Serious Games as a Tool for the Landscape Education of High School Students

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Abstract

The paper highlights the landscape related aspects of the development of a so-called "serious game" about climate change and presents feedback from high school student focus groups and expert interviews with teachers. Conclusions are drawn for the further development of landscape visualizations, e.g. that established technologies in the gaming industry such as the Unity3D engine provide affordable and easily usable tools for dynamic and interactive landscape visualization. The focus groups also show that a serious game can engage high school students with environmental and landscape topics on a high level of complexity and that the game has contributed to raising their awareness about the local impacts of climate change. However, it is too early to say whether such a game can lead to changes in behavior as well.

1 Introduction

"Serious games are very content-rich forms of educational media, often combining high fidelity visual and audio content with diverse pedagogic approaches" (PROTOPSALTIS et al. 2011). MACH (2010) first introduced the idea of serious games as educational tools in landscape architecture at the DLA conference 2010. BISHOP (2014, 2012, 2011) revisited the concept, e.g. for the simulation of behavior in dangerous landscapes, and at last year's conference, MURTHA and ORLAND (2014) presented a serious game about the landscape and visual impacts of hydraulic fracturing in the Marcellus Shelf. In the project "Future Delta 2.0 – Community based game design and evaluation for local climate change action", landscape architects, game designers, artists, teachers and high school students create a location-based serious game together further developing the previous approaches. In this game, the player has to mitigate climate change between today and 2020 in order to avoid serious impacts for the community in the Corporation of Delta (Figure 1) such as catastrophic flooding.

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Fig. 1: Design study of the Future Delta 2 overview map, here showing the Corporation of Delta

The game has multiple landscape relevant elements, from the basic work with topography and realistic vegetation to landscape strategies for climate change mitigation (urban agriculture, energy landscapes etc.) and adaptation (barrier islands, flood retention areas etc.). Novel is the concept of collaborative design involving the targeted high school students in concept and implementation already; the interdisciplinary input from not only landscape architects but also game designers, computer scientists and media artists; the non-linear storyline across time and space; a stronger focus on game pedagogy building in robust and evidence-based pedagogical and motivational strategies specific to game design as demanded by CLARK (2007); and the embedding of the game in a place-based community with social media activities beyond the game space. Usability, learning outcomes and behavioral change were assessed through empirical methods such as student focus groups and expert interviews with their teachers.

2 Serious Games as a Learning Tool

In his seminal book, GEE (2007) discussed that video games encourage and recruit situated, experimental, and embodied forms of learning and thinking. Humans tend to readily forget information they have received outside contexts of actual use, especially if they cannot imagine such contexts. GEE further discussed ways in which content in video games either reinforces or challenges players "perspectives on the world" and came to the conclusion it depends on their personal values. MCGONIGAL (2011), one of the most popular proponents

of serious games, went even further and suggested that they can lead to positive behavioural change.

BOYLE et al. (2012) provided a systematic review of studies analyzing engagement in games. Most studies refer to two prominent theories: flow theory and self-determination theory. While the flow theory focuses on cognitive features such as challenge, concentration, goals and feedback; the self-determination theory focuses more on the motivation of players and explains motivation by basic human needs such as competence and autonomy. Most empirical studies used questionnaires or surveys and only a small proportion conducted experiments. Specific to landscape, BISHOP (2011) concluded that games, which are played in a specific location particularly support learning about complex issues, allow researchers to better understand decision-making and support a new paradigm of public communications and decision-making. He argued that in terms of communication, we can learn from game developers about attractive introductions and staged learning curves, and getting players involved through goal setting, rewards and narrative flow. BISHOP et al. (2012) explored some of these motivation techniques and the Future Delta 2 serious game also emphasized the specific game pedagogy with an experienced game designer leading the development of the game mechanics. At the same time, the alternative storylines of Future Delta 2 follow underlying scientifically constructed scenarios (VERVOORT et al. 2010).

3 Methods

Future Delta 2 is a serious game about climate change and its local impacts located in a real locality, in the Corporation of Delta. The landscape within the game is presented as realistic as possible. This is reflected in the streetscapes, neighbourhoods and visualizations used to create the setting for Future Delta. Realism supports the player's attachment to place, their ability to recognize landscape features and identify with the challenges presented in the game. In addition, realism may help minimize the gap from the game to the real world and can enable the player's ability to oriente within the game space. Furthermore, challenges that the player needs to solve (i.e. identifying carbon emissions) should be realistic (you can't see carbon, so a device such as the carbon goggles facilitate its identification). However, one of the compelling aspects of the game is that is allows the player to exist within a future state of Delta that is, as yet, unwritten and unrealized. So, while realism may be important to allow the player to identify with the place, the player should also be able to exploit the hope and possibility of the future − more freely and not constrained. Creativity should be encouraged in the game – to create a balance between realistic spaces and imaginative concepts not overly restricted by present day cause & effect issues but including some elements of fancifulness (e.g. carbon vision, future vision, or other devices) that ensure the game is compelling.

Technically, the terrain was derived from a digital terrain model of Delta and aerial photos. However, it was important for the previously discussed level of realism to get as accurate building textures as possible – in terms of 3D city models, we are talking about LOD-3 models, i.e. the full architectural exterior of a building with balconies, windows and accurate textures; and even LOD-4 models that include the interior for selected levels. Since Google has surveyed the Corporation of Delta, it was possible to use StreetView to extract the correct textures and drape them over the building geometry manually modeled in Trimble Sketchup. ESRI CityEngine was also tested but the game designers opposed its use

because they thought it was creating too many polygons to be handled in Unity3D. Next, all (landscape) elements, i.e. topography, buildings, vegetation (using species typical for the area), street furniture (mostly from 3D object libraries such as Google Warehouse or the Unity Shop) and characters were put together in Unity3D. At the end of the process, interaction scripts were added to the objects to create a dynamic environment and to script the individual levels. Adding sounds, text dialogues, interface, introduction and the overview map in Unity3D completed the game (Figure 2; Figure 3).

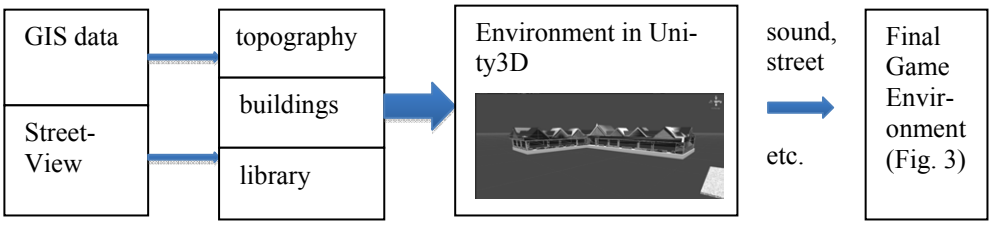

Fig. 2: Technical workflow of the Future Delta 2 game

Fig. 3: Final scene (in-game graphics) with buildings, vegetation, dynamic characters and interaction through an information window with feedback

3.1 Feedback Method

This paper focuses on the short-term evaluation in which two qualitative data collection methods were applied: First, student focus groups from three secondary high schools were used to identify key issues. Second, expert interviews were conducted with their teachers to explore the issues, raised by the focus groups, in more detail. As part of the collaborative design process the focus groups were also used to gather feedback on usability, learning (VAN STAALDUINEN & DE FREITAS 2010) and potential changes in behavior. The focus group method (PARKER and TRITTER 2006) is very common in software development and has become an integral element of the overall collaborative design approach. The three focus groups were recruited among high school students in the schools' computer and environmental working groups. A major advantage of the focus group methodology is that it

better reflects the group situation of a classroom setting than individual interviews could do and that the students can contribute throughout the development of the game. In fact, some of the students showed exceptional talent in 3D modeling and it is considered to publish the game development files under a creative commons license so that high school students can further develop the game and/or adapt it to different neighborhoods. In the scientific literature, the focus group method is sometimes seen more skeptical than in software development because of its limitations in terms of reliability and validity. In order to increase validity and reliability of the focus group results, they are compared to the interviews with the teachers. The teachers' feedback was collected through individual expert interviews with the teachers considered as experts in teaching and being able to assess the learning advancement of the students who played the game.

After a review of published evaluations of serious games, O'NEIL et al. (2005) came to the conclusion that most papers on serious games only make claims about the learning achievement without the support of qualitative or quantitative data. Furthermore, it is a common problem what the serious games are compared with and how to rate their effectiveness. Often they lack a control group without the serious game. Therefore, O'NEIL et al. proposed more reliable and valid assessment approaches for serious games. In the Future Delta 2 project, the collaborating high school teachers will provide the results of last year's class to compare with this year's student cohort, who played the serious game. Due to the long-term nature of the comparison, it will be subject of a future publication but cannot be included in this paper.

Even more difficult is the assessment of social impact or behavioral change through serious games. Although there are good examples of serious games aiming at change on the ground, there are few measurable impacts (SWAIN 2007). For the Corporation of Delta, public attitudes and awareness about climate change have been surveyed a prior to the launch of the Future Delta 2 game. It is planned to conduct a post survey in 2016 to look for potential changes in awareness and attitudes among community members resulting from the Future Delta 2 game.

4 Result and Discussions: What Can We Learn for Landscape Visualization from this Collaboration with the Gaming Sector?

The five high school student focus groups contributed to the collaborative design process highlighting potential usability issues and making suggestions how to improve the game. In general, the focus groups confirmed that the visual representation of climate change is a key factor in learning about climate change issues. Some of the more specific suggestions provide most interesting conclusions that can be transferred to the design of landscape visualizations: the focus group at school ♯2 suggested that visuals do not have to be photorealistic but they could be presented in a "sketchy" or "cartoony" style. The focus group at school ♯3 suggested, "visualizations should be connected to data". These suggestions are particularly interesting because they support well-known suggestions in landscape architecture, e.g. by REKITTKE et al. (2004) on non-photorealistic "sketchy" rendering techniques and BISHOP & LANGE (2005) emphasizing the need to base landscape visualizations on actual geodata. The observing teachers also suggested including 3D landmarks in the game to

strengthen the connection of the player with the local – similarly to the landscape feature approach suggested by van Lammeren et al. (2005).

A brief questionnaire was handed out to inquire students' levels of concern and their knowledge about climate change. The participating high school students responded that they were "not very concerned", "somewhat concerned" or "very concerned" on a five-point scale concern but no student said, he/she was not concerned at all. In terms of their previous knowledge about climate change, they stated to have either "some idea" or "a fairly clear idea" (on a five-point scale from "no idea" to "very clear idea"). It might be argued that the students would inherently assess their own knowledge high rather than low but there were additional indications that the level of knowledge was rather high. Regarding the game, students in the focus groups asked for complex concepts such as global change, adaptation, mitigation and carbon sequestration, which require a good understanding of the topic.

The focus groups unrevealed one potentially fundamental issue in using serious games for climate change communication. Several students suggested that issues needed to be over-exaggerated to compile a "catchy" storyline and an interesting game. Examples for such suggestions were the inclusion of catastrophic events or even references to currently very popular zombie movies and games. Considering the current pressure to be as scientific as possible and not to be an alarmist, the dilemma becomes obvious. Where is the balance between a thrilling game and scientifically sound, objective information? Did Future Delta 2 achieve this balance or is the representation (Figure 4) already too dystopian?

Fig. 4: Screenshot from the introduction to the third level, playing in the "Tilbury" industrial zone (in-game graphics) and taking design cues from popular "stealth games"

Key to successful awareness raising and learning outcomes is the integration into the existing school curriculum. In the teacher interviews, two teachers agreed to include the game in the sociology class with focus on geography and in the economy lecture with environmental focus, another teacher was running a sustainability program, which was obviously a good match. However, local and provincial regulations have to be considered, e.g. rules by the Union and school administration. Looking at the potentially awareness raising effect of the Future Delta 2 game, students and teachers think that the game raised awareness. A comparison of student grades will give an indication how effective the learning benefit was. At the moment, there are no indications for behavioral changes but the related longitudinal study will revisit this point.

5 Conclusion

In summary, the collaboration between landscape architects and game designers has proven beneficial for both sides. It was beyond the scope of this paper to elaborate the benefits for the game designers but the game definitely gained in local atmosphere by using realistic terrain, buildings and plants specific to the Corporation of Delta. As shown in the previous chapter, the landscape architects gained support and new ideas regarding landscape visualization, e.g. the potential of non-photorealistic rendering. Overall, it was a great opportunity to implement and test a large-scale interactive virtual landscape. In technical terms, the project also shows that the Unity3D game engine is by all means suitable for dynamic and interactive landscape visualization. Most important is the early evidence from the focus groups and teacher interviews that the serious game did raise awareness about climate change among the students. The follow-up research will now analyze in detail, how far the game could also facilitate learning outcomes and potentially contribute to behavioral changes in the community.

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