, modifications can be made to the mechanics of C:S-C to correspond more closely to realistic options. By downloading or adding digital alterations to the game, players can add building textures, allowing for personal representations, or add new system management tools, such as advanced traffic light management operators in the Traffic Manager: Presidential Edition Mod (see Figure 6), or incorporate more comprehensive monitoring tools within the game, allowing for optimised traffic management. Apart from affording more experimental capabilities, this modification-based affordance also forces players to reflect on the differences between the simplistic systems contained in C:S-C and optimal functioning in different fields of urban planning. C:S-C can therefore afford even more procedural knowledge if a technical requirement can be overcome.


**Figure 6.** The Traffic Manager: Presidential Edition Mod. Notes: Traffic management in C:S is limited to the presence or absence of traffic lights; mods allow players to install more realistic traffic management systems. Source: YUMBL (2021).

### 5.3.2. Players, Conflicts, and Boundaries

In C:S-BG, the interpersonal conflict allows for the testing of the game's boundaries, specifically through the optional game elements of player roles and news items. These allow players to influence transactions based on their role or impose limiting conditions, such as a crime wave that increases the crime metric twice as fast. These options allow for playing with role-specific skills and methods in specific urban dynamics, albeit translated to game-focused mechanics. However, the analogue nature allows for the easy adaptation of these roles and their function in collaborative debate. The boundary between local planning roles and conventions and in-game rules can be broken to use C:S-BG to simulate a planning session. Furthermore, procedures and physical assets can be added due to the paper-based gameplay, possibly tailoring the game to local contexts. In this way, the game functions as a direct experiment with subject-specific skills.

C:S-C and C:S-VR are hard-coded and largely single-player games, so they cannot easily introduce local rules or interactions into a play session. C:S-C affords multiplayer discussion of the gameplay due to a visible screen. However, only the coded or modded procedures can be discussed as the digital programming remains dominant; reflection is possible, but optimisation is challenging. C:S-VR is characterised by a solitary screen. Discussing urban planning concepts in this version is possible through casting but has more technical obstacles than the other two versions. They do afford the pursuit of a specific outcome in the shape of a city built according to predetermined principles. Building a fully sustainable city, an underwater city, or a city reliant only on public transport can be set as goals by the players or the instructor. This poses conflicts in the available choices and limits certain resources, but ultimately allows players to reflect on required resources, payoffs, and shortcomings in their design to attain an ideal city. Even without these goals, the general outcome of C:S-C and C:S-VR games relies on a functioning, happy, and profitable city, which furthermore relies on optimising city dynamics. These two versions therefore afford a deep dive into planning optimisation.

### *5.4. Metacognitive Knowledge Dimensions*

In this section, we discuss the results of our analysis that help us understand how the concrete affordances of the different versions of C:S facilitate the acquisition of metacognitive knowledge. The metacognitive knowledge requires self-reflection and identifying strengths and weaknesses in the learning process (Anderson & Krathwohl, 2001). When the formal characteristics of the game draw attention to the design of the game, metacognitive knowledge can be fostered in CBGs by facilitating confrontation with the discipline of urban planning in the game that can be identified as abstracted, or a reflection on one’s own role in urban planning.

#### 5.4.1. Players, Objectives, Procedures, Rules, Conflicts, Boundaries, and Outcomes

Although C:S-BG is subjected to game logic, it is its main procedure—discussion with other players—that affords reflection on player positions in a planning team. As an analogue discussion-led game, C:S-BG affords engagement with and discussion of planning practices within a planning team as fellow players. By selecting who the fellow players are—the rest of a planning team, residents, politicians, etc.—a play session can become a conversation starter or a reflective contrast to the complexity of urban planning. This can be conveyed even more strongly if the game completely breaks the magic circle boundary and is played according to local planning rules, thus limiting the available procedures—for instance, by not allowing industrial zone tiles, which represent factories, to be placed next to residential zones, regardless of the money and space available. In this sense, the objective of the game shifts from being goal-oriented to being a planning simulation or discussion, with conflict arising from differences of opinion. This changes the outcome to a team-building exercise for a planning team, requiring metacognitive knowledge to position oneself.

C:S-C and C:S-VR can evoke metacognitive knowledge by bending the boundaries of reality. The experimental and trial-and-error simulation allows players to design absurd creations that conflict with urban planning staples. It is precisely this contrast that allows further reflection on proper techniques, especially in C:S-C, if the built cities, as attempted recreations of real cities, are scrutinised by other players. The outcome of C:S then also affords a more reflective discussion in a team, or even identifies the need for missing elements that require a modding community to be added. The outcome of C:S-VR affords reflection on a built environment from a ground perspective, with adequate distances and sight lines. In C:S-VR, both absurdist building and planning-informed building afford metacognitive knowledge.

### 5.5. Learning Competencies and Possible Application Domains

Given the different afforded interactions with urban planning topics through the formal characteristics, CBGs can have varying applications in education. Table 2 provides an overview of the relationships between different knowledge dimensions and concrete affordances of CBGs. Following our comparative analysis of the three versions of C:S, Table 2 also includes an indication of the version required for these applications as indicated with C:S-C, C:S-BG, or C:S-VR. Additionally, reflecting on the most prevalent knowledge dimension per version and ease of use, it illustrates probable uses within urban planning education.

C:S-C relies largely on the conceptual and procedural knowledge domain due to its semi-realistic simulation of relevant urban planning elements, and the added realism through modding. To build an urban design and to consider the interrelationships of specific systems, the computer version is well suited, for instance, within the domains of transportation and logistics in urban planning. However, due to modding being a specialist activity, and the rules and procedures being largely hard-coded, adaptability is hindered. Therefore, the most accessible application will use C:S-C as a simulator of planning procedures, relying on the computing capacity and feedback more so than realism.

C:S-VR overlaps with the computer version in required competencies, yet the lack of addable mods or DLC make it less suited for realistic urban system simulations or monitoring realistic designs. Alternatively, the affordance of experiential imagery touches on factual and conceptual knowledge in that it makes concepts

**Table 2.** Applications of C:S versions in urban planning education based on afforded knowledge dimensions in each game.

| Knowledge Dimension | C:S Application |
|---|---|
| Factual | — Procedures and objectives for players to freely experiment with urban elements to remember relevant systems and facilities (C:S-C & C:S-VR)<br>— Procedures to experience the size and spread of a planned design (C:S-VR)<br>— Rebuild existing cities (C:S-C) |
| Conceptual | — Engagement with a simplified version of urban systems (all)<br>— Becoming familiar with interactions between urban elements (all)<br>— Reflecting on spatial planning and zoning theories put into visible practice (C:S-VR) |
| Procedural | — Interacting and optimising realistic simulations of urban interactions (C:S-C & C:S-VR)<br>— Designing an urban simulation according to specific objectives, rules and resources set by players (e.g., green city; C:S-C & C:S-VR)<br>— Trying out realistic urban management systems (after modding; C:S-C)<br>— Altering the rules, resources, and procedures to match local planning frameworks (C:S-BG) |
| Metacognitive | — Taking place in a team of urban planners to build a city (C:S-BG)<br>— Adapting existing procedures to approach a more realistic simulation (C:S-BG)<br>— Compiling a team of diverse city builders to reflect on the city built (C:S-C & C:S-BG)<br>— Experiencing the appeal of a city built (C:S-VR) |

and theories more empirical, and on metacognitive knowledge in that it allows for the personal exploration of agreeable designs. This C:S-VR is then suited to be used in the more design-focused domains of urban planning, such as sustainable design theory, housing, land-use management, and urbanisation, according to the overview of Sanchez and Afzalan (2018).

In C:S-BG, due to its abstracted and goal-oriented nature, conceptual and procedural knowledge is recontextualised in the strictly rule-bound nature of the game. While factual knowledge is still touched upon by using the same elements as in the other versions, the functioning of the elements is subjected to the logic of the game. However, metacognitive knowledge is the greatest strength of C:S-BG. Through collaboration, reflections on the actual functioning of urban planning can be discussed. Inspired by resources of the game, such as the roles and news cards, the metacognitive knowledge dimension is called upon specifically because of the abstraction. The physical form subsequently affords easy adaptation, and involving actual urban planning stakeholders can tailor C:S-BG to a local situation. This reliance on reflection and group discussion makes this version more suited for social and health studies, public policy, and citizen participation domains of urban planning—domains which do not focus on testing and optimising existing systems, but on agreements and compromise.

## 6. Conclusions

This study focuses on providing an understanding of how the concrete affordances of CBGs can be used to foster different knowledge dimensions in urban planning education. For this purpose, we conducted a comparative formal analysis of the computer, board game, and VR versions of the CBG game C:S. The results showed that the computer version relies on detailed and interrelated procedures and rules, leading to open outcomes. This results in a detailed and semi-realistic system simulation that thrives on conceptual and procedural knowledge dimensions that afford free-form experimentation. The board game is best suited as a discussion facilitator and adaptable simulator of urban planning teams due to its multiplayer nature and agreement-based conflicts. Despite its abstract approach, the appeal to metacognitive knowledge through interpersonal additions and role-play makes this game a team discussion facilitator. Finally, the VR version thrives on factual and metacognitive knowledge because of its procedures that allow players to take a first-person perspective on a city, and consequently its blurred boundaries with actual planned cities.

This study can facilitate urban planning instructors in applying C:S as an accessible ludic tool for their classes. Furthermore, it has provided deeper insight into the affordances of different platforms when judged as ludic tools for urban planning. This study is limited to C:S versions, however, and despite formal characteristics being comparable in other CBGs, future research should explore other commercial games and serious games focused on urban planning education, or other subjects, such as geography. Furthermore, the results outlined here require further empirical testing with urban planning students in didactic environments, to embrace playtesting affordances, as well as interviews with urban planning educators to understand the embedding in the curriculum, possibly involving even the designers themselves. Apart from the affordances of the games, contextual variables, such as demographics, digital literacy levels of students and instructors, and technological limitations in the classroom can facilitate or limit knowledge dimensions. Nevertheless, this case study of the formal differences of C:S has shown that teaching the design of skylines of cities can be done in different ways.

## Funding

This study was funded by the European Union—NextGenerationEU through the Programa para la Recualificación del Sistema Universitario Español, Modalidad "Margarita Salas".

## Conflict of Interests

In this article, editorial decisions were undertaken by Felix Reer (University of Muenster) and Salvador Gómez-García (Complutense University of Madrid).

## References

Andersen, J. L. E., & Landex, A. (2009). GIS-based approaches to catchment area analyses of mass transit. In *2009 Esri International User Conference Proceedings* (pp. 1–13). Esri.

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman.

Ashtari, D., & de Lange, M. (2019). Playful civic skills: A transdisciplinary approach to analyse participatory civic games. *Cities*, *89*, 70–79. https://doi.org/10.1016/j.cities.2019.01.022

Aslam, H., & Brown, J. A. (2022). *Affordance theory in game design: A guide toward understanding players*. Springer Nature. https://link.springer.com/book/10.1007/978-3-031-02123-7

Bereitschaft, B. (2021). Commercial city building games as pedagogical tools: What have we learned? *Journal of Geography in Higher Education*, *47*(2), 161–187. https://doi.org/10.1080/03098265.2021.2007524

Colossal Order. (2015). *Cities: Skylines* [Video game]. Paradox Interactive.

Cuccurullo, S., Francese, R., Passero, I., & Tortora, G. (2013). *A 3D serious city building game on waste disposal*, *11*(4), 112–135. Scopus. https://doi.org/10.4018/ijdet.2013100108

Czauderna, A., & Budke, A. (2022). Players' reflections on digital games as a medium for education: Results from a qualitative study. In C. Costa (Ed.), *16th European Conference on Games Based Learning* (pp. 180–188). Dechema e.V. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85141148873&partnerID=40&md5=d483e4c360c31da1ca982f7dd3e73c4a

Dahalan, F., Alias, N., & Shaharom, M. S. N. (2024). Gamification and game based learning for vocational education and training: A systematic literature review. *Education and Information Technologies*, *29*(2), 1279–1317. https://doi.org/10.1007/s10639-022-11548-w

Dhatsuwan, A., & Precharattana, M. (2016). BLOCKYLAND: A cellular automata-based game to enhance logical thinking. *Simulation and Gaming*, *47*(4), 445–464. https://doi.org/10.1177/1046878116643468

Droll, D., & Söbke, H. (2021). Realism of simulation models in serious gaming: Urban water management in Cities: Skylines. In F. de Rosa, I. M. Schottman, J. B. Hauge, F. Bellotti, P. Dondio, & M. Romero (Eds.), *Games and Learning Alliance: 10th International Conference* (pp. 277–282). Springer Nature. https://doi.org/10.1007/978-3-030-92182-8_29

Fast Travel Games. (2022). *Cities: VR* [Video game]. Fast Travel Games.

Fernández, P., & Ceacero-Moreno, M. (2021). Study of the training of environmentalists through gamification as a university course. *Sustainability*, *13*(4), Article 2323. https://doi.org/10.3390/su13042323

Fernández-Vara, C. (2015). *Introduction to game analysis*. Routledge.

Fullerton, T. (2014). *Game design workshop: A playcentric approach to creating innovative games* (3rd ed.). CRC Press.

Håkansson, R. (2019). *Cities: Skylines—The boardgame* [Board game]. Paradox Interactive.

Jolly, R., & Budke, A. (2023). Assessing the extent to which players can build sustainable cities in the digital city-builder game "Cities: Skylines." *Sustainability*, *15*(14), Article 10780. https://doi.org/10.3390/su151410780

Khan, T. A., & Zhao, X. (2021). Perceptions of students for a gamification approach: Cities skylines as a pedagogical tool in urban planning education. In D. Dennehy, A. Griva, N. Pouloudi, Y. K. Dwivedi, I. Pappas, & M. Mäntymäki (Eds.), *Responsible AI and Analytics for an Ethical and Inclusive Digitized Society: 20th IFIP WG 6.11 Conference on e-Business, e-Services and e-Society* (pp. 763–773). Springer Nature. https://doi.org/10.1007/978-3-030-85447-8_64

Krokos, E., Plaisant, C., & Varshney, A. (2019). Virtual memory palaces: Immersion aids recall. *Virtual Reality*, *23*(1), 1–15. https://doi.org/10.1007/s10055-018-0346-3

Light, J. (2008). Taking games seriously. *Technology and Culture*, *49*(2), 347–375. https://doi.org/10.1353/tech.0.0007

Monster, J. (2023, October 24). *Een computerspel als ideale gids in de gebiedsontwikkeling-zoektocht*. Gebiedsontwikkeling.nu. https://www.gebiedsontwikkeling.nu/artikelen/een-computerspel-als-ideale-gids-in-de-gebiedsontwikkeling-zoektocht

Norman, D. A. (2013). *The design of everyday things*. The MIT Press.

Pinos, J., Vozenilek, V., & Pavlis, O. (2020). Automatic geodata processing methods for real-world city visualizations in cities: Skylines. *ISPRS International Journal of Geo-Information*, *9*(1), Article 17. https://doi.org/10.3390/ijgi9010017

Sanchez, T. W., & Afzalan, N. (2018). Mapping the knowledge domain of urban planning. In T. W. Sanchez (Ed.), *Planning Knowledge and Research* (pp. 64–80). Routledge.

Shabalina, O., Mozelius, P., Vorobkalov, P., Malliarakis, C., & Tomos, F. (2015). Creativity in digital pedagogy and game-based learning techniques; theoretical aspects, techniques and case studies. In N. Bourbakis, G. A. Tsihrintzis, & M. Virvou (Eds.), *2015 6th International Conference on Information, Intelligence, Systems and Applications (IISA)* (pp. 1–6). IEEE. https://doi.org/10.1109/IISA.2015.7387963

Shakeri, M. (2022). Unstable wormholes: Communications between urban planning and game studies. *Urban Planning*, *7*(2), 218–228. https://doi.org/10.17645/up.v7i2.4953

Sierra-Daza, M. C., Martín-del-Pozo, M., & Fernández-Sánchez, M. R. (2024). Videojuegos y aprendizaje en educación superior: Una revisión sistemática. *Revista de Educación*, *405*, 64–85. https://doi.org/10.4438/1988-592X-RE-2024-405-629

Sousa, M. (2024). Cities: Skylines: The digital and analog game design lessons for learning about collaborative urban planning. In L. V. Costa, N. Zagalo, A. I. Veloso, E. Clua, S. Arnab, M. Vairinhos, & D. Gomes (Eds.), *Videogame sciences and arts* (Vol. 1984, pp. 257–271). Springer Nature. https://doi.org/10.1007/978-3-031-51452-4_18

Steam Charts. (n.d.). *Cities: Skylines*. https://steamcharts.com/app/255710

Tsai, J.-C., Liu, S.-Y., Chang, C.-Y., & Chen, S.-Y. (2021). Using a board game to teach about sustainable development. *Sustainability*, *13*(9), Article 4942. https://doi.org/10.3390/su13094942

van Vught, J., & Glas, R. (2018). Considering play: From method to analysis. *Transactions of the Digital Games Research Association*, *4*(2), 205–242. https://doi.org/10.26503/todigra.v4i2.94

Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: A systematic literature review. *International Journal of Educational Technology in Higher Education*, *14*(1), Article 22. https://doi.org/10.1186/s41239-017-0062-1

Wiltshire, A. (2017, February 14). *Why road-building in Cities: Skylines is a pleasure*. Rock, Paper, Shotgun. https://web.archive.org/web/20170214134011/https://www.rockpapershotgun.com/2017/02/10/cities-skylines-roads

Yildiz, S., & Yildiz, E. (2011). *A study on pc—Video games in terms of the space awareness from childhood to youth*. *Procedia—Social and Behavioral Sciences*, *28*, 796–800. https://doi.org/10.1016/j.sbspro.2011.11.145

Young, G. W., Stehle, S., Walsh, B. Y., & Tiri, E. (2020). Exploring virtual reality in the higher education classroom: Using VR to build knowledge and understanding. *Journal of Universal Computer Science*, *26*(8), 904–928. https://doi.org/10.3897/jucs.2020.049

YUMBL. (2021, March 24). *Traffic manager explained! Mod tutorial* [Video]. YouTube. https://www.youtube.com/watch?v=TERVATwI9uo


## About the Authors

Laura Cañete Sanz is a postdoctoral researcher at the University of Murcia. She specialises in the persuasive use of digital games in serious contexts. Her studies gather topics from the use of branded games in marketing campaigns, such as city branding and games, brand narrative expansion, or the evolution and contextualization of digital games in the marketing ecosystem, to the functions of digital games with pedagogical uses.

Sjors Martens is a project lead and lecturer of smart mobility at Breda University of Applied Sciences in the Netherlands. He holds a PhD in communication science, with a focus on game design and smart cities. His research interest is in traffic management, public transport transitions, urban planning, game design, and playful cities as a response to smart cities. He has worked at Utrecht University before and has an independent game design company.

Teresa de la Hera is associate professor of persuasive gaming at Erasmus University Rotterdam. Her expertise is related to understanding how digital games can be used as media for communication and tools for engagement, motivation, and persuasion. De la Hera is the author of the book *Digital Gaming and the Advertising Landscape* (2019) and editor of the volume *Persuasive Gaming in Context* (2021), both published by Amsterdam University Press. She is also member of PEGI's Experts Group.