How to Teach "Landscape" Through Games?

Maximilian Stintzing, Stephan Pietsch and Ute Wardenga

Abstract

Augmented Reality (AR) adds virtual features to the physical, real world that support the latter's exploration. A learning environment is enriched with location-based digital learning resources such as texts, images, maps and audio-visual presentations on certain subjects. In an ongoing project, we have applied AR to teach today's pupils the profound change of a cultural landscape—the former drain field area of Hobrechtsfelde north of Berlin, today a part of Barnim Nature Park. The paper presents the design of the digital excursion game "The Hunt in Hobrechtsfelde Forest", and how it has worked in first tests. The game explains the landscape's development through retrospective methods from Historical Geography, and illustrates it for players "in situ" through digital data on regional geography. The didactic basis consists in cross sections of time through which players have to pass. In the location-based game approach, the GPS coordinates contain the relevant, digitally prepared information on the landscape after the draining fields. Players interact, in a 'mixed reality', with physical as well as virtual objects, which cognitively activates the knowledge that they have possessed before, and/or what they are given during the excursion. At the same time, the AR game produces emotions and experiences in the context of the subject 'landscape', which further supports the transfer of knowledge.

M. Stintzing (✉) · S. Pietsch · U. Wardenga
Leibniz-Institut für Länderkunde, Leipzig, Germany
e-mail: m_Stintzing@ifl-leipzig.de

S. Pietsch
e-mail: S_Pietsch@ifl-leipzig.de

U. Wardenga
e-mail: U_Wardenga@ifl-leipzig.de

© Springer Fachmedien Wiesbaden GmbH, part of Springer Nature 2020

D. Edler et al. (eds.), *Modern Approaches to the Visualization of Landscapes*, RaumFragen: Stadt – Region – Landschaft,
https://doi.org/10.1007/978-3-658-30956-5_19

Keywords

Landscape · Augmented reality · Education · Location-based gaming · Serious games · Knowledge transfer through games · Digitization.

1 Introduction

This paper deals with the question how to teach today's pupils the profound change of a cultural landscape (German: *Kulturlandschaft*) through games; by means of new media (in this volume, connections between games and modern media are also addressed by Edler et al. 2020a; Fontaine 2020; Vetter 2020). Our example is the former drain field (German: *Rieselfeld*) area around Hobrechtsfelde, north of Berlin. Since 1998, it has been part of Barnim Nature Park. The Federal Agency for Nature Conversation (BfN) defines it as a historic cultural landscape (Schwarzer et al. 2018, p. 429).

In this article, we understand landscape as a perception of physical space constructed by humans, i.e. as an individual and social construction (Kühne 2018; see in this volume: Edler et al. 2020b; Kühne 2020; Kühne and Jenal 2020). The environment is thus viewed from a socially learnt perspective, modified by subjective primary and secondary experiences, to form a certain landscape, whereby the physical elements and structures are each given different meanings (Kühne 2019). Landscape is thus subject to constant change as the physical foundations change (Kühne 2018): A former sewage farm landscape with the function of sewage treatment can be transformed into a recreational landscape, whereby other elements and structures overlay the historical relics for the viewer and disappear from the landscape in his field of vision. On the other hand, society itself is also subject to constant change, which means that the perception of landscape features, for example aesthetic ideas of a beautiful area, also leads to a changed ideal of landscape (Schenk 2006).

At the paper's beginning, we describe, based on findings from Historical Geography, the landscape's change, which can also be understood as a change of relationships between humans and nature. Then, we outline the preconditions for the development of educational games. They include, first, a sufficient interest of teachers to convey to pupils basic notions of ever-changing landscapes by means of out-of-school learning and didactics based on media and games. Second, a gamification process, through location-based digital games, allows pupils to look behind what is directly visible; to turn that façade into an "Augmented Reality" and thus make it comprehensible as a result of dynamic change. Third, in order to translate the theoretical approach into a practical game, we need a convincing game story, which is embedded in the context of the teaching and lets the landscape crossed during the game become a new kind of experience.

2 The Former Drain Field Area of Hobrechtsfelde: History and Geography

The drain fields are located in the plain tracts of Lietzengraben and Panke rivers (Gärtner 2015) and form the western part of Barnim, a glacial plateau northeast of Berlin whose surface was shaped by the Saale ice age (ca. 186,000 years ago; Liedtke 2001). After the glaciers of the Weichsel ice age (ca. 18,000 years ago) retreated, the gains in the Barnim plateau, which originated in the Saale ice age, collected sand and gravel carried by meltwater (Bussemer et al. 2001). This gave rise to extensive outwash plains upon which a forest of birches and pines emerged. Expanding human settlement gradually supplanted it, creating a clear landscape with pockets of forest and a few linear villages by the late eighteenth century (Fig. 1).

Before the nineteenth century, the sand soils were sparsely populated because they held little water for agriculture. Industrialization, however, assigned a new purpose to them. In Berlin, the population grew so much that faeces could no longer be dumped into the city's canals and River Spree: it led to regular outbreaks of cholera, typhoid and dysentery in the German capital, since drinking water was taken from those watercourses (Koch 2015).

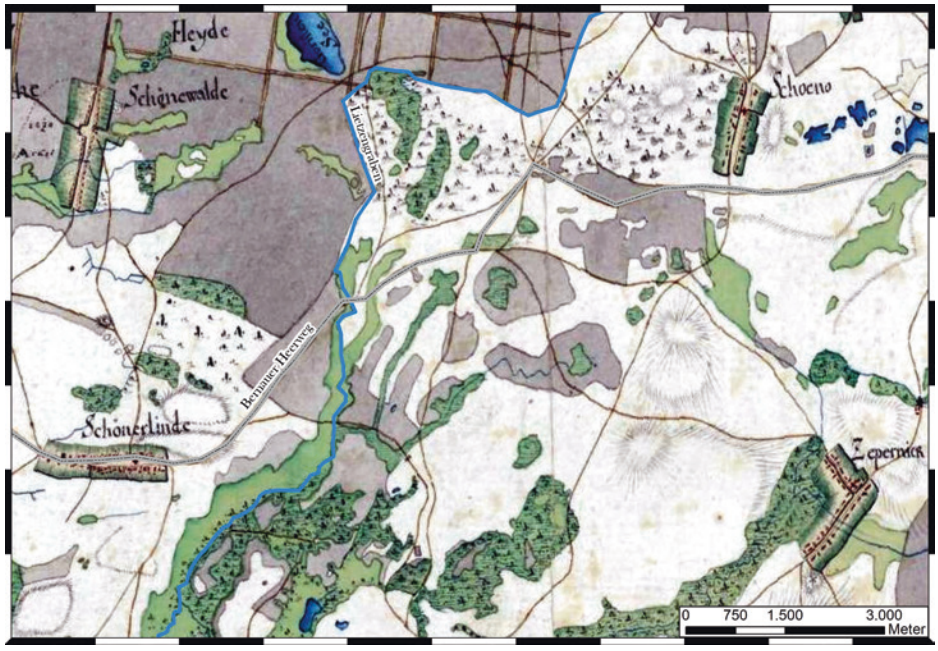

Fig. 1 Adapted extract from "Schmettau Maps", sheet no. 64: Bernau. (Source: Staatsbibliothek-Berlin/preussischer Kulturbesitz, dl-de/by-2-0)

Therefore, a new infrastructure for sewage disposal had to be set up. In England, large cities were having success with disposing of their sewages in drain fields. The example was followed by Berlin. Between 1862 and 1873, according steps were directed by urban planner James Hobrecht (1825–1902) and medical scientist Rudolf Virchow (1821–1902). As drain fields, the City purchased the sand soils in the north (Hobrecht 1884). They could serve as filters thanks to their high permeability to water. In addition, the disposal process would yield fertilizers for local agriculture (Gärtner 2015).

At the time, the drain fields were still located outside of the city. The sewage was brought there by 12 pump stations. It flowed through basins where larger suspended solids sank to the ground; they were then used as fertilizers. The pre-cleaned water was distributed on "draining tables" (German: *Rieseltafeln*): rectangular basins separated from each other by dams up to 100 cm tall. While draining into the sandy soil, the water was mechanically cleaned several times. Then, it was collected by underground pipes, led into ditches and returned to the general water cycle via fish ponds (a natural indicator of its quality) and river systems (Hobrecht 1884). After a round of draining, agriculture was possible on the draining tables, producing grains and vegetables for the Berlin metropolis (Gärtner 2015, p. 4).

The cultivation of the draining fields started in 1906. In 1908, the City's property of Hobrechtsfelde received its name in honour of James Hobrecht, the originator of the dual-use concept. In the following decades, its productive agriculture expanded to the point of employing over 200 people (Schulze 2015). After World War II, Berlin's sewage output soared again due to growing industry and population. At the same time, sewage came to be contaminated with industrial waste such as heavy metals and other inorganic materials. As a consequence, large parts of the draining fields were switched to intense filtering, that is, the originally flat draining tables were upgraded to tall basins. Here, the heavily contaminated sewage constantly stood at several centimetres and contaminated the soil, so that agriculture ceased to be possible. Intense filtering continued through GDR times until 1986, when a modern sewage treatment plant was constructed in neighbouring Schönerlinde (Senatsverwaltung für Stadtentwicklung Berlin 1992, p. 6).

In Hobrechtsfelde, attempts were then made at reforestation and renaturation; the draining fields were levelled. At first, success was limited: due to the draining system, the sandy soil was extremely permeable to water, so that up to 60% of new plants dried up. At the same time, the ground was heavily contaminated with pollutants that had to be bound through various measures in the ground. In the process, the former draining fields were gradually transformed into a recreational area for Berlin (Kappel 2015).

Today, it can be experienced as a seemingly natural, half-open forest with a great diversity of species. Even so, the area continues to require human management and cultivation in order to prevent, for example, an excessive natural reforestation or the drying-up of places as pre-cleaned water is discharged by the Schönerlinde sewage treatment plant (Kappel 2015).

3 "Landscape" Taught in School

The term "landscape" (German: *Landschaft*), once central for school teaching, has fallen into disrepute since the 1970s (Schultz 1980). In times enthusiastic about modernization (Wardenga 2019), the historical approach associated with the "landscape" term seemed outdated and not lending itself to preparing mature citizens for the future of a more and more globalized world. In school teaching, however, some perspectives and practices have survived that have belonged to the foundation of geography teaching since the late nineteenth century and that now go by the more innocuous term "space" (Schlottmann and Wintzer 2019; Wardenga 2002). One is, for example, the core skill of "orientation in space". It is supposed to enable pupils to act geographically, "make well-founded decisions in their everyday world and participate in the democractic development of the society" (Landesinstitut für Schule und Medien Berlin-Brandenburg 2015b, p. 5).

The teaching of that skill depends on concrete places of learning that allow "spaces" to be read and experienced as (historically changing) complex systems of interactions between humans and nature, and thus as "landscape". Interdisciplinary skills such as "accepting diversity" and "recognizing and appreciating (also historically) diverse life concepts" can be developed "on site" more than anywhere else (Landesinstitut für Schule und Medien Berlin-Brandenburg 2015a, p. 25), through activity-oriented learning (Schreiber 2016, p. 101). Encouraged by experiencing self-efficacy, pupils can thus develop abilities to "participate responsibly in societal and political opinion formation and decision processes"; to "negotiate their own intentions, tolerate diverse interests and find democratic solutions in conflicts" (Landesinstitut für Schule und Medien Berlin-Brandenburg 2015a, p. 26).

In Germany, first efforts have been made in recent years to adopt the "outdoor school" concept (German: *Draußenschule*), which has been successfully implemented in Scandinavia (*Udeskole*) since the 1930s (Bentsen 2016). From 2014 to 2016, the Pedagogical Institute of Johannes Gutenberg University Mainz (JGU) and the German Hiking Association (DWV) conducted the joint project "School hiking. Experience outdoors. Discover diversity. Move people" (*Schulwandern. Draußen erleben. Vielfalt entdecken. Menschen bewegen*), which included an experimental "outdoor school" (e.g. Gräfe et al. 2015, 2016a; b; Harring 2015, 2016). In Schleswig-Holstein and Hamburg, the agency "Landscape Adventure" (www.landschaftsabenteuer.de) has operated an "Outdoor School—Environmental education practical and close to life" (*Draußenschule—Umweltbildung praktisch und lebensnah*) since 2008, supported by the State of Schleswig-Holstein (Education for Sustainable Development [BNE]—Certificate "School fo the Future in Schleswig-Holstein" [*Zukunftsschule.SH*]). Both projects were accompanied by scientists and aimed at developing "best-practice models" to complement the everyday abstract teaching of knowledge in schools with out-of-school places of learning.

However, such activities, subsumed under the term "outdoor education" (von Au und Gade 2016), have so far remained exceptions: Germany in this regard still belongs to the "developing countries" (von Au 2016, p. 14) when compared to Denmark (Bentsen 2016), Scotland (Telford et al. 2016) or part of the US (Morrison 2016). In German schools, the teaching of processes related to cultural landscapes still takes place in a predominantly abstract way, with little reference to concrete views. In order to make subjects of regional geography accessible to the generation of digital natives, we need to develop attractive methods that cater to the specific needs of that group, provide links to their everyday world, and use new media for that purpose.

Taking up that task, the Federal Ministry of Education and Research (BMBF) funds the project "Spaces to Play: Lanscape as a Space for Discovery and Experience" (*SpielRäume: Entdeckungs- und Erlebnisraum Landschaft*; launched in 2018), which aims at making structures of landscape and concepts of regional geography accessible to pupils through games in out-of-school places of learning; the testing ground is Barnim Nature Park. In this framework, the authors of this paper develop digital excursion games in cooperation with the Nature Park. They are location-based games based on the application "Wherigo". Each game contains a storyline and elements of "Augmented Reality" (AR). Our tests of a game related to the drain field area of Hobrechtsfelde have shown that it both heightened pupils' motivation to look into subjects of regional geography and their ability to recap such a subject.

4 Location-Based Gaming and Gamification

Games are an abstraction of reality. They feature arcs of suspense as well as their own time and space; they are repeatable and played voluntarily (Sailer 2016, p. 20). In the process of *gamification*, elements of the real world are mixed with mechanics and elements of game so that the game maintains and increases users' motivation to carry out the game's assignments.

For today's smartphones or tablets, it is easy to recognize, visualize and anaylze spatial objects, structures and phenomena. Their User interface is constantly improved, simplified and adapted Today, almost every end device possesses numerous technical instruments that can collect space-related and geographic data and can thus be used for the geographical teaching of landscape, especially outdoors: camera, altimeter, GPS, compass, voice and sound recorders, etc. (Feulner and Kremer 2014).

Our project uses the integrated application "Wherigo". It allows the creation of GPS-based games for specific participants outdoors. For example, we can create interactive excursions or city tours including a storyline. To start the respective "game", the excursion's leader just needs to import it into the app as a so-called cartridge (that is, a programmed course of the game). The "Wherigo Builder" translates/transforms the cartridges into the respective programming language (in this case: Lua). The available

options are manifold. For example, audio-visual data (such as images, audio files, texts) can be imported that users see only in certain areas. Various actions, assignments and requests to enter things can be created through which developers can equip the excursion with elements of game (Teamer und sein Trupp 2019). Places in the physical environment are defined that players have to visit. The application assigns each place to a so-called zone. After a zone has been activated, certain events are triggered (signalled also by sounds) when the zone is approached or entered.

Wherigo has advantages also for beta versions to test methods of teaching subjects of regional geography through games. The software works without internet connection after the game file has been downloaded to the tablet or smartphone; navigation works through GPS and map systems available offline. Around Wherigo, various types of assignments and cases can be created by each developer according to the respective needs and goals (Pánek et al. 2018). Furthermore, the respective contents can be digitally prepared and, by means of "Augmented Reality" (AR), made available on the respective end device in a way that adequately complements the physical environment with virtual information.

4.1 Teaching of "Landscape" and Augmented Reality (AR)

AR is any technology that lets physical reality co-exist with virtual, two- or three-dimensional objects (Joan 2015). AR bridges the gap between the two worlds by enhancing and mixing reality with digital materials (Bacca et al. 2014; Hsin-Kai et al. 2013). That "mixed reality" (Milgram et al. 1994, p. 283; van Krevelen and Poelman 2010) ties (at least) people more closely to their surroundings (Klopfer and Sheldon 2010). It creates immersive moments and experiences that stir motivation (Lindner et al 2019) and activate existing knowledge (Hsin-Kai et al. 2013).

Therefore, AR is highly useful for education, because the concrete place of learning in the real world can be enriched with digital educational resources such as texts, images, maps and audio-visual presentations. AR thus allows pupils to experience in many possible ways phenomena that remain hidden from the eye in the real world since they are only, or can only be, "told" (Joan 2015). This shows, "[…] that AR can make educational environments more productive, pleasurable and interactive […]." (Lee 2012, p. 19) and is generally speaking, able to improve the the quality of the respective information.

AR needs to be regarded not as a mere technology, but as a very concept of teaching where AR glasses are only one component (Hsin-Kai et al. 2013). If AR concepts are incorporated into game designs and mechanics in a reflected manner, they can help players interact with the place of learning/playing.

To this end, we can for example develop virtual personalities whom players need in order to find a real, physical object in the landscape (Hsin-Kai et al. 2013). Thereby, different stages of a place's historical evolution can be made comprehensible, or the

surroundings can be charged with various meanings (Hsin-Kai et al. 2013; Klopfer and Sheldon 2010). Or, the game assigns problems that can be solved only if one or several cooperating pupils combine digital information with such from the analogue/physical surroundings. When solving the problem, new places and new virtual data, that is, new insights for pupils are unlocked gradually according to the principle of "cascading information". This principle prevents the game from overwhelming pupils with too much input at once (Joan 2015).

Moreover, AR location-based games allow pupils to organize themselves along digital/virtual information, which deepens their immersion in the subjects to be learnt. Finally, by encountering problems visually, pupils will have less difficulty solving them (Joan 2015).

4.2 Storytelling

Video games tell stories. Most of them feature narrative introductions that attach meaning to the actions expected from players. Besides, "many games have quest structures, and most games have protagonists" (Juul 2001). The event of the game is, to be sure, each time an individually constructed event. However, elements such as plot, game design and assignment structure are constitutive, as they define the framework of the subjective experience. Therefore, in video games, we should distinguish two types of interactivity: narrative situations and gaming situations. The latter offer the freedom to choose from several options (according to the game design) to solve the game's problems. In narrative situations, by contrast, the plot is driven forward in a *certain* way. In this case, it is thus impossible to adapt the plot to a player's individuality. Instead, the plot may be tied to non-player characters (NPCs; Simons 2007). In any case, to be well received by its target group, a game requires a good balance between free/gaming and predetermined/narrative situations (Lochner 2014, p. 144).

A coherent game plot, whose narrative is based on characters (Juul 2001), requires a script that plausibly combines the contents to be conveyed. From the beginning, the challenge is to meet players in their everyday world, because "every newly created world [in a game], whether set in reality or fictional, needs to have things in common with humans' surroundings" (Lochner 2014, p. 43).

For the fun of the game, it is also decisive that players first make themselves familiar with the rules of the game. This can be supported by a tutorial that is, as in our game, part of the very game, being represented by the virtual head of the Nature Park. He welcomes the players on site and makes them familiar with basic game control through little tasks of orientation.

The rest of the excursion game, which we present in the next section, follows the dramatic "three-act structure" of exposition, confrontation and resolution (Lochner 2014, p. 81). After the introduction, players are confronted with an inciting incident that causes them to embark on a journey.

5 The Drain Field Game: Hunting the Ghost of James Hobrecht

The "trigger" for our game in Hobrechtsfelde is the ghost of James Hobrecht who fears for his legacy and seeks to reactivate the drain field area. The goal of the game is to prevent him from that. In the vein of an adventure game, players, united in groups of three or four people, have to solve puzzles (such as triangulation exercises) or find objects (such as a ghost trap) that drive the plot forward (Lochner 2014, p. 147). A narrative climax is reached when players try to catch the ghost, but he narrowly escapes. Afterwards, there is a final chance to save today's Nature Park—or fail—by passing one last test.

When we tested the journey's simple version, the pupils (five times one class of grades 7 and 8) who played it gave it an average rating between "very good" (32.3%) and "good" (37%). Their satisfaction may spring from the fact that they had subconsciously been familiar with our classic way of narrating, since it is used in Hollywood films or fairytales as well (Kinateder 2012, p. 36).

A core feature of a coherent story design is the convincing design of the characters. In accordance with our goal to pass through different periods of the landscape around Hobrechtsfelde, we selected characters who represent the respective period through both their outward appearance and their way of speaking. For example, Count Schmettau speaks like an eighteenth-century Prussian nobleman, while the 1950s drain field attendant tells his work experiences with the post-war accent of Berlin. In fact, designing a game is generally not so much an academic but an artistic process. In particular, writing dialogues for the different scenes bears resemblance to composing a film script or a theatre play—including the invention of characters' personal backgrounds. Characters need to seem authentic enough to be embraced by the players.

While designing the game, we focussed on the antagonist James Hobrecht, who acts as the main teacher on the subject of drain field operation. The main challenge was to honour him, on the one hand, for his highly innovative idea of sewage treatment in the late nineteenth century, and on the other hand to make clear to players why that method is no longer viable today. We seem to have solved that challenge: 60 out of 127 pupils indicated that they especially liked Hobrecht's character.

Besides, 52 pupils stated to have learnt something about landscape development in Hobrechtsfelde—including its history as well as the functioning of its drain fields and of drain fields in general. We assume that the game was kept in motion above all by the non-player characters (NPCs) devised as antagonists. They drove the plot forward and thus proved suitable for teaching certain contents.

5.1 Conveying Time Sections

To let players retrace the historical evolution of Hobrechtsfelde Forest, we have identified characteristic cross sections of time and interrelated them with one another, resulting

in a longitudinal section of time (Plöger 2003). This is a method from Historical Geography. The cross sections are from four points of the past for which cartographic visualizations are available, each of a different mode (Schramm 2009, p. 9): the eighteenth century with the Schmettau maps; the year 1953 with an aerial picture of the drain fields; the year 2008 with an aerial picture of today's recreational area; and the year 2019 with a digital model of the area's soil structures. To deepen the immersion, the stages of development were "filled" with contemporary characters and objects. Players can experience them at a total of 16 learning stations.

5.2 The Eighteenth Century

After the brief introduction to the game's mechanics as well as plot by the virtual head of the Nature Park (Fig. 2), the appearance of the landscape in 1780 is presented through a geo-referenced excerpt of the Schmettau maps, which players see as virtual object. Their own location is indicated on the historical map and can be synchronized with a current map of the area, in order to maximize the sense of place (Klopfer and Sheldon 2010, p. 89; Pánek et al. 2018). Then, players meet the historical character of Count Schmettau (1743–1806), who is surveying the area with a military detachment.

Players are confronted with the time's language/etiquette as well as its surveying devices and methods. The devices appear as virtual objects along with optional

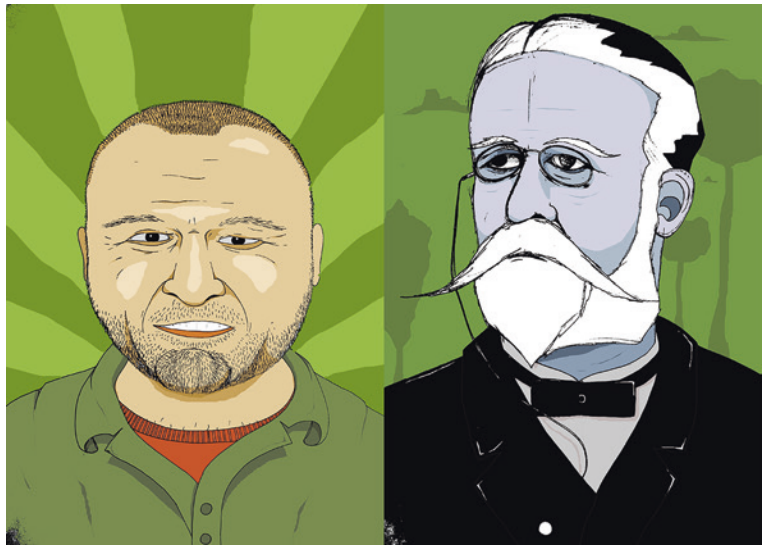

Fig. 2 *Left*: P.G., virtual head of Barnim Nature Park; *right*: James Hobrecht, originator of the drain fields. (Source: Project SpielRäume)

information on their use. Players are assigned a triangulation exercise, equally inspired by the period, on the region's oldest road, the Bernau Military Road, which today serves as a gravel path for walking and biking. After the exercise, players are given two more hints, concerning, first, the landscape's topography at the time, and second, the whereabouts of Hobrecht's ghost.

In sum, the real surroundings are enhanced with digital elements so that players immerse themselves in the time period, remember it later and anticipate the following periods (Hsin-Kai et al. 2013, p. 45; Pánek et al. 2018).

5.3 Operating the Drain Fields in 1953

Searching for Hobrecht's ghost, players are led to the next cross section of time. A worker who has been attending Berlin's drain fields in Hobrechtsfelde is debating with the ghost. The latter then disappears after opening a sewage pipe, which players have to close under time pressure. The grateful worker explains to them the operating mode and eventual problem of the drain fields. Virtual objects are provided, such as a technical plan of the drain fields and a pipe with optional extra information (unlike real objects or characters, virtual ones do not depend on external providers, so that preparation is accordingly easier). Players are assigned exercises on Berlin's demographic growth and sewage contamination.

Further information on the landscape's evolution is given to players through data on virtual objects such as a geo-referenced 1953 aerial picture showing a treeless area altered by humans. This is the players' first visual contact with the rectangular, today almost invisible structures of a drain field area as well as with the overflowing basins in times of intense filtering, which contaminated the soil. Today, the landscape at the respective game stations seems very natural, with players standing in the middle of a forest. When they are asked to compare their own location with the aerial picture, they sense a paradox. The drain field attendant deepens it with photographs of the attempts at reforestation and renaturation in 1986, which were thwarted by insufficient planning. At the same time, he points out lasting landscape features such as the Bernau Military Road and River Lietzengraben, which has to be crossed and is visible in all maps.

5.4 The Recreational Area in 2008

Still searching for the ghost, players reach a viewing platform. The virtual character of a professor at the University for Sustainable Development in nearby Eberswalde appears and explains the methods and problems of the area's renaturation. In a geo-referenced aerial picture from 2008, players see that the area's management has at last been successful, especially when they look at the half-open forest, with its structure of small parcels received from the rectangular draining tables (Fig. 3).

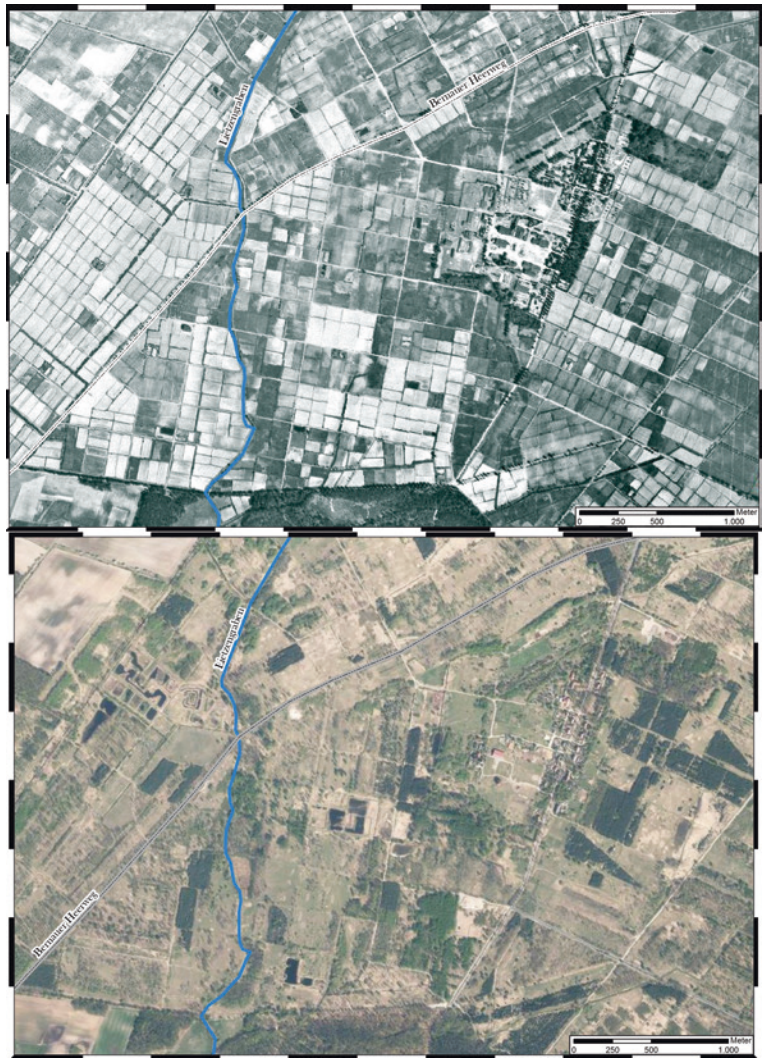

Fig. 3 Adapted extract of the drain field area of Hobrechtsfelde; *top*: 1953; *bottom*: 2009. (Source: Geoportal Berlin [Luftbilder 1953], dl-de/by-2-0; GeoBasis-DE/LGB, dl.de/by-2-0)

In the run-up to the final encounter with the ghost of the draining fields, players have to find physical boards explaining methods of re-watering and the drainage problem of a former draining field area (for other methodological approaches based on remotely sensed imagery in this volume, see: Hochschild et al. 2020; Meyer-Heß 2020). Through visual interaction with the virtual professor, the "physical" data are put in the right context. The complexity of the subject "landscape development" is alleviated by a slow, step-by-step flow of information.

5.5 The 2015 Digital Area Model

In the next and final cross section of time, a landscape planner gives players a digital model of the region, in which vegetation has been removed to carve out soil strcutures. The digital image, again geo-referenced, clearly shows the rectangular stuctures that remain from the operation of the drain fields. Moreover, explanations are provided on the lasting contamination from certain drain field products such as heavy metals in the ground; they make it necessary to constantly monitor water and soil qualities. Equipped with that knowledge, players can now confront Hobrecht's ghost, to convince him that today's landscape concept is more suitable.

6 Conclusion

The location-based digital game "The Hunt in Hobrechtsfelde Forest" conveys the genesis of a current recreational area. The landscape's development is explained through retrospective methods from Historical Geography (Plöger 2003, p. 18), and illustrated for players "in situ" through digital data on regional geography. The didactic basis consists in cross sections of time through which players have to pass; they are supported by maps and represent different stages of the development (related in this volume: Prisille and Ellerbrake 2020). Thus, the landscape appears in different perspectives of the past and the present, is given new meanings and turns out to reflect the changing relationships between human and nature (Klopfer and Sheldon 2010, p. 89). AR concepts help players experience and explore their real surroundings in an authentic manner, for example when the area of a present-day forest is shown, in an aerial picture from 30 years before, without trees, and the change is explained by virtual information or characters (Hsin-Kai et al. 2013).

In the location-based game approach, the GPS coordinates contain the relevant, digitally prepared information on the landscape after the draining fields. Players interact, in a "mixed reality", with physical as well as virtual objects, which cognitively activates the knowledge that they have possessed before, and/or what they are given during the excursion (Hsin-Kai et al. 2013, pp. 45–46). At the same time, the AR game seems to produce emotions and experiences in the context of the subject "landscape", which further supports the transfer of knowledge.

Translated from german by Maximilian Georg, Leipzig

References

Bacca, J., Baldiris, S., Fabregat, R., Graf, S., & Kinshuk. (2014). Augmented reality trends in education: A systematic review of research and applications. *Educational Technology & Society, 17*(4), 133–149.

Bentsen, P. (2016). „Udeskole“ in Dänemark. Von einer „Bottom-Up-“ zu einer „Top-Down-Bewegung“. In von Au & Gade 2016 (pp. 50–63).

Bussemer, S., Gärtner, P., & Thieke, H. (2001). Jungquartäre Reliefentwicklung auf der Hochfläche des Barnims (NE-Brandenburg). In S. Bussemer (Ed.), *Das Erbe der Eiszeit* (pp. 135–147). Langenweißbach: Beier & Beran.

Edler, D., Keil, J., & Dickmann, F. (2020). From Na Pali to Earth—An ‘unreal’ engine for modern geodata? In D. Edler, C. Jenal, & O. Kühne (Eds.), *Modern approaches to the visualization of landscapes* (pp. 279–291). Wiesbaden: Springer VS.

Edler, D., Jenal, C., & Kühne, O. (2020). Modern approaches to the visualization of landscapes—An introduction. In D. Edler, C. Jenal, & O. Kühne (Eds.), *Modern approaches to the visualization of landscapes* (pp. 3–15). Wiesbaden: Springer VS.

Feulner, B., & Kremer, D. (2014). Using geogames to foster spatial thinking. In R. Vogler, A. Car, J. Strobl, & G. Griesebner (Eds.), *GI_Forum 2014: Geospatial Innovation for Society* (pp. 344–347). Berlin: Herbert Wichmann & Vienna: Austrian Academy of Sciences Press.

Fontaine, D. (2020). Landscape in computer games—The examples of GTA V and watch dogs 2. In D. Edler, C. Jenal, & O. Kühne (Eds.), *Modern approaches to the visualization of landscapes* (Eds.), *Modern approaches to the visualization of landscapes* (pp. 293–306). Wiesbaden: Springer VS.

Gärtner, P. (2015). Vorwort—Naturpark Barnim. In S. Stoll-Kleemann (2015) (Ed.), *Wahrnehmung und Akzeptanz des bundesländerübergreifenden Naturparks Barnim* (pp. 1–6). Greifswald: Institut für Geographie und Geologie der Ernst-Moritz-Arndt Universität Greifswald.

Gräfe, R., Gillessen, C., Harring, M., Sahrakhiz, S., & Witte, M.D. (2016a). Bildungsräume anders denken. Das Modellprojekt Draußenschule. In von Au & Gade 2016 (pp. 70–78).

Gräfe, R., Gillessen, C., Harring, M., Sahrakhiz, S., & Witte, M.D. (2016b). Einmal wöchentlich draußen unterrichten? Eine qualitativ-empirische Studie zur Draußenschule aus der Perspektive von Grundschullehrerinnen. In von Au & Gade 2016 (pp. 79–95).

Gräfe, R., Harring, M., & Witte, M. D. (Eds.). (2015). *Körper und Bewegung in der Jugendbildung. Interdisziplinäre Perspektiven auf schulische und außerschulische Bildungsprozesse*. Baltmannsweiler: Schneider Hohengehren.

Harring, M. (2015). Schulische Jugendbildung? Ausgangslagen und Bedingungen für eine ganzheitliche Bildung im Kontext von Schule. In Gräfe et al. 2015 (pp. 75–91).

Harring, M. (2016). Freizeit und informelles Lernen. In M. Harring, M.D. Witte, & T. Burger (Eds.), *Handbuch informelles Lernen. Interdisziplinäre und internationale Perspektiven* (pp. 416–438). Weinheim: Beltz Juventa.

Hobrecht, J. (1884). *Die Canalisation von Berlin. Im Auftrage des Magistrats der Königl. Haupt- und Residenzstadt Berlin*. Berlin: Ernst & Korn.

Hochschild, V., Braun, A., Sommer, C., Warth, G., & Omran, A. (2020). Visualizing landscapes by geospatial techniques. In D. Edler, C. Jenal, & O. Kühne (Eds.), *Modern approaches to the visualization of landscapes* (pp. 47–78). Wiesbaden: Springer VS.

Hsin-Kai, W., Wen-Yu Lee, S., Hsin-Yi, C., & Jyh-Chong, L. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers and Education, 62,* 41–49.

Joan, D. R. R. (2015). Enhancing education through mobile augmented reality. *Journal of Educational Technology, 11*(4), 8–14.

Juul, J. (2001). Games telling stories? A brief note on games and narratives. *Game studies: The International Journal of Computer Game Research, 1*(1). https://www.gamestudies.org/0101/juul-gts/. Accessed 06 Oct. 2019.

Kappel, R. (2015). Ein Erholungswald für Berlin. In Förderverein Naturpark Barnim (Ed.), *Rieselfeldlandschaft Hobrechtsfelde. Nutzung, Umgestaltung und Entwicklung einer intensiv von Menschen geprägten Landschaft im Norden Berlins* (pp. 52–57). Wandlitz: Förderverein Naturpark Barnim.

Kinateder, B. (2012). Klassische Erzählformen. *Televizion, 25*(2), 34–35.
Klopfer, E., & Sheldon, J. (2010). Augmenting your own reality: Student authoring of science-based augmented reality games. *New Directions for Youth Development, 128,* 85–94.
Koch, K. (2015). James Hobrecht und die Berliner Stadtentwässerung. In Förderverein Naturpark Barnim (Ed.), *Rieselfeldlandschaft Hobrechtsfelde. Nutzung, Umgestaltung und Entwicklung einer intensiv von Menschen geprägten Landschaft im Norden Berlins* (pp. 25–29). Wandlitz: Förderverein Naturpark Barnim.
Kühne, O. (2018). *Landschaft und Wandel. Zur Veränderlichkeit von Wahrnehmungen*. Wiesbaden: Springer VS.
Kühne, O. (2019). *Landscape theories: A brief introduction*. Wiesbaden: Springer VS.
Kühne, O. (2020). The social construction of space and landscape in internet videos. In D. Edler, C. Jenal, & O. Kühne (Eds.), *Modern approaches to the visualization of landscapes* (pp. 121–137). Wiesbaden: Springer VS.
Kühne, O., & Jenal, C. (2020). The threefold landscape dynamics—Basic considerations, conflicts and potentials of virtual landscape research. In D. Edler, C. Jenal, & O. Kühne (Eds.), *Modern approaches to the visualization of landscapes* (pp. 389–402). Wiesbaden: Springer VS.
Landesinstitut für Schule und Medien Berlin-Brandenburg (2015a). Rahmenlehrplan Jahrgangsstufen 1–10, Teil B: Fächerübergreifende Kompetenzentwicklung. https://bildungsserver.berlin-brandenburg.de/fileadmin/bbb/unterricht/rahmenlehrplaene/Rahmenlehrplanprojekt/amtliche_Fassung/Teil_B_2015_11_10_WEB.pdf. Accessed 05 Dec. 2019.
Landesinstitut für Schule und Medien Berlin-Brandenburg (2015b). Rahmenlehrplan Jahrgangsstufen 1–10, Teil C. Geografie, Jahrgangsstufen 7–10. https://bildungsserver.berlin-brandenburg.de/fileadmin/bbb/unterricht/rahmenlehrplaene/Rahmenlehrplanprojekt/amtliche_Fassung/Teil_C_Geografie_2015_11_10_WEB.pdf. Accessed 05 Dec. 2019.
Lee, K. (2012). Augmented reality in education and training. *Tech-Trends, 56*(2), 13–21.
Liedtke, H. (2001). Das nordöstliche Brandenburg während der Weichseleiszeit. In S. Bussemer (Ed.), *Das Erbe der Eiszeit* (pp. 119–133). Langenweißbach: Beier & Beran.
Lindner, C., Rienow, A., & Jürgens, C. (2019). Augmented reality applications as digital experiments for education—An example in the Earth-Moon system. *Acta Astronautica, 161,* 66–74.
Lochner, D. (2014). Storytelling in virtuellen Welten. Konstanz: UVK.
Meyer-Heß, F. (2020). Discovering forgotten landscapes. In D. Edler, C. Jenal, & O. Kühne (Eds.), *Modern approaches to the visualization of landscapes* (pp. 33–46). Wiesbaden: Springer VS.
Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1994). Augmented reality: A class of displays on the reality-virtuality continuum. *Proceedings of SPIE (Society of Photo-Optical Instrumentation Engineers), 2351*, 282–292.
Morrison, L. L. (2016). Outdoor education in Iowa, United States. Eine kurze Übersicht. In von Au & Gade 2016 (pp. 64–70).
Pánek, J., Gekker, A., Hind, S., Wendler, J., Perkins, C., & Lammes, S. (2018). Encountering place: Mapping and location-based games in interdisciplinary education. *Cartographic Journal, 55*(3), 285–297.
Plöger, R. (2003). *Inventarisation der Kulturlandschaft mit Hilfe von Geographischen Informationssystemen (GIS). Methodische Untersuchungen für historisch-geographische Forschungsaufgaben und für ein Kulturlandschaftskataster*. PhD thesis, Rheinische Friedrich-Wilhelms-Universität Bonn. https://hss.ulb.uni-bonn.de/2003/0156/0156.pdf. Accessed 20 Jan. 2020.
Prisille, C., & Ellerbrake, M. (2020). Virtual reality (VR) and geography education: Potentials of 360° 'experiences' in secondary schools. In D. Edler, C. Jenal, & O. Kühne (Eds.), *Modern approaches to the visualization of landscapes* (pp. 321–332). Wiesbaden: Springer VS.

Sailer, M. (2016). *Die Wirkung von Gamification auf Motivation und Leistung. Empirische Studien im Kontext manueller Arbeitsprozesse*. Wiesbaden: Springer.

Schenk, W. (2006). Der Terminus "gewachsene Kulturlandschaft" im Kontext öffentlicher und raumwissenschaftlicher Diskurse zu "Landschaft" und "Kulturlandschaft" . In U. Matthiesen, R. Danielzyk, S. Heiland, & S. Tzschaschel (Eds.), *Kulturlandschaften als Herausforderung für die Raumplanung: Verständnisse—Erfahrungen Perspektiven* (pp. 9–21). Hannover: Verlag der ARL.

Schlottmann, A., & Wintzer, J. (2019). *Weltbildwechsel. Ideengeschichten geographischen Denkens und Handelns*. Bern: Haupt.

Schramm, M. (2009). *Digitale Landschaften*. Stuttgart: Franz Steiner.

Schreiber, J.-R. (2016). Kompetenzen, Themen, Anforderungen, Unterrichtsgestaltung und Curricula. In J.-R. Schreiber & H. Siege (Eds.), *Orientierungsrahmen für den Lernbereich Globale Entwicklung im Rahmen einer Bildung für nachhaltige Entwicklung* (2nd ed., pp. 84–110). Bonn: Engagement Global.

Schultz, H.-D. (1980). *Die deutschsprachige Geographie von 1800 bis 1970. Ein Beitrag zur Geschichte ihrer Methodologie*. Berlin: Geographisches Institut der Freien Universität Berlin.

Schulze, A. (2015). Das Berliner Stadtgut Hobrechtsfelde und die Rieselfeldbewirtschaftung. In Förderverein Naturpark Barnim (Ed.), *Rieselfeldlandschaft Hobrechtsfelde. Nutzung, Umgestaltung und Entwicklung einer intensiv von Menschen geprägten Landschaft im Norden Berlins* (pp. 30–38). Wandlitz: Förderverein Naturpark Barnim.

Schwarzer, M., Mengel, A., Konold, W., Reppin, N., Mertelmeyer, L., Jansen, M., Gaudry, K.-H., & Oelke, M. (2018). *Bedeutsame Landschaften in Deutschland. Gutachtliche Empfehlungen für eine Raumauswahl, Bd. 1: Schleswig-Holstein und Hamburg, Niedersachsen und Bremen, Mecklenburg-Vorpommern, Nordrhein-Westfalen, Sachsen-Anhalt, Brandenburg und Berlin*. Bonn-Bad Godesberg: Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (BMU).

Senatsverwaltung für Stadtentwicklung und Wohnen Berlin (1992). *Umweltatlas Berlin, 01.10: Rieselfelder (Ausgabe 1992)*. https://www.stadtentwicklung.berlin.de/umwelt/umweltatlas/e_text/k110.pdf. Accessed 20 Jan. 2020.

Simons, J. (2007). Narrative, games, and theory. *Game Studies: The International Journal of Computer Game Research,* 7(1). https://gamestudies.org/0701/articles/simons. Accessed 06 Dec. 2019.

Teamer und sein Trupp (2019). *Wherigo-Tutorial*. https://www.geocaching-dresden.de/?s=wherigo. Accessed 10 Dec. 2019.

Telford, J., Beames, S., & Christie, B. (2016). „Outdoor Learning" in Schottland. Ein Überblick. In von Au & Gade 2016 (pp. 42–49).

Vetter, M. (2020). Technical potentials for the visualization in virtual reality. In D. Edler, C. Jenal, & O. Kühne (Eds.), *Modern approaches to the visualization of landscapes* (pp. 307–317). Wiesbaden: Springer VS.

van Krevelen, D. W. F., & Poelman, R. (2010). A survey of augmented reality technologies, applications and limitations. *International Journal of Virtual Reality, 9*(2), 1–20.

von Au, J. (2016). Einführung und Überblick. In von Au & Gade 2016 (pp. 13–39).

von Au, J., & Gade, U. (Eds.). (2016). *„Raus aus dem Klassenzimmer". Outdoor Education als Unterrichtskonzept*. Beltz Juventa: Weinheim & Basel.

Wardenga, U. (2002). Alte und neue Raumkonzepte für den Geographieunterricht. *Geographie Heute, 23*(200), 8–11.

Wardenga, U. (2019). Vergangene Zukünfte—oder: Die Verhandlung neuer Möglichkeitsräume in der Geographie. *Geographische Zeitschrift (Online first)*. https://elibrary.steiner-verlag.de/article/https://doi.org/10.25162/gz-2019-0009. Accessed 10 Dec. 2019.

Maximilian Stintzing was a research assistant at the Leibniz Institute for Regional Geography, Leipzig (IfL) from 2017 to 2020. Since then, he works at the Bavarian State Library, Munich. He studied geography (Bachelor) and historical geography (Master) at Bamberg University. His research focuses on colonialism and spatial development, Geoanalysis and agricultural geography.

Stephan Pietsch has been a research assistant at the Leibniz Institute for Regional Geography, Leipzig (IfL) since 2013. He studied Modern and Contemporary History at Dresden Technical University, Geography (Bachelor) at Jena University, and Human Geography: Globalization, Media and Culture (Master) at Mainz University. His main research interests are spatial images, political geography, media geography, and the history of geography and cartography.

Professor Ute Wardenga has been working at the Leibniz Institute for Regional Geography, Leipzig (IfL) since 1996. She heads the department "Theory, Methodology and History of Regional Geography" and coordinates the research group "Historical Geographies".