Learning with Location-Based Gaming

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Abstract. Along with popular location-based game Pokémon GO and advancements with mobile technology, location-based gaming has drawn interest in education. Schools may well pose a feasible context for the further mainstream use of location-based games aimed for educational purposes. We present conceptual work with location-based gaming in education and mobile learning literature together with in-use examples of location-based games to highlight the ongoing tendency in schools to adopt these games for pedagogic activities. Implications are provided for further research, practice and game design.

Keywords: Location-Based Games, School, Learning.

1 Introduction

Location-based gaming shifted from its previously niche status to mainstream agenda as Pokémon GO (PGO) [1] was launched in 2016. This also increased the amount of research conducted on location-based games in general. Location-based gaming has drawn interest of scholars in its early years [2] [3], in the past decade [4] [5] [6], and exponentially in terms of publications and citations after PGO was introduced to the world [7] [8] [9]. In the past, mobile devices were seen as setting limitations for the gameplay [2], but these limitations have partly vanished with developments of smartphones and networks. The wide appeal of Pokémon GO (See Fig. 1) implicates past technological nuisances with location-based gaming have become bearable, although providing accuracy and reliability in these games still remain an issue [10]. We think the time, technology and research is ripe for opening up a discussion of location-based gaming in education.

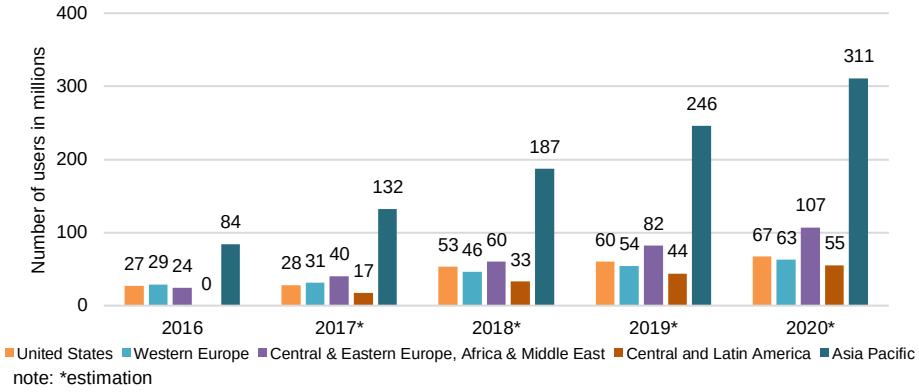

Fig. 1. Number of active users of Pokémon Go worldwide 2016 – 2020, by region [11].

The purpose of this paper is to initiate a discussion, though not for the first time, about the use of location-based gaming for education, especially in the context of basic education (from now on here, for the sake of consistency: school). As mobile devices have become ubiquitous in learning environments, using location-based games in school context with moderately young players can add an interesting path for research and practice. Smartphones have already changed the ways in which we learn and teach outdoors [12]. Likewise, there is nascent evidence of the movement of scaling location-based games to schools for educational activities. In the post Pokémon GO era, there are new affordances to be found for education, affordances which we provide here. Our research question is therefore: **what are the implications of using location-based games in schools?**

2 Location-Based Games

Until Pokémon GO, location-based games were mostly research demos without major significance or mainstream status [13]. They were often considered difficult to create, grow, and maintain over long periods of time [14]. Short-run examples such as Bot-Fighters [15], Songs of North [16] and Shadow Cities [17] were seen in the early years, but none of them gained a significant foothold or financial viability. Unlike other game types, location-based games are commonly played outside one's home. They are a sub-category of pervasive games [10] that uses real-life environments such as city streets, parks and indoor places for game play [18]. Pervasive games exist in the intersection of phenomena such as urban culture, mobile technology, reality fiction and arts thus combining varying contexts to produce new play experiences. Pervasive games blur and bend the traditional boundaries of game. Before mobile technology became the platform for arranging pervasive game experiences, many of the pervasive game genres

were already established. These include *treasure hunts* and *assassination games, pervasive larp, alternate reality games* (ARG) and *urban adventure games* [19]. Many of these pervasive game genres are fundamentally based on location and environment of the player which then has influenced the more technology-enhanced location-based gaming of today.

Game events and play balance in location-based games are built around the physical location of the mobile device, which mostly relies on Assisted-Global Positioning System (A-GPS) [10]. More accurate and robust indoor positioning using for instance Bluetooth beacons, QR-codes or Wi-Fi still remains a challenge inside the industry [20]. Location-based mobile games such as Pokémon GO, Parallel Kingdom [21], and Ingress [22] use a virtual map as a basis for displaying, monitoring, and projecting the game reality. They use maps as portable game-boards that may transform everyday spatiality, performativity and practices, and can create emotional relationships to places [23] [24]. According to de Souza e Silva and Hjorth [25], these games force people to consider urban spaces as a game board, challenging traditional definitions of play and how we see city spaces as playful spaces. As noted by Leorke [26], location-based games enable strangers to play and interact with each other and transforms public spaces for shared playful areas. Location-based games enable people to coordinate in urban spaces and to create communities, being simultaneously formed in physical and digital spaces. This has been also described as hybrid reality [4]. We believe that this hybridization can be used for learning.

3 Mobile Game-Based Learning

From the learning perspective, location-based gaming may offer advantages. Mobile learning is characterized as the disentanglement of traditional obstacles, such as school buildings and schedules, from learning. Sharples, Taylor and Vavoula [27] define mobile learning as a situation where learners are constantly "on the move", changing their location across spaces where learning resources are seized from one context to another. Based on activity theory [28], and task model for mobile learning [29], an activity-based approach has been suggested for the mobile learning agenda by Naismith, Lonsdale, Vavoula and Sharples [30], and it has previously being applied in Avouris and Yiannoutsou´s [31] review on the learning potential of location-based games. But unlike Naismith et al.'s approach to create categories for mobile learning pedagogies based on educational paradigms, Frohberg, Göth and Schwabe [32] see paradigmatic categorization ambivalent, since a single setting (in our case a location-based game) could be positioned to several educational paradigms, making such general categorization impractical. Frohberg, Göth and Schwabe [32], however, introduced a classification of mobile learning based on task model [29] including (1) context, (2) tools, (3) control, (4) communication, (5) subject and objective. Frohberg, Göth and Schwabe [32] presented that each category can be evaluated regarding specific mobile learning technology with a scale ranging from 1 to 5. In addition, context (See Fig. 2) is constitutive since instead of providing mere content to mobile device (independent context),

it is seen less advanced and innovative approach compared to building for instance virtual reality for learning (physical context). The location of the learner (i.e. context) and its connection with learning activities is seen highly relevant in mobile learning [33].

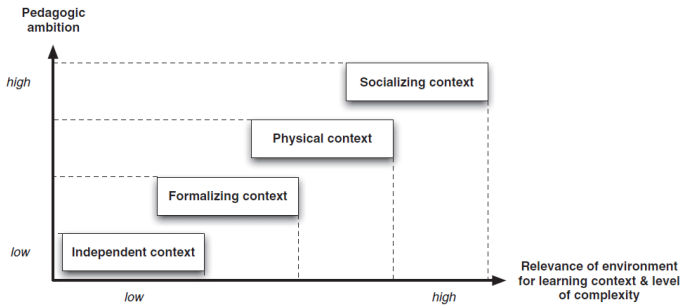

Fig. 2. Classification of mobile learning by the factor 'context' [32].

Formalizing context is described as typical classroom-like learning environment, where benefits are found mainly from learners being in the same environment, learning from each other. Physical context is about a place being relevant for learning (e.g. museum guides, location-based games). In a socializing context, in turn, learners share sustainable, interpersonal relationships, including past situations, emotions, friends and learning history covering the whole informal learning setting as well. This socializing context, however, lacks examples that would perfectly exist. [32.] *Tools* refer to material, content or medium that is used to mediate the learning process. Tools can be categorized from (1) one-size-fits-all content delivery to (5) high-end content construction. *Control* reflects on the responsibility of the learning process ranging from (1) tight teacher control to (5) full learner control with varying advantages between modes. *Communication* includes social aspects that are fundamental in learning. Depending on the tool and learning activities, (1) learner can be isolated when it comes to communicating with other learners, or (5) in full reflective cooperation completing the learning task in a social group. For instance, location-based game *Savannah* [34] was developed to enable learner communication and social interaction with game and tasks. *Subjects* are learners that are considered as novice (1) or (5) experts from their previous knowledge on the given topic, and how the educational medium considers its users from their previous knowledge. Finally, *object* refers to the level of knowledge from (1) know to (5) synthesize and evaluate. [32.] For educational activities used with location-based game, physical context comes by default, because the location and environment of the player is relevant for the game. If and when one adopts location-based game for learning activities, the level of complexity and pedagogic ambition should be considered as well. Active learning may provide a comprehensible approach to evaluate location-based games from learning activities perspective and how to design the actual learning activities with varying modes of ambition.

Games in general have been rigorously studied for decades from the learning perspective (e.g. [35]). According to Kiili [36], games as learning environments make it

possible for learners to discover new rules and ideas rather than memorizing the material that others have presented. His model highlights the importance of providing players with feedback, clear goals and challenges that are matched to user's skill levels [36]. Educational games are an effective way to facilitate flow condition, engagement and immersion thus supporting learning that is eventually a rather complex process [37]. In 2012, Avouris and Yiannoutsou published a review of the learning potential of location-based games [31]. They investigated research conducted from location-based games that were typical so-called "first generation" location-based games. The research publications were from 2004 - 2010, and the majority of the games were played using Portable Digital Assistant (PDA) devices. Avouris and Yiannoutsou (ibid.) introduced a viable category of traditions for location-based games that we adopt here: the ludic, the pedagogic and the hybrid. In this system, ludic games are games that are mainly constructed for the enjoyment of the players (e.g. Pokémon GO), and hybrid games are those combining entertainment and learning such as games built for museums or cultural sites. The pedagogic tradition consists of games with explicit learning objectives, in a probably less developed field compared to the ludic or hybrid traditions [31]. These traditions however overlap, when thinking about learning, since ludic and hybrid traditions can and usually do possess learning dimension: these games broaden our understanding of our surroundings, and social interactions occur in these games. In addition, it is not always clear whether and if people recognize something as learning [30].

4 Location-Based Games in School

Vuorio, Okkonen and Viteli [38] investigated the affordances and usage of location-based game aimed mainly for educational purposes in Finnish comprehensive schools (n=10) with 324 children age between 8 to 15 (Table 1). It found that a location-based game aimed for schools was scalable for multiple content domains and disciplines, and that teachers found new ways to use the game for educational purposes, even when they were not explicitly instructed for such use.

Table 1. Activities done with location-based game in schools (ibid.).

Subjects	Sports	Biol. & Geography	Miscellaneous	Mathematics	Arts	History	Chemistry	Religion
Activities	Push-ups	Nature walk	Christmas quiz	Percentage	Selfies	Centennial quiz	Vitamin quiz	Pilgrimage
	Long-jump	Animal recognition	Christmas carols	Recess math tasks	Photographing	Historical persons	Fire safety	
	Dance	Plant recognition	Unicef-walk	Fractions	Filming a video			
	Running	Forest quiz	Team shout task	Divisions	Art history quiz			
	Walking	Nature arts	Oldest teacher quiz	Multiplications				
	Orienteering	Forest cottage visit						
	X-jumps	Bird recognition						
	Hill run							

The study also found that although sports was the most influential domain for the use of a location-based game, physical activation occurred across all domains, because all of the interactive quizzes and tasks regarded walking. Seasonal festivities and local community and culture also influenced the way in which teachers used the game with children (e.g. Christmas; centennial quiz). Furthermore, teachers constructed stand-alone games that students could play during recesses by scanning QR-codes placed in the school's courtyard. [38]

Schools can be a viable context for location-based games for many reasons. Here, we demonstrate that these games are probably being adopted increasingly, since they deliver many of the aforementioned benefits for enhancing learning and making daily school activities more enjoyable. Research is still however missing in this area, despite such tools foster learning in an authentic environment, delivering engagement and promote learning outside conventional formal learning environments [5]. We therefore present four key examples of location-based games with educational uses. They come from Finnish and Estonian context yet carry implications for the development and future of location-based educational gaming around the globe.

Here we present four case examples of already in-use location-based games in that are mostly in schools. First, in Figure 3 there are two location-based games: Nomadi [39] and Action Track [40]. Both games are used with mobile devices yet creating content and monitoring requires an access to browser in laptop or desktop computer (i.e. Mac/PC).

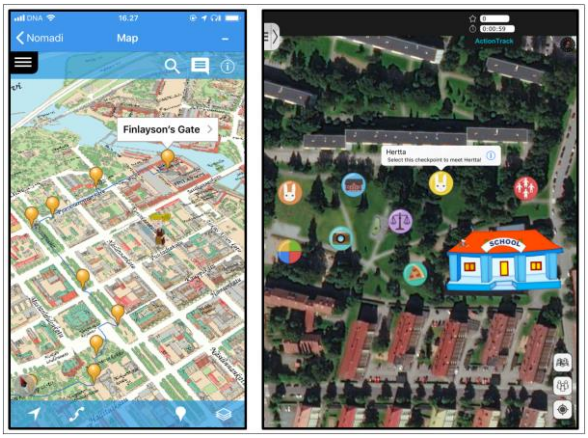

Fig. 3. On the left Nomadi, copyright Citynomadi; on the right Action Track, copyright Team Action Zone, used with permission.

Both platforms have similarities in how they are being used. First, teacher place points of interest on virtual map layer and then adds content to those points using content creator in a dashboard view. Content can be text, hyperlinks, YouTube videos, pictures, quizzes, and so on. In addition, teacher can add tasks involving field data gathering by using smart phones camera. After GPS-points and content is being set, a typical way is to combine all GPS-points to create a consistent learning path or a track where one can find a starting area and a finish line. Advanced features are available such as automated

alert in student´s smartphone if leaving a specified gameplay area, chat-tool to support communication between teacher and student, and open repository of tasks, ready-to-use games (e.g. treasure hunt) and content. Indoor positioning is available by scanning QR-codes, a rather low tech solution yet probably convenient for schools. From dashboard view, teacher can monitor the real-time activity of students during the gameplay and all data and answers are recorded and can be accessed later from the dashboard. Both Nomadi and Action Track are highly scalable meaning teacher can virtually pick any subject domain and start creating engaging content. Both systems are also being used to discover cultural sites, for tourism and recreational purposes.

In Figure 4 there are two location-based games Seppo [41] and Avastusrada [42].

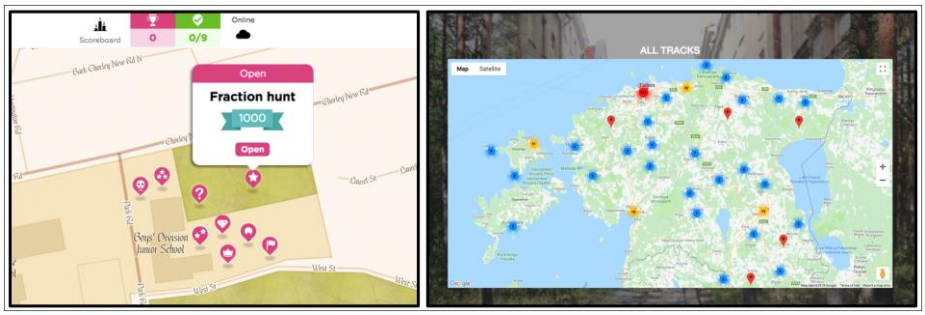

Fig. 4. On the left Seppo, copyright Seppo.io; on the right Avastusrada, copyright Tallinn University, used with permission.

Seppo is a location-based game aimed specifically for schools to gamify lesson plans and educational activities whereas Avastusrada was developed for environmental education, schools and for recreational activities. Seppo combines gamification, social learning, digital storytelling and physical movement via virtual map. Setting up game activities in Seppo is similar to previous examples with teacher led content creation, dashboard settings, shared content repositories and reporting tools. Avastusrada that is partly a research spin-off (See [43]) consists of tracks created by schools and other organizations covering all Estonia yet focused around the capital city Tallinn. Compared to other games, Avastusrada is an open game platform with virtual tours, quizzes and information linked to environmental education and historical sites aiming to gamify outdoor learning in general. Avastusrada is used with browser whereas Seppo can be played by using either smartphones browser or with an application.

To conclude our examples, we present Table 2 to illustrate the ongoing development with location-based games in schools. We also highlight the notion these games do not yet possess an augmented reality component, which in many ways have influenced the widespread of Pokémon Go respectively.

Table 2. Case examples listed by their preferences according to task model

Location-based game	Mobile Learning Classification (Frohberg, Göth &Schwabe 2009; Taylor et al., 2006)						Tradition (Avouris & Yiannoutsou 2012)	AR enhancement
	Context	Tools	Control	Communication	Subject	Objective		
Nomadi	Physical (3)	Content delivery (1) to content construction (5)	Full teacher control (1) to mainly teacher control (3)	Lose couples (2) to communication within group (4)	Novice (1) to little previous knowledge (2)	Know (1) to analyze (4)	Hybrid	No
Action Track	Physical (3)	Content delivery (1) to content construction (5)	Full teacher control (1) to mainly teacher control (3)	Lose couples (2) to communication within group (4)	Novice (1) to little previous knowledge (2)	Know (1) to analyze (4)	Hybrid	No
Seppo	Physical (3)	Content delivery (1) to content construction (5)	Full teacher control (1) to mainly teacher control (3)	Lose couples (2) to communication within group (4)	Novice (1) to little previous knowledge (2)	Know (1) to analyze (4)	Pedagogic	No
Avastus-rada	Physical (3)	Content delivery (1) to content construction (5)	Full teacher control (1) to mainly teacher control (3)	Lose couples (2) to communication within group (4)	Novice (1) to little previous knowledge (2)	Know (1) to analyze (4)	Hybrid	No

In Table 2, we conclude provided location-based games possess relatively interesting approach to set up learning activities through the lens of mobile learning task model and classification. With moderate differences, these games in our understanding may well provide means from mere content delivery to content construction e.g. through data gathering with smartphone camera and through student led content and activity construction. It is therefore up to teachers how much they give away control from creating learning tracks solely on their own. In addition, as students can accomplish tracks on their own or typically in dyads or groups, these games could also support further communication through these game systems. Finally, there are no augmented reality components in these games (yet) in our understanding.

5 Discussion and Conclusion

Location-based games are a rising trend in schools, and present learning opportunities. The urban environment as a historical context of location-based games where these games have been developed and used at scale is a start. In addition, cities may plausibly be testbeds of location-based games and learning in the future, through a widespread of sensors and services, and through the social dimensions of these games, which invite people to shared play. Furthermore, after the initial success of Pokémon GO the overall interest towards location-based games has progressed. It has influenced research, development and users, as well as schools that may now be ready to adopt location-based games.

In this paper, we have highlighted that for education, location-based games should be considered through their context of use, which possessed relevancy and pedagogical value. Likewise, location-based games appear to be scalable for varying subject domains, and should be studied more for that purpose. These games seem to provide a viable and interesting approach for pedagogic ambitions as we have demonstrated from the mobile learning theory. Finally, we presented four examples of these games demonstrating that location-based games are attracting users from schools and educational society and these games have been starting to appear in Northern Europe. Hopefully, we´ll learn there are other games as well out there.

First, there are implications for schools considering adopting location-based game. Game-based learning was found to be efficient way to consolidate engagement, flow, motivation and eventually learning. Play-based achievements are known to be efficient as learning tools [44], but it is important to note how physical presence and movement from one location to another affects that sense of achievement. Secondly, location-based games remove certain obstacles from learning activities such as time and place, especially since nowadays even the physical location of all players in a team is no longer a hindrance, as location based games can be played also from the home couch (e.g., The Walking Dead: Our World [45]). A teacher may monitor the progress of several students simultaneously, arrange stand-alone recess activities or gamify outdoor learning. In general, learning can be arranged in authentic environments. Thirdly, using location-based game enables the physical activation of students, with possible positive health and recreational outcomes for students. Finally, it seems location-based games

can be efficiently used for any subject domain. Currently our examples showed these games are designed mainly for the teacher to monitor and construct activities yet we believe loosening up this control may plausibly add more value for learners. Location-based games should therefore foster active learning and learner-centric approaches and support deeper communication and group activities as well.

Several limitations nevertheless occur, since this is a conceptual indication of a much wider research agenda toward location-based games in schools and for learning. For example, the social motivation of PGO players is more relevant to gaming time than are health, immersion, or achievement-based motivation [46]. It would be negligent not to think that this social motivation would not occur in also the learning context in some sense.

In addition, we believe that studying whether learning takes place in the context of ludic, pedagogic, or hybrid traditions is a discussion that needs further work in the context of locational games. In all of our four examples, more ludic activities could have been provided, and the potential learning better grounded in game elements and game-based storytelling. Furthermore, to move away from the orchestrated and teacher-to-student learning activities that seem to be the common case in our game examples, it is apparent that location-based games, and how the activities in them are created, must stem from the learners themselves. A viable path is therefore to use the collaborative design of location-based games (e.g. [47]). We also think adding AR to these games would enrich the learning experience beyond as proved in PGO. To conclude, robust studies are needed from these games in order to examine their potential for learning, social interactions, motivation, flow conditions, health, engagement but also of their transformative and cultural dimensions for schools and education.

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