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# Applying and Facilitating Serious Location-based Games

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**Abstract.** The popularity of location-based games continues unabated and is benefiting from the increasing use of mobile end devices and advantageous general conditions, such as the Internet of Things and the Smart City paradigm. This enormous potential of engagement should also be tapped for serious location-based games, i.e. the use of location-based games beyond the purpose of entertainment. The workshop "Applying and Facilitating Serious Location-based Games" aims to contribute to the development of this potential. In the article, the theoretical basis for this workshop is derived and corresponding frameworks are presented.

**Keywords:** Serious Games, Pervasive Games, Internet of Things, Smart City, Instructional Design

## 1 Introduction and background

Location-based Augmented Reality (AR) games like Ingress [1] in 2013, Pokémon GO [2] in 2016 and nowadays Minecraft Earth [3] attract increasingly more attention both for leisure as well as for “serious” use. The suitability of using location-based games as learning tools is rooted in a few characteristics that make the use highly appealing: location-based games guide learners to real objects on location and add these objects with information that may impose a learning process.

Zydney & Warner reviewed the educational use of mobile apps, which includes location-based games [4]. They identified several theoretical foundations laying the base for the usage of mobile apps in an educational setting: situated learning, inquiry-based learning, social-cultural theory, scaffolding, and seamless learning are explicitly referred to. One of the identified theoretical foundations is Mayer's cognitive theory of multimedia learning [5]. Two examples are the contiguity principle (i.e. the temporal

and/or spatial combination of object and information) and the signaling principle (i.e. the insertion of additional clues). Sweller's cognitive load theory [6] is also considered as a potential theoretical basis for the use of mobile apps, for example, [7] use cognitive load parameters for assessing the learning efficiency of a location-based app. The large variety in theoretical foundations used, indicates the possible multiple didactical application options of mobile apps. This in turn, allow the transfer of the educational potential to location-based games, which already has a long history [8] and the relation to pervasive games [9]

Several case studies explore the genre: Coenen et al. showcases the pervasive game *MuseUs*, which allows the creation of a virtual exhibition in a museum and thereby invites visitors to explore the museum's objects [10]. The authors have examined the App PlayVisit in a digital scavenger hunt scenario aiming at conveying basic knowledge on water management [11]. Gurjanow et al. describe teaching mathematics using a trail in the environment [12]. There are also apps with different purposes from learning: e.g. the pervasive health game *Candy Castle*, which encourages the player to measure blood sugar at as many different locations as possible [13]. A review of the well-known health effects of Pokémon GO in literature shows the big potential of popular commercial location-based games for serving non-entertainment purposes [14].

These case studies suggest that mobile location-based games are encountering improved general conditions: The spread of mobile end devices is growing, and in several areas, it has reached a point where every resident owns at least one mobile device. The availability of mobile internet has also increased accordingly. Other factors that increase the spread and versatility of location-based games are developments such as the Internet of Things (possible communication with objects via the Internet), Smart City (possible communication with sensors and services within the city) and the ever-increasing number of sensors on mobile devices [15].

However, besides case studies similar to those mentioned, there are hardly any systematic design and application recommendations for serious location-based games that have achieved general recognition and widespread up-take and application. The dynamic development of the technical and organizational general conditions also shows a need for further development of such concepts. Therefore, in this article we would like to outline the conceptual considerations for a workshop that will support the design and use of location-based games on a theoretical and practical level. The workshop is the continuation of a series of workshops on location-based games, including 2019 in Arequipa [16] and 2016 in Vienna [17].

## 2 Aspects of serious-location-based games

The design and application of serious location-based games is guided by various aspects, which will be summarized below, and which may serve as a basis for the workshop's ongoing efforts.

## 2.1 Game design

From the aspect of game design, studies on motivation and engagement in general [18] and specifically in location-based games [19–21] are relevant. Further, guidelines for the design of mobile AR games are provided by [22]. They distinguish guidelines into different categories, such as *general*, *virtual elements*, *real world elements*, *social elements*, *technology* and *usability*. Additionally, a classification of pervasive games is provided by [23], while [24] gives an overview of the design space for location-based games, as well as [25] makes an introduction into pervasive games.

From a design perspective, it is also required to look at the sustainability of these apps—i.e. how easily they can be upgraded or adjusted for a different technology. This has become even more apparent during the current situation with many students not being able to attend school or outdoor activities. In this way, the situation has also called for looking at how location-based activities can be designed both for outdoor and indoor activities and how indoor can replace outdoor designed activities. An integration of QR codes and Beacons has proven to be suitable alternatives.

The advantage of this is that the usage of QR codes are widely used in the teaching-learning process and can be used in classroom to create activities such as treasure hunt games within and/or around the classroom, to guide students within laboratories, to integrate media in presentations/projects or for storytelling. The process of creating a game-based lesson plan using QR codes is not complicated but a few steps must be taken in order to create a successful activity and to motivate the students. Integrating Beacons as a part of such activities is a little bit more challenging, since several resources are needed: a beacon management system; sensors (Beacons); an App installed to read the beacon data; a Smartphone. An advantage of using beacon is that there is no need for internet connection, but in both cases, there are suitable templates that can be re-used for such a purpose, so that this can reduce the development efforts [28]

## 2.2 Didactical design

Didactical design supporting learning is an example for purposeful design of location-based apps beyond the purpose of entertainment. Design guidelines for educational location-based games comprise also different categories, such as general game design, engagement, learning aspects, and social aspects [26].

Suarez et al. [27] provide a two layer-classification of mobile activities used in inquiry learning potentially serving as inspiration for a classification in location-based gaming. In [28] we are particularly interested in the activities with regard to location-based apps that are conducive to learning, while in [29] we discuss customizable meta games as tools for serious game design.

## 2.3 Frameworks for purposeful integration of content

In addition to the purposeful design discussed in the previous section, meeting non-entertainment goals using location-based apps requires integrating the corresponding

content into the apps. There are already available certain frameworks for this purpose of adding learning content in serious games [30–32].

#### 2.4 Technical constraints

Although the technical framework conditions are constantly improving, location-based mobile games also belong to digital artefacts that are closely linked to the general technical development and are subject to so-called game aging, i.e. they lose their utility value and functions over time [33]. Strategies must be developed to slow down the aging process or to mitigate its effects.

#### 2.5 Facilitation

In addition to the design of games, the integration of content and the fitting of technical environment, the application of serious location-based games is considered the phase in which the games become effective. The term *facilitation* is used to describe the application of serious games supported by lecturers. Facilitation contexts differ in various parameters, for example whether the game is used in lectures or as homework. In addition to the design of facilitation contexts, the lecturers, here called game facilitators, must have various competencies. Therefore, competence models applicable to serious game facilitation [34, 35] need to be discussed.

### 3 Summary

Location-based games are facing increasingly better general conditions. The workshop "Applying and Facilitating Serious Location-based Games" is intended to contribute to leveraging this potential for learning and other purposes by elaborating the framework conditions and systematically presenting existing guidelines and practices.

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