Studying Cartographic Game Maps:
Video Game Maps Matter.

Claire Dormann, Günter Wallner

Institute of Computer graphics, Johannes Kepler University, 4040 Linz, Austria
{claire.dormann,guenter.wallner}@jku.at

Abstract. Maps are critical elements of video games that provide an alternative representation of the game world. While navigation is considered an essential function of game maps, they play additional selective roles in and have multiple functions that influence players' experiences. To refine our understanding of the complexity and intricacies of their design, we conducted a thematic analysis of online posts dedicated to this subject. In these posts, authors share their understanding of and critical perspectives on video game maps. Our findings illustrate aspects of the cartographic process. We first show how maps work as information systems. Then, aesthetics and usability are introduced as salient facets of their design. We further highlight playful aspects and how maps work as ludonarrative devices. We believe that designers will benefit from our analysis, helping them to craft innovative games and entertaining cartographic experiences. Lastly, we further outline a new research agenda dedicated that domain.

Keywords: video game map, design, thematic analysis, cartography, navigation, aesthetics, usability, playfulness

1 Introduction

Maps are one of the earliest visualisations that emerged in human history to assist with navigation and exploration. Likewise, maps have long been associated with games as spatiality - like in the real-world - plays an important role in various games, with many of them being situated in geographical spaces. They are an essential element of many board games, or fantasy role-playing games such as *Dungeons & Dragons*. Subsequently, they were first introduced as external posters and then slowly started to appear on-screen in video games in simple diagrammatic forms. As games became more complex with their ever-increasing size and elaborateness, players also needed appropriate tools for navigating game worlds leading to a variety of 2D representations and subsequently 3D maps. As such, since their introduction to video games, the conception of game maps has greatly changed. As Toups Dugas et al. [1], Ahlqvist [2], and Arnott [3] have shown, the development and diversification of video game maps followed technological advances in games, cartographic development, and the inception of new game genres.

While maps have received widespread attention in many domains over the years, this has not been the case for video game maps. Although the interest in game maps has been growing steadily, publications dedicated to this subject are still few and far in-between. Research in this domain is quite heterogeneous, spanning across disciplines such as human-computer interaction, game studies, and cartography. Besides, articles are quite dissimilar in issues addressed, or in the sample of games studied. Thus, the various design parameters for successful game cartography are not always fully understood or shared.

Our goal is thus to synthesise new knowledge that complements existing literature to bring forth new insights that contribute to a deeper understanding of the intricacies of map design in this context. To find out why game maps matter, we carried out an investigation of game maps through a reflexive thematic analysis of specialised reviews, or posts dedicated to this subject. A game map has to be understood in this article, as a graphical representation of the game world or part of it. Game maps considered in our sample include both diegetic maps, i.e., those embedded in the game world, as well as those integrated in the heads-up display (HUD). Such an analysis provides a different perspective on game maps, emerging from the diverse understanding, viewpoints, and critical perspectives of post authors.

Through our analysis, we aim thus to discern key design facets and illustrate issues that arise from designing video game maps and interacting with them during gameplay. In doing so, our study provides new insights into fundamental aspects of game maps, ranging from cartography to information design. We discuss their potential for supporting an immersive gameplay, contrast the role of maps for stimulating aesthetics experiences, and elaborate on the negative impact generated by usability issues.

As such our investigation should benefit game developers and designers, those crafting new games, as well as cartographers interested in the production of game maps. Our findings could also be useful for the design of serious games in a variety of contexts (e.g., historical, cultural heritage, etc.), and other virtual worlds. It should also stimulate research in game studies, and more generally, into ludic cartography or gamified interaction design.

The reminder of this paper is structured as follows. After reviewing previous work on this topic in Section 2, we explain our thematic analysis process in Section 3. We then present our results along the identified themes and sub-themes in Section 4. This is followed by a discussion highlighting implications for future research in Section 5 before the paper is concluded in Section 6.

2 Background

In the following we discuss the different facets of game maps, starting with their fundamental design, then moving on to their interactive features as well as to how they support gameplay and player experience.

First, to understand the design of game maps, we need to consider their foundational aspects and how they are constructed. Thorn [4] outlined the basic visual variables and components entering into the composition of game maps (e.g., symbols,

location and shape, colour). A game map, through its base layer and content, gives players information about the game world. It illustrates the world geography, its cities, and landmarks, etc. Mukherjee [5] and Wängdahl [6], on the other hand, described how their design is grounded in cultural and cartographic conventions. Horbiński and Zagata [7] highlighted the importance of familiarising players with cartographic conventions used in games. As Bunting [8] stated, their representations are based on our understanding of reality, rules, and power structures. Thorn [4] highlighted an additional and specific aspect of game maps, i.e., ways in which their information can be hidden (and then revealed) to support gameplay.

Moving on toward interactive features, literature often differentiates between passive and active maps [4, 9, 10]. Gekker [9] outlined how such a choice affects gameplay: a passive world map can be used to challenge players, while an active map can make navigation easier. When looking at interactive map affordances, there are a finite number of ways that a user can manipulate them. Thorn [4] highlighted interaction primitives found in game maps (i.e., pan, re-symbolise, zoom, save, etc.). Then, Toups Dugas et al. [10] developed a catalogue of affordances that entail acts of cartographic transformations followed by different ways these are used in gameplay. Horbiński and Zagata [7] stressed that additional affordances need to be provided, such that maps become shareable in multiplayers games in order to accommodate players' strategies.

An important consideration in game map design is how they enable and support gameplay. The emergence of Role-Playing Games (RPG) in the 1980s gave a more prominent role to maps, henceforth massive multiplayer online and open world games [1]. Those would hardly be playable without them. Players use maps to explore, orientate themselves, and locate objects. As such maps are often seen primarily as a navigational aid for players [1, 3, 11]. However, their impact goes beyond navigation: Forest [11] showed how different types of maps can fashion players' experiences of game spaces.

Besides functional considerations, affective aspects of game maps and their impact on players' engagement also needs to be highlighted. Indeed, Mukherjee [12] considered maps as affective systems that influence players' experiences. Through his studies of the *Elder Scroll*s series, Friche [13] showed how game maps stimulate players' imagination and participate in their mental construction of the game universe. Fraser and Wilmottt [14] give an example of how playfulness can be created at the intersection of the 2D map representation and the 3D landscape by creating spatial puzzles that led to intriguing explorations across multiple game levels. As such the map design influences players' actions and emotions triggered during gameplay.

3 Method

3.1 Data Collection

To collect posts dedicated to cartographic game maps, we searched the Internet systematically using keywords like video games and equivalent (digital games,

computer games, or in-game) in combination with maps, and cartography (or cartographic). Using game, map, and cartography led to the most focused results.

A clarification of terminology is necessary at this point: within the game industry or game development, the term *game map* is often used as an equivalent to *game world* or *game environment*. We do not refer to that meaning but to video game cartographic maps, thereafter called game maps to shorten the nomenclature.

The search results were initially filtered to remove irrelevant posts. After further screening, we excluded very short posts, mostly comments, which were not detailed enough to be insightful. We did not keep any posts dedicated to comparisons of map sizes (such as posts on the biggest maps ever) as these were quite superficial. Besides size, no other aspects were generally discussed. We then read each selected post again more fully and ported it to an individual file. The search took place over six months in 2023. Once the search was stopped, all posts were screened again by two researchers to confirm their relevance and inclusion in the dataset.

Table 1. Posts included in the sample

Author	Title	Year	Ref.
Breault, Chris	Cartographic Survey: The Year in Video Game Maps	2014	[P1]
Cheever, Nathan	The Art of Game World Maps	2018	[P2]
CityMonitor	What does map design tell us about video games?	2016	[P3]
Ganker	The magic of video game cartography	2017	[P4]
GLHF	The joy of video game maps as a worldbuilding device	2022	[P5]
Hetfeld, Malindy	The brilliance of video game maps	2018	[P6]
Inderwildi, Andreas	What videogame maps can tell us about their worlds	2019	[P7]
Kowalsky, Katie and Thorn, Ross	Cartographers Play Video Games: A Review of the Map in Elden Ring	2022	[P8]
Kylie, Aaron	Inside the intricate world of video game cartography	2019	[P9]
Lipscombe	The miles we walk: How physical maps can guide the development of sprawling game worlds	2020	[P10]
Long, Zach	(Mini) Maps: How Cartography Makes Great RPGs Greater	2017	[P11]
McCarthy, Caty	20 Amazing In-Game Maps That Did More Than Show the Way Forward	2020	[P12]
MegaBearsFan	Open world maps as checklists instead of game spaces	2016	[P13]
Nerurkar, Martin	No More Wrong Turns	2009	[P14]
Pope, Zachari	Maps and GIS in Video Games	2018	[P15]
Schreier, Jason	Give Me More World Maps in My RPGs	2012	[P16]
Smith, Adam	Fantastic Cartography: Why Videogame Maps Matter	2024	[P17]
Stuart, Keith	The lost art of video game cartography	2010	[P18]
Sullivan, Lucas	What's in a game map? A lot, actually	2016	[P19]
Taylor	Video Game Maps: An Ode to Overworld Cartography	2010	[P20]

This resulted in a sample of 20 posts, all available in the public domain. We extracted the text from each post, ranging from 500 to 1,500 words, which served as the basis for the thematic analysis. The posts also included screenshots of some of the

maps discussed in the texts. The posts were written by enthusiastic and diverse game actors, ranging from journalists (*retronauts.com*), game writers (*kotaku.com, rockpapershotgun.com*) to academics and map designers (*stamen.com),* as well as expert gamers (*ganker.com*), etc. The posts were written between 2014 and 2022. Table 1 provides an overview of the posts in our sample. Their complete references can be found in the appendix.

The examples discussed in the posts span from early computer games to the most recent ones. In the posts, authors discussed diverse aspects of video game maps through specific examples situated in the context of their games. Additional references to games could be made to substantiate writers' arguments. Some maps were discussed by different authors**.** The two largest samples of maps stemmed from action-adventure games and RPGs.

3.1 Data Analysis

The dataset, i.e., posts, was analysed using a process of reflexive thematic analysis as this method provides a flexible and systematic way to identify patterns of shared meaning in qualitative data [15]. We approached our data within a constructivist paradigm, recognising the importance of both repeated occurrence of a theme alongside its meaningfulness from the standpoint of the post authors [16]. Such analysis is interpretive in nature and is produced through the active work of the researcher. Thus, others might come to different focal points and conclusions [17].

Guided by an inductive approach, the posts were coded following the guidelines from Braun and Clarke [18, 19], which include six comprehensive steps to describe, organise, and report patterns in the data. During this interpretation process, we focused on what the post authors said explicitly but also looked for implicit meanings. This approach helps to capture the full richness of the data, including nuances.

Thus, we first familiarised ourselves with the data by reading all posts and noting ideas and observations. To help organise and interpret the data, we then began to generate codes, bringing forth important features of the data. Codes were reviewed iteratively as new ones emerged, as well as deleted or regrouped as necessary. We then reviewed the data to make sure that emergent codes were applied consistently. In the next stage of this process, we looked for larger patterns across the dataset and grouped the codes into different categories based on perceived shared meaning. Thereafter, themes and sub-themes were generated based on these categories. The data was then systematically reviewed to ensure that each theme and sub-theme was identified and labelled correctly. Themes were finalised during the writing process. The final step consisted of writing the analysis, weaving together findings and data extracts. Considerable effort was made at each stage to ensure that the emerging analysis came from the available data. The researcher strived to stay open-minded and free of preconceived ideas. Furthermore, notes and memos were written and refined at every stage of the process to support the interpretation of the data and emerging patterns.

4   Results

Six main themes were identified through the thematic analysis of the posts with some having two sub-themes as summarised in Table 2. Below, these themes and sub-themes are introduced and accompanied by illustrative quotes from the posts (kept in their original formulation and spelling). Additionally, to make our findings clearer, we include examples of maps for each theme (i.e. map screenshots).

Table 2. Summary of themes and sub-themes.

Themes	Sub-themes
Cartographic Design Process	-
Navigation	Fast-Travel
	Exploration versus Task-based Navigation
Maps as Information Systems	Geo-cultural and Gameplay Information
	Map Information and Interpretation
Map Aesthetics	Design Aesthetics
	Stylistic Congruences
Dramatics and Ludonarrative Maps	Anticipation
	Maps as Ludonarrative Devices
Good Design and Map Usability	-

4.1   Theme 1: Cartographic Design Process

This theme focuses on the map design process or steps taken during the production of maps. Post authors highlight substantial aspects from their most basic elements to issues arising from the representation of fictional game spaces. As with any other map, game maps use a graphical language developed to fit and represent the game world through colour, graphical symbols, lines, etc. Their conception and composition influence how a map is perceived, its appeal, and ease of use. For instance, the map of *Red Dead Redemption 2* (see Fig. 1), with its typography and stylized icons, strives for simplicity to prevent cognitive overload and support gameplay.

> "*It's the font work that I really love about its map. Along rivers, the old timey font is italicized. Cities and towns get a strong bold. The icons are a simple black circle – never distracting too much from the slight detail. It all just fits the setting. For a world as hectic as Red Dead Redemption 2's, its map is resigned in comparison. But it needed to be that way, and that's what makes it a truly beautiful map*." [P12]

A map is a representation arising from a number of cartographic operations and choices. It is a reduced, selective, and symbolic representation of an environment, in our case of the game world. Specific design principles are used in their compositions such as contrast, visual hierarchy, and layers.

> *"A map will provide your brain with a different frame of reference, allowing you to see "more at once", which complements your cognitive map. Maps usually do this by increasing the contrast or hierarchy of importance within a space. Unimportant things get reduced or removed while everything important gets amplified".* [P5]

In addition, a number of games are inspired and conceived after real-world settings such as *Assassin's Creed Odyssey*. The game is seen as an imaginary historical reconstruction of southern Greece. In this game, designers strived for verisimilitude by selecting symbolic elements that players recognise immediately, like the contour of the Peloponnese. Some maps might not need perfect geographical accuracy. Semantic elements like recognisable landmarks might carry more weight for generating authenticity than others. It might be enough to trigger recognition while using players' imagination to fill gaps.

> *"[...] was to create a game world that had a recognizable footprint from a bird's-eye perspective, from the unmistakable hand-shape of the Peloponnese to the cove of Salamis to the peninsula of Attica to the trident of Macedonia."* [P9]

When creating such maps there is a tension between the need for authenticity and supporting gameplay. Thus, as in *Assassin's Creed Odyssey* (see Fig. 2)*,* specific manipulations and distortions of the fictional space represented on the maps might occur to better accommodate gameplay and enhance players' experiences. Different scales might be applied to account for both idle spaces and rural areas in which not much happens and dense gameplay zones like cities.

> *"Hall and his team [designers] made informed cartographic generalizations to strike a balance between realistic replication and the map's purpose, in this case to be "playable" in the game's context."* [P9]

Maps should also be plausible within the context of the game world, its look and feel. Otherwise, it may hinder make-believe and the players' immersion into the game. As such a good balance between cartographic representations and the map's role as a gameful object intended to support players' objectives needs to be found. Good design means giving the player a well-devised map but also one that feels right for the game's world, its lore, story, and characters.

> *"And to the point of immersing the player in the setting of the game, a medieval character isn't really going to have a mini-map guiding them like Master Chief has a radar to show enemies in the Halo franchise."* [P8]

Fig. 1. An excerpt from the map *of Red Dead Redemption 2* with the city of Saint Denis in the centre.
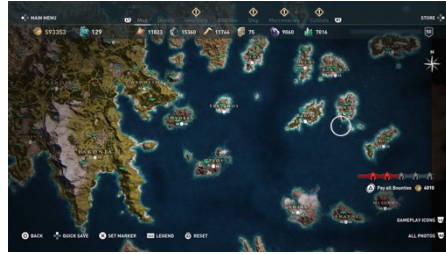

Fig. 2. The fictional map of *Assassin's Creed Odyssey* resembles the geography of Greece.

4.2   Theme 2: Navigation

Nearly all post authors commented on navigation, considering it the most important function of maps**.** This theme captures dimensions of traversing, travelling, and exploring the game space, as well as mechanisms that support this. Players can locate where they are, find out where they want to go, and plan their way to their destination. In some games, players rely heavily on navigation in order to progress. A player's experience would thus not be the same without maps*.*

> *"Some games provide a map exclusively for navigation, and I love these too. To get between towns and dungeons or from one level to the next your character appears on a zoomed-out map and then you zoom them off to where you want to go"* [P20]

World maps, defined as depictions of the entire playable game world, were most often associated with navigation. They help players in situating themselves and guiding them on their journey. Besides, mini-maps are another important tool for navigation (see Fig. 3 for an example). Small and permanently displayed in a corner of the player's screen**,** they provide a limited set of wayfinding information. Interestingly, post authors did not discuss their design but rather their value. On the positive side, it is easier for players to navigate with them. Moreover, players may become more aware and react faster to punctual events, as they can see their immediate surroundings.

> *"It may be a more traditional mini-map, in that it shows your immediate surroundings, but giving you the direct route allows you to get from point-a to point-b faster. In the world of Witcher this is important because dangerous, higher-than-you level monsters lurk around every corner."* [P11]

However, while some authors find mini-maps useful, others do not and argue strongly against their use. They can be detrimental to players' experiences. Some

authors find the focus and level of concentration they require overwhelming, distracting them from looking at and appreciating the game world. In some cases, alternative navigational tools should hence be considered.

> *"I can't help but think about is the huge sprawl of modern open-world games, the beauty and artistry, the carefully crafted views, the tangle of natural systems that create wildlife. All of that, and how little I notice it, because I am on a mission all the time, and I am an arrow on the tiny, unsatisfying mini-map, but the mini-map is entirely accurate and so I only really need the arrow and the map and the real world itself is an irrelevance for huge stretches and so I pretty much tune it out."* [P6]

Other navigational tools are added to work conjointly with maps such as a compass or radar. An example is given further below and in Fig. 4 in conjunction with *Miasmata*. A compass can occasionally replace a mini-map such as in *Skyrim*. Satellite navigation for cars in games like the *Grand Theft Auto* series*,* as well as phone-like maps, might be seen as variations of mini-maps albeit without their pervasiveness. Moreover, navigational cues can also be integrated into a game's environment. In general, navigational tools aim to facilitate and direct players' progression, keeping them on track, but imposing constraints on their movements and journey.

> *"Games have become much easier to complete, I guess, since we got mini-maps and waypoints. We all laughed when those glowing chevrons turned up in Perfect Dark Zero, but they were heralding an era of games where being lost was no longer allowed."* [P6]

Fig. 3. A close-up of the mini-map from *The Witcher 3*.

Fig. 4. The diegetic map of *Miasmata*. The two black lines relate to the triangulation feature.

Sub-Theme: Fast-Travel. It is a popular navigational mechanism enabling players to jump from one location to another, by selecting markers on a map. In a game like *Assassin's Creed*, it is designed to take players faster to points of interest. Nevertheless, there might be some constraints associated with fast-travel such as players needing to have access to a specific part of the map before they can use it.

> *"The maps of Assassin's Creed Unity, Shadow of Mordor, Far Cry 4, and Dragon Age: Inquisition are all cut from the same cloth. Each is filled in progressively as the player claims structures that double as Fast-travel points: AC's Viewpoints, Mordor's Forge Towers, Far Cry's Outposts and Radio Towers, and DA: I's camps. It's the template Ubisoft popularized."* [P1]

Fast-travel enables players to shortcut navigating across long stretches of landscapes. When part of the game world is sparsely populated or playable, fast-travel can be a good navigation solution. However, by regulating and directing traffic to specific locations, it can inhibit exploration.

> *"Do you even bother to continue to walk across the map once you've unlocked the ability to fast-travel to where you want to go? Probably not. The reason is that the space itself, the distances between locations, and their physical placement relative to one another, is not really important or worthwhile in its own right"* [P13]

Sub-Theme: Exploration versus Tasks-Based Navigation. Two main navigational strategies are contrasted in exploration versus tasks-based navigation: either the map helps to stimulate exploration or privileges goal-oriented missions. Indeed, its design and its affordances mandate how players experience navigation and the game world. Some games just demand to be visited and explored. Maps can be made to invite players to linger and look at them, thus helping to generate a sense of speculative inquiry toward the game world. Some maps aim to stimulate players' curiosity and foster exploratory behaviour. They can maximise freedom of play, in a sense that players own the world and get to know a region or a city in depth.

> *"A map, within a game, puts the viewer of the object in control. [...] The beauty of games is being able to discover. They place a power in the hands of the player who, through exploration, wandering or general movement slowly uncovers a sprawling metropolis to be constantly recalled."* [P10]

There were a few examples in which the topographic maps and navigational components were so entwined that they deliver a specific explorative play experience akin to orienteering. Like in physical space, players use detailed maps with a compass in games such as *Kholat*, *Firewatch,* or *Miasmata* to orient themselves in wild spaces and find their destination. To do so, all three games use a diegetic paper map, thought to increase immersion, which the player's character holds in its hand. Thus, they became more central and playful, maximising the connection between the map and territory through gameplay.

> *"In the 2012 title Miasmata the protagonist must also hold a map and compass in front of him to find the way. It's less of a looker than Firewatch's map, but the way you interact with it is far more interesting.*

To fight the horror vacuum and fill in the blanks, you need to triangulate your position by finding two known landmarks (e.g., a statue whose location is already marked on the map) in the distance. It's tricky business that demands spatial awareness like few other games, but the pay-off is a uniquely intimate player-map relationship." [P4]

Other games, in contrast, are very goal-oriented, requiring players to move from one objective to the next. In such a case, navigation is a carefully orchestrated and driven operation: travel is not an asset, and getting lost is hindered. Mechanisms utilised to support exploration have shifted to those enabling treasure hunts and gathering collectables.

"The whole concept of exploration has changed; we no longer need to explore to progress, we explore to find power-ups and hidden extras, and in this overtly stage-managed form of freedom, cartography isn't really necessary. The pictorial map has been replaced by the didactic walkthrough." [P18]

4.3 Theme 3: Maps as Information Systems

This theme explores the different kinds of information that are integrated into a map to increase the player's knowledge of the game world. Maps provide an alternative representation of the world. They help to situate the game in the mind of players as they get a window or an open vista on its size, features, and landscape.

"And where would we be without video game maps? Maps in games have long been our guide; our peek at a world much larger than our current, limited viewpoint. They illuminate the biomes of the planet; the mountains and landmarks that seem insurmountable". [P12]

Sub-Theme: From Geo-cultural to Gameplay Information. Game map information relates primarily to the geography and culture of the game world, but also to gameplay markers and events embedded in it. In large open world maps, players can see the many different types of geographic terrains, including oceans, mountains, deserts, lakes, and rivers that will serve as their playing field. In addition to geographical facts, maps supply chronological and cultural information about the game world through their architectural style and design. Players also acquire knowledge about society, religion, or mythology through iconic representations such as dragons, heraldic shields, or gods embedded on them. Thus, they are offered hints and cues on how a particular world functions.

"Some maps present a conceptual view of the world, for example, according to medieval Christianity. The Vvardenfell map [shown in Fig. 5] doesn't merely show routes and topography either, but also various architectural styles of cities and fortifications: hinting at its various factions, cultures, and their seats of power." [P4]

Maps show specific information about the game state such as collectables and treasures. In a way, maps and their symbols can all be interpreted in terms of gameplay. They can be read as a semiotic system, not of places or geographical objects, but of gameplay entities and actions to be performed to progress and succeed.

> *"A world map, more than anything, is a collection of symbols. Symbols for castles that expand once you enter them. Symbols for mountains that block your progress. Symbols for your character. Symbols for the passage of time. Symbols for the distance you travel."* [P16]

The types and numbers of gameplay events included in them will depend on the kind of map, the game's genre, and their complexity. In Real Time Strategy or First-Person Shooter (FPS) games, they often show the enemies' positions, military units, or other strategic key information that is important for gameplay.

> *"To that end, it often also contains other information on the game state such as the position and state of units or objects in the spaces. This makes maps very helpful for games in which the spaces are sprawling and complex and/or where there's a lot of different information to manage."* [P14]

Many games also give players the pivotal ability to add information to a map in simple ways such as via adding icons or markers. In some games like *Ultima Underworld: The Stygian Abyss* or *The Legend of Zelda: Phantom Hourglass,* players can also make annotations. It helps them to make strategic decisions as they can see what they have explored and found so far. In some cases, the map itself can be customised, and in a few cases, even be made by players themselves.

> *"There have been a few titles that have attempted to engage us in map-making again – the DS RPG Etrian Odyssey requires you to draw your own map on the touch screen [see Fig. 6], while Legend of Zelda: Phantom Hourglass lets you customise and add notes to the pre-designed map display. But these are rare novelties."* [P18]

Fig. 5. *Elder Scrolls Online* uses different icons on the map to indicate different structures and points of interest.
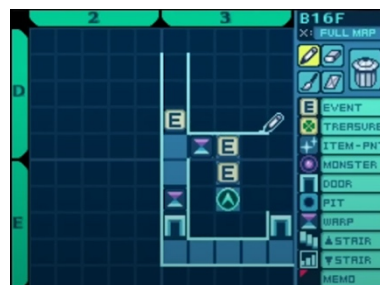
Fig. 6. *Etrian Odyssey* requires players to draw their own maps. Currently, a wall is being placed (pen icon).

Sub-Theme: Map Information and Interpretation. Players' reading of the information conveyed through maps is at the centre of this sub-theme. Maps are not neutral; they shape and sustain players' understanding of the fictional space. Despite being "fictional", they are familiar objects that players interpret based on their appraisal of reality and knowledge of cartographic conventions, further refined and consolidated through their gameplay experience:

> *"When we see an empty spot on such maps, we tend to assume that nothing of interest awaits."* [P6]

Players learn to decode game maps and make inferences from their information. Events and items that are unusually represented on them then become highly significant like a specific icon for the Devastating-Near-Impossible-To-Beat-Weapon. Some features, like steep topography that are difficult to explore, become an object of interest as they are associated with yielding better resources or treasures.

> *"Topographic maps in video games are often based on reward systems like treasure hunts or resource management, with areas that are difficult to navigate due to their steep topography yielding better resources or treasures."* [P15]

4.4 Theme 4: Map Aesthetics

This theme refers to the aesthetic quality of game maps, what makes them stand out, and the effect they have on players. Aesthetics emerged as an important aspect of game maps, which can make them unique. They produce a strong impression on players: they are stunning or intriguing, and are remembered. In its simple form, an aesthetic map demonstrates great beauty. Post authors simply highlight their quality with statements referring to the totally gorgeous map of *World of Warcraft,* or the truly beautiful one of *Red Dead Redemption 2*.

> *"There has always been a beauty to the video game map. Sometimes maps have stunning art, other times how they're implemented into the game itself is neat on its own. Video game maps are easy to remember, and hard to forget. At least the good ones are."* [P12]

Sub-Theme: Design Aesthetics. Design elements and techniques that define aesthetics maps are highlighted in this sub-theme. Maps lauded for their aesthetics included those of *The Witcher 3, The Legend of Zelda: Breath of the Wild, Tyranny,* and *Elden Ring.* The world map of *Tyranny* catches the eyes of players through its visual playfulness and noticeable imagery taken from mythologies. In *Breath of the Wild,* the stylistic choices and design principles used in the map contribute to fashion it in a remarkable way (see Fig. 7). Its visual hierarchy is used to draw players' attention and to highlight important elements of the game.

Fig. 7. The map of *The Legend of Zelda: Breath of the Wild* heavily uses contour lines and visual elements to attract user's attention.

Fig. 8. An excerpt of the Sevastopol space station map from *Alien Isolation*. The restrained appearance fits the science fiction setting.

> *"Breath of the Wild delivers a map that rejects aesthetic flourish in favour of simple elegance — it is uncommonly sparse and reluctant to provide much information about what lies hidden in its world. While its topography is presented in impressive detail, with contour lines and shading indicating elevation, it is careful not to compete with the visual splendour of the world it represents. Its spatial hierarchy, too, is noteworthy, with Castle Hyrule visually dominating the map, centred and slightly elevated [...] like Jerusalem in many medieval maps, these seats of power claim the navels of their worlds."* [P4]

Although aesthetics is most often discussed in conjunction with world maps this is not always the case, as with the example of a floor plan from *Alien Isolation* (depicted in Fig. 8). It shows part of the schematics of the Sevastopol space station infrastructure. The style shapes its appeal: the blueprint, colour, its typography, etc.

> *"Here is an example of a lovely floor plan type of map. I like it because it strikes a good balance between details, simplicity and plausibility [...] Industrial aesthetics front and centre, this map goes for a blueprint-like style with its grid, how notations are incorporated and the very minimal use of colour. In keeping with the very lived-in look of the environment, the map screen is also a bit glitchy."* [P5]

The aesthetics of game maps go beyond traditional static aspects to encompass interactive features. Aesthetic interactions stimulate a deeper connection between the players and maps, sustaining immersion. *Firewatch*, for instance, has been acclaimed for the quality of its map design, its materiality and texture of the paper, its slight wear-and-tear, and the way it bends when the player's character moves while holding it. Multimodal interaction contributes to the aesthetics of the diegetic maps of *Alien Isolation* with their multi-sensory aspects being well encompassed by the following quote:

"I have no doubt that it's one of the most tactile digital maps ever made. Just listen to the snap and whirr of unseen reels as you zoom—not in one continuous motion, but shuddering between two fixed positions. Listen to the plonk of the new button used to switch floors. For once, the map isn't just in your head. Ripley collects it personally, pulling new layouts from glowing terminals around the station." [P1]

Sub-Theme: Stylistic Congruences. In this sub-theme, stylistic congruences – a specific aspect of map aesthetics – stemming from the correspondences between a map and the game world, is addressed. A map should fit the overall tone of the game. Common aspects such as colour or typography can be aligned. However, as with *The Witcher 3: Wild Hunt*, the map is refined in a way to make it stand out:

"The subtle use of color to depict forests, and houses, and castles is perfectly balanced to match the world. It feels like you're sitting down and looking at a hand-drawn depiction as Geralt of Rivia. Every detail in the map makes you want to wander around and see every monster that lurks in the shadows, or under the trees, or in the lakes." [P11]

The stylistic congruence between the map and the game does not rely uniquely on its visual characteristics. It can be driven by different aspects such as the kind of map used. The floor plans of the Willamette Parkview Mall from *Dead Rising* are on par with the game setting, benefiting the game's plot. Correspondences between both are, however, not always direct and their relation can be metaphorical. In *Planetscape: Torment* the world map looks like a skin crudely stitched together, where places are represented as tattoos reflecting the game's strange cosmologies.

"My favourite kind of map also heightens immersion. This can mean a lot of different things depending on what the intended outcome is. For example, you could play a game that takes place in a mall. Of course, it would be very fitting to have a map that is styled after what the majority of players would expect from a mall plan." [P5]

4.5 Theme 5: Dramatics and Ludonarrative Maps

This theme illustrates how maps function as stories, serve storytelling, and support game mechanics. Maps are at the heart of world-building, they are a fantastic means to enrich the game world. They show places to tell stories. Indeed, they can also be seen as unfolding stories – moments captured in time and space – that reflect players' actions:

"What's cool in gaming is that you can commit changes to the map by just playing the game." [P8]

Sub-Theme: Anticipation. Anticipation refers to how maps work as dramatic devices to make a game more attractive and engaging. They function as a stage to direct players' journeys; they are the starting point from which players begin to flesh out the game world. If designed in such a way, they impart affective and cognitive cues, drawing players to specific places, "*I want to go there*", then driving expectations until fulfilment, as players reach their goals.

> *"It may not seem overly groundbreaking but even the 'overworld' map of Super Mario Bros 3 was meticulously designed to envelope the player into the universe, often acting as a precursor to what the player could expect from the levels."* [P10]

Overall, emotional attachment to the game can be stimulated through maps. They can captivate players and arouse emotions such as wonder, curiosity, and excitement. They are used as powerful tools for holding players' attention: they involve the mystery of the unknown, build a sense of anticipation, or foreshadow experiences to come. As such maps will influence players' gameplay decisions, even whether to play a game or not.

> *"In my mind, the best games are about understanding your objectives and achieving them through some degree of satisfying effort – and a map's design can help you determine not only the path you'll take, but if you even deem it worth taking at all."* [P19]

Sub-Theme: Maps as Ludonarrative Devices. This sub-theme describes maps' ability to work at the intersection of ludic and narrative elements to advance a game's plot. They might serve as canvases on which part of a story takes place. In *Firewatch*, for example, notes that appear on the maps are driven by players' decisions. A map (or a part) can be hidden, transformed, and altered in creative ways to suit the game's narrative, thus playing an essential role as a ludonarrative device. As in *Thief: The Dark Project,* it can stimulate players' curiosity, enhance playfulness, and facilitate exploration (cf. Figure 9). A stronger interplay between the game and its map can be created when the latter needs to be updated and completed.

> *"In Thief: The Dark Project, for example, master thief Garrett unsurprisingly doesn't have access to the floor plans of the mansions he's planning on burglarising and has to make do with sketches full of gaps and guesswork. Not only does this make your thieving expeditions unpredictable and keeps you on your toes, but it also tells us something about Garrett's illicit handiwork – its thrills and pitfalls – as well as the ways of the criminal underworld he inhabits."* [P7]

Games might also offer maps as a kind of game puzzle: the players have to find them first. In *Elden Ring*, discovering hidden map fragments throughout the game world stimulates emotional immersion. In *Silent Hill 2,* the dialogical approach constructed between the map and the player's character James Sunderland sustains the

game's plot. It serves as a dramatic device complementing the uncertainty and ambiguity of the situation and character.

> *"James doesn't automatically have a map of each area; he has to find it. In an apartment building it might be stuck to the wall in the lobby, as may be the case in the real world. The problem is, that map shows the place as it should be, not as it is now that reality has shifted. It doesn't reflect the space as you experience it. So, when a door suddenly ceases to be a door, James scribbles it out on the map [depicted in Fig. 10]. [...] It's brilliant because it takes a tool that's primarily there to assist the player and makes it part of the psychological narrative."* [P17]
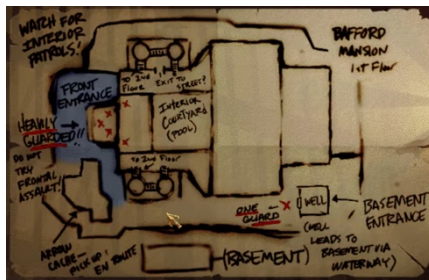

Fig. 9. A map from *Thief: The Dark Project* which is purposefully incomplete to match the setting the of the game.
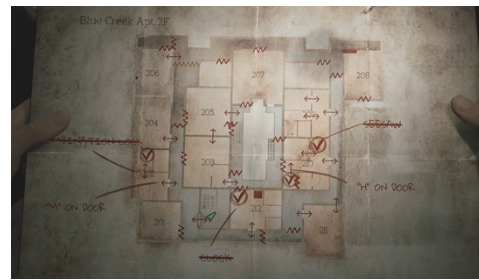
Fig. 10. A map from the *Silent Hill 2* remake, with scribblings added to the map as the game progresses.

4.6 Theme 6: Good Design and Map Usability

This theme relates to an essential attribute of map systems: usability and the negative impact they can have on players' experiences. Despite being an ode to game maps, quite a few post authors argued quite emphatically how badly designed they and their interfaces can be. A map with a poor layout, as in *Dragon Age 2* (*DA2*, see Fig. 11), can disorient players, impede navigation, and introduce a high cognitive.

> *"I remember the first time I opened the map up in DA2 and was instantly lost. It took me forever to figure out where I was going. After several hours, I finally got used to it, but man was it awful."* [P11]

Another notable issue is connected to decreased readability stemming from cluttered and overcrowded maps. Besides information overload, they have other shortcomings. For example, issues pertaining to individual elements such as text, lines, frames, and colours. Moreover, as maps in games are very often interactive, other usability issues arise when using features such as zooming, filtering, or panning. However, this is not always the case as in this example of *Assassin Creed Unity* (also see Figure 12):

"Synchronizing a new map section reveals a mass of hexagons with magnifying glasses or scrolls or shields inside, GPS flags, medals inside transparent circles, staircases, orange hexagons containing various symbols, fast-forward icons, chests in four different colors, houses colored red or black, and hexagons with houses inside them. It looks like the record of a war between mathematicians and realtors. And it barely even works." [P1]

While 2D maps are probably prevalent, 3D maps are sometimes integrated into a game as well as they offer a more accurate and realistic representation of a game's objects and space. However, they seem to have their share of usability problems, as players can have difficulties with interpreting or figuring them out. For example, concerning *Metroid Prime 3: Corruption*:

"A negative point of note about this map, though, is that it is in 3D, which makes it a bit hard to use. It's still quite good compared to other attempts at 3D mapping though. For example, the map in Splinter Cell: Chaos Theory is in 3D, and it's anything but easy to use. Using 3D makes it much harder to quickly understand the complex space – which partially defeats the purpose of the thing in the first place." [P14]

Navigational markers used in-game in combination with maps, for example, to compensate for design issues or to simplify players' navigation can also lead to usability issues. For instance, the jarring effect of the golden arrow contradicts the carefully crafted world of *BioShock*, breaking the fourth wall and annoying players, thus affecting emotional immersion.

"BioShock! You're under the sea in a fascinating failed experiment of a city where monsters roam and secrets lurk. Do be a dear and follow the golden arrow at the top of the screen? Nobody was laughing then, but that golden arrow ruins BioShock, and I don't know whether they should be ashamed for sticking it in there or whether we should be ashamed for needing it." [P6]
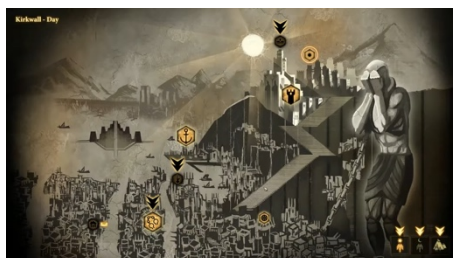

Fig. 11. The map of *Dragon Age 2* is rather high-level and abstract.

Fig. 12. The map of *Assassin's Creed Unity* can become cluttered with icons.

5 Discussion

In our analysis we examined specialised reviews and posts focused on game maps. In doing so, this study delivers insights into the different facets of map design and impacts on player experiences. In the following, we first examine issues linked to the basemap layer and then discuss two complementary values identified in the themes: aesthetics and usability. We then move on to gameplay, looking at navigation, before focusing on their utilisation as ludonarrative mechanisms and matters of immersion. Lastly, we present avenues for future research and review limitations of our study.

5. 1 Fundamentals of Map Design

Game maps shape, inform, and sustain players' understanding of the game world. Next, we first look at how they were conceptualised: from their visual variables to cartographic principles entering their compositions to rhetorical operations facilitating gameplay and making them compelling. They are steered based on a player's comprehension of cartographical conventions and refined by players' mastery of game maps.

Several games are inspired and conceived after real-world settings, ranging from the whole game world to cities. A fundamental question thus concerns the relationship between the map, the game, and the real-world object. The verisimilitude of the map was an important element in case of *Assassin's Creed Odyssey*. World war FPS games are also closely grounded in real-world representations, recreating real locations as their playing field, and using authentic maps of major battles. We should therefore further explore authenticity in this domain, important distinctions might come about between those that need factual accuracy and those requiring experiential authenticity based on psycho-cultural dimensions of our experiences [20]. For Mukherjee [12], hand-drawn and discoloured maps from *Dragon Age* – analogous to medieval ones – have an element of historical authenticity, but only in so far in how they match players' ideas of how they should look like.

On the contrary, using a mini-map in the context of a medieval game would infringe negatively on plausibility. Indeed, external plausibility relating to players' real-world knowledge is another important facet of game maps [21]. There are rules in which geographic terrains evolved and can occur. For example, *Final Fantasy II* and its map were constructed in an impossible geologically way, thus its design is conflicting with external plausibility. Although not discussed in the post reviews, fans of *Dungeons & Dragons* have created extensive guides for making believable maps, ranging from how rivers and tributaries should flow to the creation of mountain chains [22]. Such guidelines could be adapted successfully to video game maps.

Lastly, we should look further at the rhetoric of cartography and its implications for game maps. As Bunting [8] explained, fundamental cartographic conventions used in their production are far from universal (e.g., Mercator projections). Thus, national and cultural norms underlying a map representation could have some impact on its reception and players' experiences.

Information design is another crucial aspect. Maps are most fundamentally information systems, and might be considered as the oldest forms of information

architecture. As Thorn [4], we found that through world maps players gain important insights about the game world, its size, geography, and culture. They also yield emotional information on which players base their decisions on such as where to begin a quest, which places to go to, or which to avoid. Besides fundamental gameplay items, additional layers of information can be contemplated. Map-based visualisations of gameplay are frequently employed in game analytics [23]. However, as far as our knowledge is concerned, the application of such techniques within in-game maps has not been investigated although they could have varying use cases. For example, to avoid disorientation and stimulate exploration, player paths could be plotted on world maps. In FPS games, heat maps could give players indications of where enemies congregate or highlight gang activity on city maps in games such as those of the *Yakuza* series. Thus, map-based in-game visualisations open up another avenue for research.

5.2 Valuing Map Design

A critical aspect of maps is the importance of good design, such that players can understand the information represented and, in turn, make the best gameplay decisions they can. Game maps should be easy to use and efficient, facilitate navigation, and accommodate players' needs. However, our analysis has shown how badly conceived some maps and their interfaces can be. Based on these findings, it is believed that usability is a major issue.

Usability issues pertained to the user interface, content, and representation. One set of issues related to the readability of map elements themselves, others to their symbols and meaning making. The density and granularity of information represented on maps can be quite problematic at times. For instance, Horbiński and Zagata [24] who, studying *Valheim* map symbols, showed how colour combinations affected their usability: symbols could not always be recognised. In addition, Skarlatidou et al. [25] showed that different map colour schemes applied to identical geographical data led to different ratings of its trustworthiness and likeability.

Last, seamless interactions with the map, including zooming and panning, as well as toggling elements led to difficulties. As mentioned earlier, 3D representations seem to generate another set of issues. The 3D holographic map from *Dead Space* was notoriously difficult to use, so much so that a locator feature was implemented to support navigation. Later, it was completely redone in 2D. Indeed, they are not always considered as beneficial due to the increased complexity of navigation, difficulty of understanding relationships between entities, as well as problems with depth perception and occlusions [26]. Thus, looking further at this issue would seem justified. More generally, investigations into the usability or playability of game maps are desperately needed but appear to be sorely lacking.

Aesthetics play a key role in map design, being an important component of its effectiveness and generating a strong feeling of appreciation. As seen, aesthetic maps cannot only contribute to pleasurable feelings, but can also provoke stronger emotions as they are stunning or exciting. Consequently, studying their aesthetics can show important attributes that contribute to their composition. For example, colour is a rich source of emotions. It is one of the key ways in which cartographers generate

aesthetic reactions. Its meaning is infused with great symbolic power. Anderson [27] showed that affective incongruence in colour, like using bright cheery colours for a horror game map, confused map viewers. Besides colour, imagery is used to make maps more appealing [28]. Maps such as those of *World of Warcraft* (Northend) or *The Witcher 3* (Northern Realms) include strong and beautiful representations of gods and evils, dragons, or monsters. Designers are not limited to static aspects of maps, thus producing aesthetic interactions could become one of their interesting aspects. It could drive players to explore a map system in a more dynamic, inquisitive, and pleasurable manner. Besides finding examples of good practices, analysing their aesthetics could lead to the formulation of guidelines applicable to this context.

A game map that is stunning leads to aesthetic contemplation, thus while remaining in players' attention it changes their experiences [29]. As seen, aesthetics maps can influence players' relation to the game world. Playful emotions arise through the connection between map, play, and game space. As Mukherjee [12] pointed out, the aesthetic experience of one changes over the time, not only because the map itself changes, but because it is influenced by feelings that players experience through gameplay. Thus, maps' aesthetic experiences are fluid and dynamic processes which should be taken in consideration while assessing players' responses.

5.3 Map and Gameplay

Maps are purposely planned to support players and drive their gameplay experiences. Besides their design, we discussed certain aspects of player experience. Here, we discuss two specific aspects of gameplay, maps' roles in navigation and sustaining ludonarratives.

First, navigation unsurprisingly became an important theme in our analysis. Results of this study are consistent with previous research discussed in Section 2. Maps and their affordances fostering specific navigational strategies have a strong impact on gameplay. In particular, world maps oscillate between those that enable freedom of play, exploration, and serendipitous encounters, with those that are orchestrated as reward systems to maximize immediate gratification.

Fast-travel seems a prime navigational mechanism, which conception and implementation greatly affects players' experiences. Differences relate to the number of fast-travel markers embedded into the maps and how they are accessed. As Forest [11] demonstrated, fast-travel enhanced navigation by preventing players getting lost but disrupted the acquisition of spatial knowledge. This, in turn, inhibited exploration and wanderings. Fast-travel reduces the ability to apprehend and imagine the game world, distancing players from it. As seen, mini-maps also impact players experience and enjoyment of the game world. Beyond studying the quality or efficiency of navigational systems on a whole (or the best combination of components to use), future work should also look at the resulting journeys and gameplay experiences they produce.

Maps are an important narrative tool, they capture and tell stories through drawing attention to locations and events. In fact, they can tell many kinds of stories: reveal, compare and contrast places, or show journeys. In *The Elder Scrolls III,* hundreds of books can be picked up to enhance game lore or deliver side quests. For instance, the

Pilgrim's Path book details a pilgrimage to holy sites that players can read and re-enact [30]. Travellers' tales are a common storytelling subgenre from which story quests can be generated. Just as treasure maps render hints and false trails, maps can enter in or support a myriad of stories.

As Roth [31] argued, visual stories stimulate empathy. Striking examples of maps acting as visual stories are found in older games such as the one of the kingdom of Erathia in *Heroes of Might and Magic.* World maps provide affective cues that drive expectations, players anticipate their experiences and visualise themselves into the world. As games unfold, they help to contextualise players' wanderings.

Maps can turn into powerful ludonarrative devices that evolve over time. In examples like *Thief: The Dark Project* and *Silent Hill 2*, designers played creatively with map elements and structure. They were altered, distorted, or erased in such ways that the map stimulated playful interaction and took on a dramatic value befitting the psychological ludonarrative at the heart of the game. In other cases, cartographic puzzles for hiding treasures and producing devilish parkour sequences are built by playing with the map and the spatial representation of the game space. Their design entails a ludic cartography, demanding complex exploration and negotiation of 3D spaces across multiple game levels [14].

5.4 Immersion

Immersion was introduced in our thematic analysis in relation with specific examples. Immersion is a key aspect of games defined as drawing players into the game world but has also been equated or associated with flow [32], spatial presence [33], and involvement [34]. Thus, we further look at immersion in relation to our analysis. We believe that the different facets of maps identified in the themes can enhance but also negatively impact immersion. First, an important distinction has to be made between creating immersive maps and how they support in-game immersion.

Maps generating aesthetic contemplation increase absorption, fostering in-game immersion through anticipation and affects. In accordance with Thorn [4], we believe that the stylistic congruence between the map and game supports immersion. The stronger the relation between them, the more immersive it will become.

Using maps as ludonarrative devices can foster emotional or imaginative immersion, strengthening the relation between them and games. In *Assassin's Creed Odyssey*, its map supports players' immersion in the ancient Greek civilisations, but also in the culture or lore of the game [35]. Diegetic maps such as in *Firewatch* increase immersion as players do not need to leave the game [36]. Besides, the strong mimetic way the player's character is using it for orienteering while walking in the wood also contributes to upholding immersion.

Rich aspects of maps including their representation, interaction, and gamefulness nurture immersive experiences, showing how integral to immersion they can be. Thus, in-depth studies of immersive maps and how they support in-game immersion seem warranted. More generally, in video games, usability issues have been shown to be a hindrance to immersion [37]. Thus, we should ensure that they are usable and follow good design principles.

5.5 Considerations for Future Research: From Map Design to Players Evaluations

To further our understanding of game maps, we should take into account their multiplicity, diversity, and richness. The majority of maps discussed by the post authors, as within the academic literature, are world maps (or part of one). These are sometimes contrasted with mini-maps. Nevertheless, they are hardly the only ones found in video games. We presented an example of blueprints from *Alien Isolation,* but quite a few more were discussed such as street and city maps, e.g., from *Grand Theft Auto: San Andreas.* We argue that there are fundamental differences between map categories that affect gameplay because they are based on different cartographic conventions, information designs, and interactions. World maps are grounded in geography, while those of cities relate to urban planning, and building maps to architectural design. Thus, we should investigate the distinctive factors and mechanisms that separate each kind including affordances characterised by Thorn [4] and Toups Dugas et al. [10]. Dimopoulos [38] discussed and illustrated many game cities, but their map systems were not considered in depth. Building on his work, we might want to develop a case study of city maps.

We have already presented several issues that can be further examined. For example, authenticity is often raised in relation to video games, especially in the context of historical games, but seldom taken into account in connection to game maps. We have discussed broadening the scope of map information by integrating different types of visualisations of players' data. With the advent of GPS-like functionalities, new forms of cartographic representations have been integrated into video games. For instance, *Terragenesis* uses digital model representations for simulating rainfall and increasing sea levels to show how landscapes of planets can change in relation to weather conditions [39]. Increasingly sophisticated game maps might work like Geographic Information Systems, enabling different types of gameplay strategies and allowing new games to arise. Furthermore, it can be expected that new types of maps will continue to emerge. We may find augmented maps in strategic war games, or orthomosaic ones to make their way into the next *Call of Duty*.

We should also briefly look at creativity in connection to game maps. Imaginative uses as ludonarrative devices could lead to innovative games. Map-based visual stories and map-driven quests can be generated and integrated into games. Map-making is embedded in *Etrian Odyssey*. As *Firewatch*, *Mu Cartographer,* or *Map Map – A Game About Maps*, cartography can be deeply rooted in digital games. Thus, map-making and new mechanics could lead to original cartographic games and new forms of ludic cartography.

Moreover, usability is essential for enjoyable players' experiences. Thus, there is scope to develop different lines of inquiries that range from devising usability studies to creating tools for facilitating their appraisal. Issues mentioned in connection to world maps in our study are similar to those found by Abraham [40] who investigated geoinformation apps. Thus, we could turn to cartography and interactive maps and, for example, adapt heuristics developed by Marquez et al. [41] to this context.

In view of the value of aesthetics, evaluating players' responses seem a prerequisite. Aesthetic emotions could be assessed using general emotion scales [42].

It would enable the differentiation between representations of the same map, or of different styles. Otherwise, tools for evaluating the aesthetic pleasure (or beauty) of visual representation might be suitable to our context [43]. More generally, we could also consider assessing different aspects of emotional experiences.

It would be interesting to investigate how the aesthetics of maps would affect matters of immersion such as sensory, imaginative, or challenge-based immersion [44]. Further studies on immersion, could complement and refine existing knowledge to show, for example, if all diegetic maps are equally immersive or if different degrees of "immersiveness" can be found, and if so, on which elements.

Thus, we can devise an innovative research agenda articulated around two major threads: investigating map design issues and carrying out player studies. However, while the research directions outlined in this paper are at the heart of such an agenda, there are still many issues yet unexplored.

5.6 Limitations

Our thematic analysis revealed important insights pertaining to different facets of game maps. Moreover, it shows the potential of maps to generate innovative games and let us contribute to novel research directions. However, we need to acknowledge certain limitations of our study. First, one limitation is connected to the purposive sample studied, as it related to the interests and perspectives taken by the various post authors. Moreover, the game maps discussed by the different post authors are partly dependent on the year in which they were written. Second, cultural differences could have had an impact on the findings as very few games in our dataset originated from Asia (e.g., Japan). However, it is known that, for instance, cross-cultural variations affect wayfinding [45] and aesthetics preferences [46] which, in turn, could impact a map's value. Szigeti-Pap et al. [47] have shown the existence of cultural differences in map reading and interpretation that might affect players' experiences. Thus, the inclusion of a greater sample of Asian games might have led to the identification of a different set of issues.

There was also a practical limitation stemming from the post format. Authors discussed map examples in their posts, choosing one map in relation to one game. Nonetheless, many games have more than one. Open worlds require a dynamic and wide information range with multiple levels of spatial information and content. Thus, a range of maps can be found in large and complex games with different orientations, levels of detail, or schemata (i.e., from world maps to blueprints). To give an example: In *Assassin's Creed Valhalla*, the gameplay is situated in large disconnected geographical areas as well as mythical regions, resulting in a multiplicity of maps. Forest [11] showed differences with respect to the navigational affordances provided by maps of exterior and interior spaces in *Fallout 3*.

Thus, we might want to look more closely at map systems, as well as at the correspondences, constraints, and interdependencies between maps in a game and how they impact players' experiences.

6. Conclusions

This qualitative study offered deeper insights into fundamental aspects of video game maps, ranging from cartography to information design, and from aesthetics to immersion. We showed that video game maps and their conceptions do matter. This study reinforces the usefulness of maps as a navigational tool, for wayfinding, and for facilitating exploration. However, maps also tell and capture stories, create anticipation, and engage players' curiosity. They become imaginative ludonarrative devices. In addition, aesthetics and usability were introduced as salient aspects of game maps.

   Besides, we identified gaps in game map research, for example, in relation to usability. Undertaking usability studies is seen as essential for ensuring smooth and gratifying player experiences. More generally, the development of tools, heuristics, and guidelines for conducting player evaluations would greatly enhance game maps. This study contributes to their design to enable fulfilling players' experiences. We further proposed an innovative research agenda structured around two major threads: map design and player studies. There is also scope for devising experimental game map designs (including the creation of novel mapping systems), as well as exploring inventive ludonarrative devices and new cartographic games. Such research would strengthen the conceptual understanding of game maps and support designers. Ultimately, such research would contribute to improving game design.

CRediT author statement
Claire Dormann: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft. **Günter Wallner:** Writing- Reviewing and Editing

References

1. Toups Dugas, P.O., LaLone, N., Spiel, K., Hamilton, B.: Paper to pixels: A chronicle of map interfaces in games. In: Proceedings of the 2020 ACM Designing Interactive Systems Conference. pp. 1433—-1451. DIS '20, Association for Computing Machinery, New York, NY, USA (2020). https://doi.org/10.1145/3357236.3395502
2. Ahlqvist, O.: Converging themes in cartography and computer games. Cartography and Geographic Information Science 38(3), 278–285 (2011). https://doi.org/10.1559/15230406382278
3. Arnott, L.: Mapping Metroid: Narrative, space, and other m. Games and Culture 12(1), 3–27 (2017). https://doi.org/10.1177/1555412015580016
4. Thorn, R.: How to play with maps. In: Abstracts of the International Cartography Association – 29th International Cartographic Conference (2019). https://doi.org/10.5194/ica-abs-1-365-2019
5. Mukherjee, S.: The cartography of virtual empires: Video game maps, paratexts, and colonialism. In: Beil, B., Freyermuth, G.S., Schmidt, H.C. (eds.) Paratextualizing Games, pp. 75–95. transcript Verlag (2021). https://doi.org/10.14361/9783839454213

6. Wängdahl, L.: The worldliness of the Dragon Age: Origins game world. In: Meaningful Play 2012 Conference Proceedings (2012)

7. Horbiński, T., Zagata, K.: View of cartography in video games: Literature review and examples of specific solutions. KN - Journal of Cartography and Geographic Information 72, 117–128 (2022). https://doi.org/10.1007/s42489-022-00104-8

8. Bunting, B.S.J.: Languages of power, languages of protest: Exploring the rhetorics of game maps. Games and Culture p. 15554120241237303 (2024). https://doi.org/10.1177/15554120241237303

9. Gekker, A.: (Mini) Mapping the Game-Space: A Taxonomy of Control, pp. 134–155. Institute of Network Cultures, Amsterdam, Netherlands (2010)

10. Toups Dugas, P.O., Lalone, N., Alharthi, S.A., Sharma, H.N., Webb, A.M.: Making maps available for play: Analyzing the design of game cartography interfaces. ACM Trans. Comput.-Hum. Interact. 26(5) (2019). https://doi.org/10.1145/3336144

11. Forest, A.: Which way from here? The spatiality of maps & navigation in first-person single-player video games. Master's thesis, Queensland University of Technology (2011), https://eprints.qut.edu.au/47014/

12. Mukherjee, S.: 'here be dragons': Aesthesis, affect and ethics in videogame cartography. In: 13th International Philosophy of Computer Games Conference (2019)

13. Friche, L.: Analyser le rapport entre le joueur et l'espace de jeu par la cartographie Etude de l'interface de carte, ses attributs, et leurs rapports dans la formalisation de l'ethos ludique. Master's thesis, Université de Lorraine (2020), https://inria.hal.science/hal-03018946/

14. Fraser, E., Wilmott, C.: From underground to the sky: Navigating verticality through play. In: Playful Mapping in the Digital Age, pp. 114–133. Institute of Network Cultures, Amsterdam, Netherlands (2010)

15. Sparrow, L.A., Gibbs, M., Arnold, M.: The ethics of multiplayer game design and community management: Industry perspectives and challenges. In: Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems. CHI '21, Association for Computing Machinery, New York, NY, USA (2021). https://doi.org/10.1145/3411764.3445363

16. Byrne, D.: A worked example of Braun and Clarke's approach to reflexive thematic analysis. Quality & Quantity 56, 1391—-1412 (2022). https://doi.org/10.1007/s11135-021-01182-y

17. Braun, V., Clarke, V.: Reflecting on reflexive thematic analysis. Qualitative Research in Sport, Exercise and Health 11(4), 589–597 (2019). https://doi.org/10.1080/2159676X.2019.1628806

18. Clarke, V., Braun, V.: Thematic analysis. In: Lyons, E., Coyle, A. (eds.) Analysing Qualitative Data in Psychology, pp. 84–103. Sage Publications, London, UK, 3 edn. (2021)

19. Braun, V., Clarke, V.: Toward good practice in thematic analysis: Avoiding common problems and be(com)ing a knowing researcher. International Journal of Transgender Health 24(1), 1–6 (2023). https://doi.org/10.1080/26895269.2022.2129597

20. Mochocki, M.: Heritage sites and video games: Questions of authenticity and immersion. Games and Culture 16(8), 951–977 (2021). https://doi.org/10.1177/15554120211005369

21. Hofer, M., Hartmann, T., Eden, A., Ratan, R., Hahn, L.: The role of plausibility in the experience of spatial presence in virtual environments. Frontiers in Virtual Reality 1 (2020). https://doi.org/10.3389/frvir.2020.00002

22. Bassett, A.: Exclusive: Greg & Dan cartography. Worldbuilding Magazine 2, 10–17 (2018), https://www.worldbuildingmagazine.com/2018/10/cartography-and-navigation/

23. Drachen, A., Schubert, M.: Spatial Game Analytics, pp. 365–402. Springer, London (2013). https://doi.org/10.1007/978-1-4471-4769-5_17

24. Horbiński, T., Zagata, K.: Map symbols in video games: the example of "Valheim". KN - Journal of Cartography and Geographic Information 71, 269–283 (2021). https://doi.org/10.1007/s42489-021-00085-0

25. Skarlatidou, A., Wardlaw, J., Haklay, M., Cheng, T.: Understanding the Influence of specific Web GIS Attributes in the Formation of non-experts' Trust Perceptions, pp. 219–238. Springer, Berlin, Heidelberg (2011). https://doi.org/10.1007/978-3-642-19143-5_13

26. Amini, F., Rufiange, S., Hossain, Z., Ventura, Q., Irani, P., McGuffin, M.J.: The impact of interactivity on comprehending 2d and 3d visualizations of movement data. IEEE Transactions on Visualization and Computer Graphics 21(1), 122–135 (2015). https://doi.org/10.1109/TVCG.2014.2329308

27. Anderson, C.L., Robinson, A.C.: Affective congruence in visualization design: Influences on reading categorical maps. IEEE Transactions on Visualization and Computer Graphics 28(8), 2867–2878 (2022). https://doi.org/10.1109/TVCG.2021.3050118

28. Dozio, N., Marcolin, F., Scurati, G.W., Ulrich, L., Nonis, F., Vezzetti, E., Marsocci, G., La Rosa, A., Ferrise, F.: A design methodology for affective virtual reality. International Journal of Human-Computer Studies 162, 102791 (2022). https://doi.org/10.1016/j.ijhcs.2022.102791

29. Atkinson, P., Parsayi, F.: Video games and aesthetic contemplation. Games and Culture 16(5), 519–537 (2021). https://doi.org/10.1177/1555412020914726

30. Browne, J.: Narrative mechanics: World-building through interaction. Facta Ficta Journal of Narrative, Theory & Media 2(2), 35–50 (2018)

31. Roth, R.E.: Cartographic design as visual storytelling: Synthesis and review of map-based narratives, genres, and tropes. The Cartographic Journal 58(1), 83–114 (2021). https://doi.org/10.1080/00087041.2019.1633103

32. Michailidis, L., Balaguer-Ballester, E., He, X.: Flow and immersion in video games: The aftermath of a conceptual challenge. Frontiers in Psychology 9 (2018). https://doi.org/10.3389/fpsyg.2018.01682

33. Weibel, D., Wissmath, B.: Immersion in computer games: The role of spatial presence and flow. International Journal of Computer Games Technology 2011(1), 282345 (2011). https://doi.org/doi.org/10.1155/2011/282345

34. Calleja, G.: Revising immersion: a conceptual model for the analysis of digital game involvement. In: Proceedings of the 2007 DiGRA International Conference. pp. 83–90 (2007)

35. Wołek, Z.: Lore exposition in video games: How to effectively convey an in-game world to the player (2022), https://www.theseus.fi/handle/10024/746225

36. Silva, I.C.S.d., Frosi, F.O.: Game Interface: Influence of Diegese Theory on the User Experience, pp. 1–11. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-08234-9_288-1

37. Leroy, R.: Immersion, flow and usability in video games. In: Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems. CHI EA '21, Association for Computing Machinery, New York, NY, USA (2021). https://doi.org/10.1145/3411763.3451514

38. Dimopoulos, K.: Virtual Cities: An Atlas & Exploration of Video Game Cities. Unbound, London, UK (2020)

39. Pazar, C.C.: Planetary engineering theory and its application to future terraforming for colonization (2018), https://www.researchgate.net/publication/323153326_Planetary_engineering_theory_and_its_application_to_future_terraforming_for_colonization

40. Abraham, S.A.: Usability problems in GI web applications: A lesson from literature. AGILE: GIScience Series 2, 17 (2021). https://doi.org/10.5194/agile-giss-2-17-2021

41. Marquez, J.O., Meirelles, P., da Silva, T.S.: Interactive web maps: Usability heuristics proposal. Proc. Int. Cartogr. Assoc. 4(70) (2021). https://doi.org/10.5194/ica-proc-4-70-2021

42. Schindler, I., Hosoya, G., Menninghaus, W., Beermann, U., Wagner, V., Eid, M., Scherer, K.R.: Measuring aesthetic emotions: A review of the literature and a new assessment tool. PLOS ONE 12(6), 1–45 (2017). https://doi.org/10.1371/journal.pone.0178899

43. He, T., Isenberg, P., Dachselt, R., Isenberg, T.: Beauvis: A validated scale for measuring the aesthetic pleasure of visual representations. IEEE Transactions on Visualization and Computer Graphics 29(1), 363–373 (2023). https://doi.org/10.1109/TVCG.2022.3209390

44. Ermi, L., Mäyrä, F.: Fundamental components of the gameplay experience: Analysing immersion. In: Proceedings of DiGRA 2005 Conference: Changing Views: Worlds in Play. DiGRA, Tampere, Finland (2005)

45. Ito, K., Sano, Y.: Cultural differences in the use of spatial information in wayfinding behavior. In: Proceedings of the 25th International Cartographic Conference (2011), https://icaci.org/files/documents/ICC_proceedings/ICC2011/

46. Mikuni, J., Spee, B.T.M., Forlani, G., Leder, H., Scharnowski, F., Nakamura, K., Watanabe, K., Kawabata, H., Pelowski, M., Steyrl, D.: Cross-cultural comparison of beauty judgments in visual art using machine learning analysis of art attribute predictors among japanese and german speakers. Scientific Reports 14 (2024). https://doi.org/10.1038/s41598-024-65088-z

47. Szigeti-Pap, C., Kis, D., Albert, G.: Understanding map misinterpretation: Factors influencing correct map reading and common errors. ISPRS International Journal of Geo-Information 12(12) (2023). https://doi.org/10.3390/ijgi12120479

Ludography

2K Boston: *BioShock*. [PC] (2007)

Amplitude Studios: *Endless Legend*. [PC] (2014)

Atlus: *Etrian Odyssey*. [Nintendo DS] (2007)

Bethesda Game Studios: *Fallout 3.* [PC] (2008)

Bethesda Game Studios: *The Elder Scrolls III: Morrowind.* [PC] (2002)

Creative Assembly: *Alien: Isolation*. [PC] (2014)

BioWare: *Dragon Age II*. [PC] (2011)

Black Isle Studios: *Planescape: Torment*. [PC] (1999)

Blizzard Entertainment: *World of Warcraft*. [PC] (2004)

Blue Sky Productions: *Ultima Underworld: The Stygian Abyss.* [PC] (1992)

Bungie, Halo Studios: *Halo* (franchise). [various] (2001)

Campo Santo: *Firewatch*. [PC] (2016)

Capcom Production Studio 1: *Dead Rising*. [Xbox 360] (2006)

CD Projekt Red: *The Witcher 3: Wild Hunt*. [PC] (2015)

Creative Assembly: *Total War: Warhammer II*. [PC] (2017)

EA Redwood Shores: *Dead Space*. [Xbox 360] (2008)

Edgeworks Entertainment: *TerraGenesis*. [PC] (2016)

FromSoftware: *Elden Ring*. [PC] (2022)

IMGN.PRO: *Kholat*. [PC] (2015)

IonFX: *Miasmata*. [PC] (2012)

Iron Gate Studio: *Valheim*. [PC] (2021)

Limbic Entertainment: *Might and Magic Heroes VII*. [PC] (2015)

Looking Glass Studios: *Thief: The Dark Project*. [PC] (1998)

Millet, Titouan: *Mu Cartographer*. [Windows] (2016)

Monolith Productions: *Middle-earth: Shadow of Mordor*. [PC] (2014)

Nintendo EPD: *The Legend of Zelda: Breath of the Wild*. [Wii U] (2017)
Nintendo R&D4: *Super Mario Bros. 3*. [NES] (1990)
Obsidian Entertainment: *Tyranny*. [PC] (2016)
Pipapo Games: *Map Map - A Game About Maps*. [Windows] (tba)
Rare: *Perfect Dark Zero*. [Xbox 360] (2005)
Retro Studios: *Metroid Prime 3: Corruption*. [Wii] (2007)
Rockstar Games: *Red Dead Redemption 2*. [PS4] (2018)
Rockstar North: *Grand Theft Auto: San Andreas*. [PS2] (2004)
Ryu Ga Gotoku Studio, New Entertainment R&D Dept., Syn Sophia: *Yakuza* (franchise). [Various] (2005)
Stoic: *The Banner Saga*. [PC] (2014)
Sucker Punch Productions: *Ghost of Tsushima*. [PS4] (2020)
Team Silent: *Silent Hill 2*. [PS2] (2001)
Ubisoft Montreal: *Far Cry 2*. [PC] (2008)
Ubisoft Montreal: *Assassin's Creed Unity*. [PC] (2014)
Ubisoft Montreal: *Far Cry 4*. [PC] (2014)
Ubisoft Montreal: *Assassin's Creed Valhalla*. [PC] (2020)
Ubisoft Montreal, Ubisoft Milan: *Splinter Cell: Chaos Theory*. [PC] (2005)
Ubisoft Quebec: *Assassin's Creed Odyssey*. [PC] (2018)
ZeniMax Online Studios: *The Elder Scrolls Online*. [PC] (2014)

Appendix: List of Posts

P1. Breault, C.: Cartographic survey: The year in video game maps (2014), https://readwrite.com/video-game-maps-2014-grand-theft-auto-kill-screen/ Accessed: 25.11.2024

P2. Cheever, N.: The art of game world maps (2018), https://medium.com/@EightyLevel/the-art-of-game-world-maps-b41c18633bf7 Accessed: 25.11.2024

P3. CityMonitor: What does map design tell us about video games? (2016), https://www.citymonitor.ai/analysis/what-does-map-design-tell-us-about-video-games-1937/ Accessed: 25.11.2024

P4. Ganker: The magic of video game cartography (2017), https://ganker.com/the-magic-of-video-game-maps-cartography-44636/ Accessed: 25.11.2024

P5. GLHF: The joy of video game maps as a worldbuilding device (2022), https://ftw.usatoday.com/lists/video-game-maps Accessed: 25.11.2024

P6. Hetfeld, M.: The brilliance of video game maps (2018), https://www.eurogamer.net/the-brilliance-of-video-game-maps Accessed: 25.11.2024

P7. Inderwildi, A.: What videogame maps can tell us about their worlds (2019), https://www.rockpapershotgun.com/what-videogame-maps-can-tell-us-about-their-worlds Accessed: 25.11.2024

P8. Kowalsky, K., Thorn, R.: Cartographers play video games: A review of the map in Elden Ring (2022), https://stamen.com/cartographers-play-video-games-a-review-of-the-map-in-elden-ring/ Accessed: 25.11.2024

P9. Kylie, A.: Inside the intricate world of video game cartography (2019), https://canadiangeographic.ca/articles/inside-the-intricate-world-of-video-game-cartography/ Accessed: 25.11.2024

P10. Lipscombe, D.: The miles we walk: How physical maps can guide the development of sprawling game worlds (2020), https://www.gamesradar.com/the-miles-we-walk-how-physical-maps-can-guide-the-development-of-sprawling-game-worlds/ Accessed: 25.11.2024

P11. Long, Z.: (mini) maps: How cartography makes great rpgs greater (2017), https://www.gameskinny.com/culture/mini-maps-how-cartography-makes-great-rpgs-greater/ Accessed: 25.11.2024

P12. McCarthy, C.: 20 amazing in-game maps that did more than show the way forward (2020), https://www.usgamer.net/articles/the-20-best-in-game-maps Accessed: 24.04.2023

P13. MegaBearsFan: Open world maps as checklists instead of game spaces (2016), http://www.megabearsfan.net/post/2016/07/18/How-open-world-games-fail-to-use-space.aspx Accessed: 25.11.2024

P14. Nerurkar, M.: No more wrong turns (2009), https://www.gamedeveloper.com/design/no-more-wrong-turns Accessed: 25.11.2024

P15. Pope, Z.: Maps and GIS in video games (2018), https://www.linkedin.com/pulse/maps-gis-video-games-zachary-pope Accessed: 25.11.2024

P16. Schreier, J.: Give me more world maps in my RPGs (2012), https://kotaku.com/give-me-more-world-maps-in-my-rpgs-5935634 Accessed: 25.11.2024

P17. Smith, A.: Fantastic cartography: Why videogame maps matter (2014), https://www.rockpapershotgun.com/videogame-maps Accessed: 25.11.2024

P18. Stuart, K.: The lost art of video game cartography (2010), https://www.theguardian.com/technology/gamesblog/2010/oct/19/mapping-video-games/ Accessed: 10.06.2025

P19. Sullivan, L.: What's in a game map? a lot, actually (2016), https://www.gamesradar.com/whats-in-a-game-map-a-lot-actually-or-maybe-not-enough/ Accessed: 25.11.2024

P20. Taylor: Video game maps: An ode to overworld cartography (2010), https://www.autostraddle.com/video-game-maps-an-ode-to-overworld-cartography-35399/ Accessed: 25.11.2024