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Martin Knöll, Tim Dutz, Sandro Hardy, Stefan Göbel
Darmstadt, Germany

Active design – how the built environment matters to mobile games for health

Abstract

Mobile games for health aim to provide both for an attractive gaming experience and for a positive effect on their users' wellbeing. Most of these games are context-sensitive, as they take note of the state of the player's environment and use this information to adapt the game experience. This article points to the limited research available that validates either the physiological effects of playing context-sensitive games for health regularly, or research that focuses on the complex relationship between mobile games, a players' health and wellbeing, and the (urban) environment in which many of these games are being played. It reviews aspects of health-oriented urban design that has been shown to influence people's everyday activity patterns including running and cycling. It speculates how "active design" context can also have an impact on how we play mobile games for health and explains how this knowledge can be used to improve such games.

Introduction

More than half of the world's population now lives in cities, which has placed research and development of health-promoting urban environments at the core of policy making (Dye, 2008). Gameful and playful experiences have shown signs of success in addressing health-related behaviors and their close relation to the context of people's everyday activities - situations, agendas and specific built environments. For example, designers turned the steps of a Stockholm underground station into a large piano keypad with every step of the stairs causing a corresponding sound. It was observed that two-thirds more people took the stairs that day compared to the adjacent escalator (Volkswagen, 2009). Knöll et al. describe such approaches as "spontaneous interventions for health", which creatively combine serious gaming technologies and new urban interfaces in order to stimulate health-related behavior changes. Next to the obvious potentials of such interventions to urban environments, they indicate the need for more in-

depth studies in order to evaluate their long-term health-related effects. To this end, Knöll et al. suggest an increased interdisciplinary cooperation between urban designers and serious gaming researchers and highlight new curricula that would make students more aware of the existing potential to initiate and implement joint projects (Knöll, Moar, Boyd Davis, & Saunders, 2013). In this article, we focus on the design and evaluation of mobile games for promoting physical activity, so-called exergames, as a further approach to playful experience that is highly sensitive to urban context. The game *Zombies, Run!* by British software developer *Six to Start* has been one of the most successful fitness apps on the *Apple App Store* in 2012 (SixToStart, 2012). As we have argued before, the concept of mobile, context-sensitive exergames has great potential to engage users, as these games can blend interactive, virtual storylines into the user's real life environment, thus adding a new aspect to the challenge of motivating players for physical activity (Knöll, Dutz, Hardy, & Göbel, 2013). In this article, we argue that a great potential exists for mobile and context-sensitive exergames to make more out of the urban context they are played in. By urban context, we understand all social, cultural, and behavioral aspects of living in a city that are directly or indirectly influenced by the shape and content of the built environment. Related work in this field has pointed to the possibility to identify real world locations that would augment the atmosphere and storytelling that is stimulated in pervasive gaming experience (Walther, 2007). Many designers and researchers in the field of mobile and context-sensitive gaming have highlighted the need to make sure that users are safe while moving around the city with their attention focused on the displays of smartphone screens (Boyd Davis, et al., 2007). There is an emerging research on how the urban environment influences our daily (traditional) movement patterns such as walking, cycling, or running. However, to our knowledge, there is no scholarship that elaborates how this body of research can contribute to the design challenges mentioned above. Specifically, there seems to be no research available that looks into the mechanisms involved in stimulating the amount, intensity, and quality of moving in the real world while playing mobile exergames.

In this article, we thus seek to provide a theoretical model that helps game designers and serious gaming researchers to better understand the role of the built environments in exergames. This model is meant to provide a better insight into the broad spectrum from which to choose locations for exergames and for which to develop context-sensitive playful activities. First, we will identify relevant research from the field of urban design and planning. We will present relevant literature on *Active Design* guidelines and illustrate them with best practices. Second, we will address the question of how to integrate insights from other disciplines with more established research on locations in pervasive gaming. Third, we will develop and present a model that makes this knowledge accessible to mobile exergaming design and research processes. And finally, we will discuss

these models by presenting early prototypes that have been developed in the first months of our integrative and interdisciplinary design seminar *Developing Urban Health Games* at the *TU Darmstadt*, Germany, where students of architecture, psychology and computer science jointly develop and research context-sensitive games in small project teams.

Activity patterns: Walking, cycling, running, mobile exergaming?

For the last twenty years, researchers have collected a considerable body of knowledge that shows how different aspects of the built environment shape its inhabitants' daily activity patterns. Frank and colleagues have provided a comprehensive overview of aspects of urban planning from the scale of regional to neighborhood planning (Frank, Engelke, & Schmid, 2003). They have focused on walking, cycling, and running – both as utilitarian activities (e.g., to commute from home to work) and as non-utilitarian activities (with foremost recreational purposes). Specifically, they have highlighted the importance of walking for health and wellbeing, as it is highly accessible and also the most cost-efficient mode of transportation, as it does not require any additional equipment or accessories. Walking could therefore be well integrated into almost any routine and agenda. This observation is important for us, as for our purposes we have to estimate if playing mobile exergames and / or using mobile fitness apps in general can be compared to those more traditional activity patterns. Using fitness apps has been described as moderately accessible, with mobile devices and access to mobile internet is becoming more and more widespread among users of all age groups and as almost every new mobile phone sold today in western countries is a smartphone (Bitkom, 2013). With the average cost of an iOS-based app being about 0.19 US dollars (Gordon, 2013), the overall accessibility of applications for smartphones is extremely high, including apps for health and wellbeing and especially exergames. In terms of exercise, exergames may well be compared to walking and running, depending on the degree of physical exhaustion their gameplay activity seeks to stimulate. Based on this observation, we assume that mobile exergaming can be compared to walking and running in terms of accessibility for a wide range of users and the possibility to integrate exergaming into daily routines and agendas. Figure 1 gives an overview of the relationship between the built environment, people's activity patterns and public health outcomes, as observed by Frank et al. in 2003.

Figure 1

Future research will have to address the distinctive differences and similarities between traditional activity patterns shown in Figure 1, and new emerging patterns of digitally enhanced ways of moving through the city. To this date and for the purpose of this article, we feel it is safe to assume that knowledge on how the built environment shapes movement patterns will also be relevant for analyzing how people move within an urban environment while using exergames. In the following sections, we will outline some of these guidelines.

Which context matters when playing exergames in the city?

In order to guide our investigation of the large body of research on *Active Design*, we identify the following key aspects that have been shown as being crucial for playing digital games in real world locations. In one of the few more comprehensive works on the topic, Walz has put forward a framework of "locative dimensions" as a set of questions to be asked about space when designing and analyzing digital games (Walz, 2010):

- **Player:** Where in the game is the player and where is the game for the player?
- **Modality:** In what modalities of location, when, and for how long does the game take place?
- **Kinesis:** How does the location affect kinesis and rhythms between player and play-other?
- **Enjoyment:** What is the play pleasure set of the game's locale? What emotions does the site inspire?
- **Context and Culture:** How do the context and culture of the play site affect the play site?

Even though Walz excludes the field of serious and persuasive games from his discussion and does not distinguish between mobile games and traditional console and PC video games, his set of questions may well help to orient our own analysis. In other research, Knöll et al. have found Walz' five "locative dimensions" helpful to organize the variety of locations that they have observed where mobile exergames are played. Their typology of "locations in mobile exergames" includes parks, conduits, modern agoras such as shopping malls, places to socialize and to rest, and street furniture. Their observation confirms aspects such as a users' agenda, sense of safety, social interaction, and practical matters such as GPS signal reception as being crucial for mobile exergaming (Knöll & Moar, The Space of Digital Health Games, 2012). Walz' "player-dimension" points to a site's topographic dimensions such as widths, heights, shapes, and borders. These dimensions enable designers and researchers to locate the player within a specific area of the built environment and to develop playful activities based on access and movement patterns. Zooming in on a more detailed view of objects, street furniture such as benches, fountains or stairs, architects would extend their observation to other "morphological qualities" including textures, colors, haptic and olfactory sensation (Janson & Tigges, 2013). This morphology of urban context will influence how people engage in physical activity in interaction with the urban space, comparable to free running as observed by Feireiss (Feireiss, 2007). In our view, the aspect of movement and play rhythm indicates the need for designers to consider in how far the shape of a site delivers restrictions or potentials for safety, but also for playful activities that require GPS reception and mobile internet access. As introduced above, Walz furthermore points to "modality" as the question of when and for how long a game takes place at a given site. In our view, modality is a further relevant aspect to exergames, as it allows putting the game sessions in the context of their users' agendas, e.g. their existing activity patterns. Designers may ask what a players' place of origin is, and what their destination will be after playing a mobile exergame. The sense of enjoyment, as well as social and cultural context, are crucial for making people engage in location-based games as much as for moving in between everyday locations. Urban designer Jan Gehl points to the potential of "lively" public spaces for city development including public health agendas (Gehl, 2012). Debra Liebermann has pointed to immersion as the grade to which players feel invited to enter a new world while the surroundings seem to vanish, focusing their attention and becoming "the character we play" (Lieberman, 2010). She highlights that immersion and engagement in games for health are being closely related to many intended outcomes such as learning and behavior change. We suggest summarizing factors as enjoyment, cultural aspects, and atmospheres of urban context as the capability to contribute to player's immersion and engagement to mobile exergames.

As a result, we will summarize the aspects discussed above in the following three topics and questions to ask when analyzing urban design guidelines and mobile exergaming:

- **Safety:** In how far do morphological dimensions provide a safe environment for becoming physically active?
- **Agenda:** How does the built environment influence or indicate a user's agenda before and after the game?
- **Immersion:** How does the atmospheric, social, and cultural context of the location or a series of locations provide activities that influence the activities in the game?

Active design guidelines

In this section, we present key aspects of the built environment that have been shown to shape physical activity patterns on various scales of urban planning. Recently, research has started to investigate how the layout of buildings influences people's choices to become active, for instance by climbing the stairs as opposed to taking elevators (City of New York, 2010). And even though we assume that this field will become relevant to the design of future context-sensitive exergames that are designed to be played indoors, for instance the iOS-based stair-climbing game *Monumental* (Me You Health, 2011), we exclude active building design from our investigation and refer it to future work. Here, we rather focus on findings on a neighborhood scale, which we consider as more relevant for current mobile exergames design practice. Games such as *Zombies, Run!*, *Geochaching*, or Google's popular *Ingress* cover an area within walking distance for the player and consist of play sessions between a few minutes and a couple of hours. As pointed out before, the way in which different layouts of neighborhood areas influence activity patterns has attracted a lot of research interest over the last couple of years with a considerate body of studies and evidence and as shown above, Frank et al. have indicated "land use mix, transportation systems, and urban design aspects" as crucial factors on this scale of urban planning and design (Frank, Engelke, & Schmid, 2003). In the following, we will present research and specify its potential influences on exergaming through our three dimensions of morphology, agenda, and immersion:

1) Land use mix

A great variety of different usages within a neighborhood such as resident, work, recreation, shopping, and transport facilities results in a great amount and density of destinations to walk both from and to in a city area. In such areas,

which can be found in inner city centers, people are more likely to undertake non-optional daily tasks such as shopping on foot. Many studies have shown the close relationship between neighborhoods with a diverse use mix and an increased amount of pedestrian traffic (Robertson-Wilson & Giles-Corti, 2010). In the design of a context-sensitive exergame such areas, as opposed to purely residential areas, will allow for a gameplay that extends and addresses existing walking patterns. For mixed-use areas, designers can assume those walking patterns to be considerably higher in a majority of inhabitants than in suburban areas with residential use only. A variety of usages will also allow for more possibilities to respond to with the exergame gameplay. It would therefore cater to a greater amount of use case scenarios and people's agendas.

2) Transportation systems

The layout and shape of the street networks and the sizes of blocks also have been shown to have great influence on walking patterns. A "well-connected" street network is one in which pedestrians can walk the most direct way between two destinations. This can be seen in grids with short block lengths, which also provide more than one option to choose from while allowing to walk close to the shortest (Frank, Engelke, & Schmid, 2003). In our view, choosing a well-connected street layout as a context for a mobile exergame will allow for gameplay activities that require players to change directions and to navigate through the city. On the other hand, exergames which seek to augment an otherwise "less interesting" task - such as going for a run – with a story seem to be less dependent on choosing well-connected areas. Our own observation of playing the game *Zombies, Run!* suggests that getting immersed in an audio content requires not having to focus on navigation too much. We speculate that less well connected areas may have a positive influence on immersion to comparable kinds of games, as less pedestrian traffic and possible routes to choose from also reduce distraction through navigating in real world locations. Yet, such a hypothesis would have to be investigated in future research.

3) Urban design features

More recently, the influence of design characters of urban spaces such as squares, public gardens, and sidewalks has received increasing attention from research projects. Gehl has pointed to the effect that well-designed urban space sparkles on the livelihood of cities and has directed our attention to its various positive effects on activity patterns. Gehl explains how seeing and hearing other people makes us want to stay in a public space, makes us feel safe and as a result

affects the likelihood of us choosing one possible path through the city over another. He also points out that children prefer to play in populated places and especially in those where there are adults to play with and show off their skills to (Gehl, 2012). What we have framed above as the capability of a site to stimulate immersion extends to the potential to divert from gameplay activities. Both potentials being stimulated by a more populated place will influence gameplay. Knöll and Moar have shown that many exergames are played in parks, as they provide for an enclosed space, which is indicated by walls and entrances. Their boundaries suggest and to some extent provide for a safe environment which is protected from car traffic (Knöll & Moar, The Space of Digital Health Games, 2012). Burden et al. have gathered and commissioned research on how different qualities of sidewalks – building heights, sidewalk widths, and the design of the sidewalk "room", influence the usage of sidewalks (Burden, Burney, Farley, & Sadik-Khan, 2013). We suggest that studying comparable work and looking into sections of sidewalks and places will help game designers decide, if a certain site provides a safe context for an exergame.

Evaluation

As pointed out before, in 2013 we initiated and led a novel and ongoing course at the *TU Darmstadt* which brings together students from the fields of architecture, psychology, and computer science with the goal of establishing a cooperative environment that promotes the creation of urban mobile exergames. The students enlisted in the course are assigned to small project teams of five to ten members, each team consisting of at least one student of each of the three fields of science. The basic idea is that this kind of arrangement guarantees an expertise in each of the three steps required to create successful serious game prototypes, namely design, implementation, and testing and evaluation (Goebel, Hardy, Wendel, Mehm, & Steinmetz, 2010), with the game design being mainly the task of the prospective architects, the implementation of the Android-based prototypes being within the responsibility of the computer scientists, and finally, the psychological and physiological effects of these games being investigated by the students of psychology. The necessity of this type of interdisciplinary approach was supported by our experiences gained from a course *Games for Active Design*, which was limited to students of architecture and led by Knöll (Knöll, Lehre, 2013). The students of this course were also assigned the task of creating urban mobile exergames, but while some of the designs presented here were exceptionally creative, almost all of the participants failed to implement a working prototype, leaving alone an evaluation of the effects that their game has on its players. This confirmed our assumption that an interdisciplinary team of students might actually be necessary to produce much more comprehensive results and that stu-

dents from a single scientific field might not bring all the skills required for creating such games. But while the interdisciplinary student teams indeed provided working game prototypes and were able to conduct evaluations of their effects, we found that the coordination of, and the collaboration within, these teams was not without difficulty.

During the summer course of 2013, one of the student teams produced an Android-based game named *GoGreen*. The game is centered on a specific park in Darmstadt and features a set of small location-based games to be played in this park. Among them is a game named Gate Run, which requires players to pass a series of random "Gates" (GPS coordinates) within a given amount of time. The game also features a virtual player avatar dubbed *Mee*, which changes its appearances over the course of days, depending on whether the player mainly selects running activities or games that promote an upper body workout, meant to motivate the player to ensure a balanced full-body workout. Figure 2 shows a screenshot of the app's main screen in which the player selects an available activity and a design draft of the *Mee*.

Figure 2

While the group technically produced a very good result considering the time they had available to do so, the project also illustrated the need to ensure that such teams work together from the very beginning. Through the final project documentation, we found that the architecture students had precisely analyzed forty different places within the city of Darmstadt that might be suitable as locations for urban health gaming. As a first step, the group preselected spots that were in walking distance of the central university campus in order to comply

with daily routines of their target group and the modality of playing during their lunchtime break. As second step, the team analyzed the sites using *Active Design* guidelines and additionally using guidelines provided by the German *Federal Ministry of Transport, Building and Urban Development* to evaluate the sites' potential value to rest in public spaces (Bundesministerium für Verkehr, Bau und Stadtentwicklung, 2011). Figure 3 shows two exemplary location breakdowns of the *GoGreen* student team, illustrating the sites' potential to rest or to become active, which in turn would influence the game character *Mee*. They had ultimately failed to make their knowledge accessible to their team members in a way that it would influence the game mechanics, partly because the computer scientists did not realize the necessity of waiting for their colleagues to present the results and simply began implementing the game once the general concept was concluded. Consequently, the final game is playable at only a single location. This vividly demonstrates the necessity to foster knowledge transfer in interdisciplinary teams from the very beginning and to especially stress the fact that urban health games will benefit from carefully selected locations, as pointed out in the previous sections of this article.

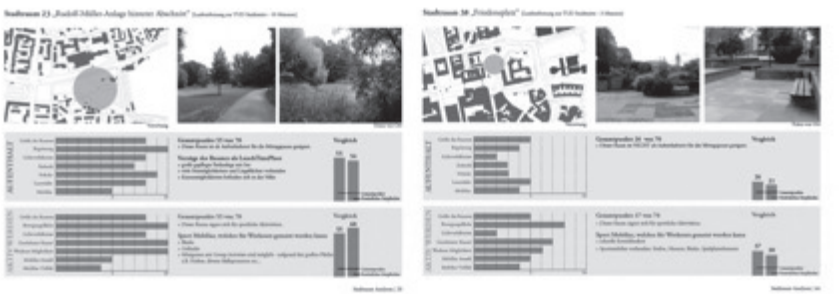

Figure 3

The second student team designed and implemented a game named *PacStudent*. The game is basically a location-based version of the well-known arcade game Pac-Man. In this group, the collaboration between the team members went much smoother and the places that the architecture students identified as optimal for playing the game actually made it to the final game version. Figure 4 shows three screenshots of the game, the location selection screen on the left and two actual in-game screens on the right. Next to being in walking distance and providing a space safe from car traffic, the *PacStudent* team focused on how morphological aspects such as floor finishing, guiding plants along the path, or topographic differences would influence the ease with which people navigate a given site. The two in-game screens on Figure 4 show how the *PacStudent* team adopted the original Pac-Man game mechanic to different game sites by altering the rules how the virtual coins are distributed and how the player and her virtual en-

emies (the "ghosts") would move. More information on *PacStudent* is available at http://pacstudent.de.im/.

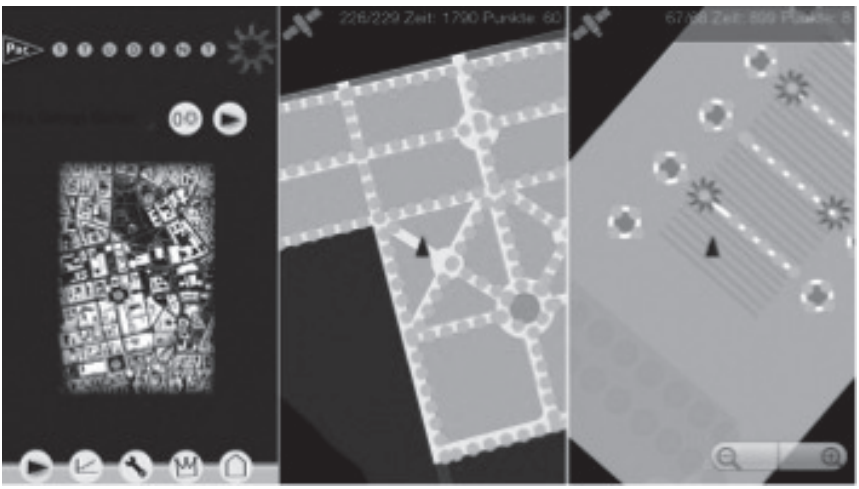

Figure 4

Discussion

The first results of our new interdisciplinary student course have provided a useful framework to experiment with form and content of our cooperation between architects and serious games researchers. Specifically, the projects have confirmed and pointed to further work needed in our theoretical framework that we have discussed above. Whereas *PacStudent* provides the possibility to point to safe environments by analyzing the morphological features of a site, it was also experimented how urban design features such as fences, sculptures, and floor finishing can stimulate different ways of playing the exergame. Both projects used data from land usage and walking distances to estimate if the game would fit into a players' daily agenda, e.g., into a student's day on campus. The question to what extent the environment effected players' immersion has only been marginally targeted by the student groups. The group *GoGreen* was analyzing to what extent different atmospheres would be suitable to get active or to relax. Both groups have found the *Active Design Guidelines* a useful tool to analyze urban context with respects to how different layouts and shapes of the built environment stimulate activity patterns. They have also pointed to its possible restrictions when they combined active design to other urban design guidelines - for instance, guidelines dealing with a site's potential quality to relax the player. We therefore conclude that our model can be applied to other use cases by choosing research on context according to the intended purpose. For example, designing a mobile

game for health that seeks to support activity in players with restricted motoric skills would have to analyze the urban context from the perspective of *Inclusive Design* (Burton & Mitchell, 2006) rather than *Active Design*. The three dimensions of urban context that we introduced in this article - safety, agenda, and immersion – act as a mediator between an in-depth analysis of urban context and the actual game design.

Outlook

In the upcoming next seasons of our interdisciplinary seminar *Developing Urban Health Games*, we will focus on methods that allow game designer to better access location-based information. One possible route is to combine analysis with more established categories of location-based services such as *Foursquare* or *Google Maps*. As part of the design curricula, we will ask architecture students to combine their own analysis of potential game sites with the use of existing data bases such as data on sound and pollution emissions. At the same time, students with a background in computer sciences will be asked to combine their analysis of location specific health aspects with openly accessible APIs of location-based services.

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