Potential Benefits of Playing Location-based Games: An Analysis of Game Mechanics

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Abstract. Previous studies have reported various potential benefits from playing location-based games (LBGs). These include being outdoors, exercise, decreased sedentary behavior, increased knowledge of surroundings, improved cartographic, geographical and navigation skills, increased social interaction, meeting new people, forming acquaintances and activating people. One of the benefits of LBGs is that compared to other self-help applications and games, they are able to reach demographics who have trouble or are not interested in seeking improvement in their lives. This study focuses on the currently available LBGs (N=60) and identifies how their gameplay supports the observed benefits of playing the games. The found LBGs were sorted into five sub-genres. At the core of the popular LBGs *Pokémon GO* and *Harry Potter: Wizards Unite* were three main game mechanics all supporting each other: (1) moving around to find points of interest (PoIs), (2) travelling to PoIs and (3) walking to trigger game-events. Most gameplay were tied to these, as were also the potential benefits of playing the games. These findings highlight the importance of PoIs, their location and their quality, for maximizing the benefits gained from playing LBGs.

Keywords: Location-based games · gameplay · game mechanics · Pokémon GO · potential benefits

1 Introduction and Background

This study investigates the potential benefits of playing location-based games (LBGs) by analyzing game mechanics [57] of currently available LBGs for both Android and iOS platforms. The data set of games is based on the paper of Laato et al., [35] which was revised and supplemented for this paper. The current analysis departs from previous studies [3, 35] by utilizing the Gameplay loop [21] framework for identifying key game mechanics of currently available LBGS, and analysing their connection to potential benefits. The results of this study can be used by game designers and academia to understand more specifically which game mechanics support the unique potential benefits often reported from playing LBGs.

1.1 What are location-based games?

Location-based games (LBGs) are a new emerging genre of games which take into account the players' location in one way or another, and make it a central

part of the gameplay [53]. The development of smartphone technology including a stable mobile data connection and a GPS or similar signal have only recently, as of after 2000s, made LBGs viable to a large public. Famous examples of LBGs, as we understand them, include *Zombies, Run!*, released in 2012, *Ingress*, released in late 2013, *Pokémon GO* released in 2016, *The Walking Dead: Our World*, released in 2018 and *Minecraft Earth* released for early access in 2019.

Among the earliest work on LBGs is a study by Nicklas et al. [48] who classified LBGs into three categories: (1) Mobile games, which do not rely on accurate location data, (2) Location aware-games which can be played anywhere and require and accurate GPS signal and (3) Spatially-aware games, which are played on small areas and rely on identifying real world environments for triggering game events. Since this classification however, mobile games have become a large genre of their own [40] and are no longer discussed as LBGs. Furthermore, the term LBG has become an umbrella term referring to all games which include gameplay tied to the players' real world location, and additional specifications like "AR" or "mobile" are used in addition to the term, to further focus the genre of the games [4, 70]. Yet, LBGs are still sometimes discussed as AR -games [4], mixed reality games [67], hybrid reality games, pervasive games [8], location-based mobile games [50], geolocation games [58], GPS-games and many others. However, the term LBG has become the most prominently used among recent research and is therefore adopted in this study to describe all games which rely on the players' real world location.

As LBGs take into account the players real world location, and use that as a way to influence the game world, playing LBGs forces players to move outside. LBGs are different from traditional games in the way that they include aspects of the real world as gameplay elements and the playing experience will be different based on where the games are played [39]. The playing location needs to be taken into account in the design and implementation of serious LBGs or educational LBGs [60]. This is also true for the design of any LBG and their game mechanics. For example, *Pokémon GO* locates special ex-raids, which bring together a lot of people [1], mainly to parks, instead of, for example, busy crossroads, thus allowing players more space and peace to talk to each other.

One of the purposes of this study is to provide further evidence for the sub-genre classification for LBGs originally proposed by [35]. As all game genres, the sub-genres of LBGs are also mostly determined by the games' features and gameplay, at least in the ludological approach to game genres [10]. Depending on the chosen method of classifying games into genres, the results can be numerous. In 2009, GameSpot had 157 game genres listed [10] and with technological affordances and innovations emerging, the number is only likely to increase, or be different, based on the changing classification method. As is the case with all language acquisition and adoption, there is constant evolution occurring [7], and, therefore, it is not yet clear which terminology for LBGs and their sub-genres is going to prevail in popular use. Similarly to [35] this study sorts LBGs to sub-genres based on the ludological approach [14], using features and gameplay to group similar games together and identifying key characteristic for each

sub-genre, for the purpose of constructing a basis for further analysis of positive effects of LBGs on players.

1.2 Outcomes of Playing LBGs

Playing in the real world moving around, in comparison to playing inside in a confined space, radically alters the playing experience, as the actions players take also extend into the real world [39]. Therefore, in addition to the LBG itself, the playing environment will also influence the potential benefits and negative outcomes. Often the boundary between direct and indirect outcomes of playing LBGs is blurred. Because of this, it is worth considering the effects of the playing environment as well, as the environment can radically alter the playing experience and also the potential benefits.

Potential Benefits. LBGs can offer a natural environment for learning, as opposed to formal or institutionalized education [38]. Thus many of the benefits can be regarded to be implicit. The potential benefits of LBGs have been observed, for example, from a pedagogical perspective [60] and a health perspective [37]. An overwhelming majority of studies on the outcomes of playing LBGs use *Pokémon GO* as the case study, however, many of the studies predict their results translate into other LBGs. There are certain potential benefits which are characteristic to the LBG genre, but then again, some LBGs have been found to have potential benefits which are more general in the sense that similar or better outcomes can be achieved by other genres of games equally well. It can be taught that LBGs provide a unique mix of implicit learning opportunities and physical and social benefits, which together, can be classified into four categories: (1) social interaction [11, 71, 66], (2) exercise [6, 46, 74, 25, 43, 26, 45], (3) story or narrative-based learning [2, 36, 67] and (4) cartography/navigation [15, 49, 12].

One particular example of the importance of social interaction primarily in Niantic's games *Ingress* and *Pokémon GO* is occurring outside the actual game. Players meet each other and make friends in real life when they confront each other on the battlefield or trade Pokémon, but even more significant are all the big events around these games. Niantic organizes Pokémon festivals around the world in big parks, where all interested Pokémon trainers can gather and catch rare Pokémon during the event. There are also other social activities during these festivals. For *Ingress* players Niantic organizes competitions between the two factions in the game in so called Anomalies, in different locations around the world. Thousands of players around the world travel to these events in order to meet other players, play the game and have fun together. Friendships are established or renewed, and so for many, these games and events are a way of life, not just a game. The benefits of these kinds of activities might materialize in participation, engagement and physical activity [16, 44], as well as the possibility to blend formal and informal education, making learning more implicit and fun [73, 38].

LBGs have various kinds of gameplay, and the games support and encourage positive behavior in players differently. Even if a playing a certain LBG might not have direct potential benefits for the player, it might subtly encourage towards positive behavior. An example of this would be the subtle push to leave the house, eventually resulting in a more active lifestyle and decreased sedentary behavior [6]. Moreover, it has been argued that LBGs might have on impact on youth suffering from severe social withdrawal, by encouraging them to leave their house [63]. In addition to the indirect potential benefits for the players, there are many more direct outcomes. These can include, for example, exercise, increased social interaction and cartographic, geographical and navigational practice. Also depending on the LBG, the game might teach about history [2, 36, 52, 67] or language learning [13] as examples. Undoubtedly there are other potential benefits on top of the ones mentioned as predicted by popular models such as the LM-GM model [9].

Negative Outcomes. Playing video games is usually regarded as a stationary indoor activity. Bringing the gameplay out in the real world obviously has positive effects as discussed. However, it is clear there will be negative impacts as well. In addition to concerns of players privacy (e.g. [23]), also land-owners rights for privacy has gained increased attention as LBG players have been reported to trespass private property and restricted areas while looking for new Pokémon, despite the Niantic's PoI generation systems guidelines to not to add PoIs in private locations [29, 42, 54]. Notably, as evidenced in the study by Graells et al. [20], *Pokémon GO* players take advantage of breaks during the day or commuting times to play the game, and according to the findings, typically LBGs are played in places near homes or the workplace suggesting that the exercise and exploration might be centered upon a limited area. The impact on motivation to keep on playing while the new discoveries are decreasing in the limited area is uncertain, but undoubtedly cartographic and navigational skills do not develop for casual players as well as for more active players who are seeking out new places to play.

Moreover, concerns of children's security in respect of injury, abduction and violence while playing LBGs outdoors has been of concern [56], but no such things have been widely reported as of yet. There are also other more genreal negative outcomes which are not specific to LBGs that need consideration, such as internet game addiction, especially among MMORPG players [32], the lack of self-control when spending money on the game or job performance [75]. Wagner-Greene et al. [69] discussed risks involving the LBG *Pokémon GO*, citing playing while driving and playing while biking to be risks to personal security and that of others in the traffic. Skipping sleep to play and trespassing were also mentioned as associated harmful behaviors [69], however other studies on *Pokémon GO* found that LBG players did not permanently adopt these unwanted behaviors [5].

1.3   Linking Gameplay and Potential Benefits in LBGs

Playing LBGs can be fun and engaging, and for example, games such as *Minecraft Earth*, *Pokémon GO* and *The Walking Dead: Our World* have been designed primarily for entertainment, even though they all do contain a varying degree of undoubtedly intentional subtle pushes towards a more healthy lifestyle [6]. Perhaps due to the phenomenal popularity of *Pokémon GO* since its initial release in 2016, a lot of recent research has been focused on that particular game, with studies observing *Pokémon GO* players and then extrapolating the results to present LBGs in general (ie. [4, 22]). Consequently, not much attention has been paid to the growing number of LBGs, and thus information of the extent and variety of LBGs and their usage in serious gaming is scarce. Provided that some LBGs are adopted for educational purposes, the mechanisms of these games and their affordances for learning are of great importance. Some frameworks have been proposed for analyzing LBGs such as The Pervasive Game Design Framework (PGDF) by Söbke et al., [60], which combines pedagogical objectives with difficulty and assessment. Also methods for educational LBG development have been proposed, for example, by Erenli [17] as well as a framework for using *Pokémon GO* in education [55].

In order to understand the game mechanics and learning mechanics of the popular LBGs it is essential to consider them as a part of a larger context, to uncover the similarities and differences between LBGs. Some classifications have already been generated (see [3, 35]), but the exploration is still at its infancy and more rigorous studies are needed. This paper will contribute by proposing a new classification of five sub-categories for LBGs based on ludological analysis of game mechanics. For this end, the Gameplay loops [21] is harnessed to identify core gameplay in currently available commercially developed LBGs. The research question of the current study is thus formulated to be as follows: *"How do the characteristic potential benefits of playing LBGs relate to LBG sub-genres and their game mechanics?"*

2   Research Design

The research design of this study consists of three main parts: (1) Searching for all currently available LBGs for mobile phones (2) Categorizing the LBGs based on their game mechanics into sub-genres and (3) Analysing the game mechanics to identify the mechanisms in these games that scaffold the potential benefits identified in previous studies on LBGs.

2.1   Searching Available LBGs

In order to find all currently available LBGs, the dominating mobile operating systems and their main online stores, Google Play Store and iOS App Store were scanned. As the both Stores have only subjective search functions available which provide biased results, previous studies have utilized, for example,

scripting to find all available apps from these stores [27]. However, the problem with the current study is the location-based aspect. As developers can quite freely pick the category and descriptions of their app, it remained difficult to systematically ensure that all available games are found. Therefore, the results were supplemented with findings from previous academic work on LBGs [3, 35] as well as data obtained from forums and other search engines. The following search terms were used in App Store and Play Store: "location-based", "mixed-reality", "AR", "geolocation", "hybrid-reality", "spatially-aware" and additionally direct names of popular LBGs such as Pokémon GO.

All found games were stored into a data sheet. The authors then proceeded to download the applications when available, to test whether they matched the inclusion criteria, which were:

– Available on Google Play or App Store
– Available in English
– Be location-based games, games even loosely fitting the genre were also accepted.
– Be playable, including server side support when required.

All applications matching the above mentioned criteria were included in the final datasheet of available LBG, which is available in the Appendix.

2.2   Categorisation

Previous studies have already identified certain sub-genres for LBGs including scavenger hunt games [61, 31] and spatially-aware games [59]. As game genres evolve naturally, it is possible that some categorizations become outdated [10]. The ludological approach groups games together based on their game mechanics and gameplay [14]. Based on this method the identified sub-genres were the following: (1) Scavenger hunts/treasure hunt (2) Movement-based games (3) Spatially-aware games (4) geolocation games and (5) LBMMORPGs (location-based massive multiplayer online role-playing games). Indicators based on which games were sorted into a category were defined to be the following:

1. **Scavenger hunt games.** Players are given missions to complete alone or together requiring navigating to certain PoIs. Usually limited to a small area, and usually played in an organized fashion. Key features: *Not available at all times, limited to a certain area, multiplayer, navigating to PoIs, contains tasks.*
2. **Movement-based games.** LBGs which do not include PoIs, but main input method is physical movement. Key features: *Player physical movement used to trigger game events, no PoIs, can be either singleplayer or multiplayer, can contain additional elements.*
3. **Spatially-aware games.** Take into account the surrounding space. Usually only playable in pre-scanned areas and can only be played in those confined spaces like castles or museums. Key features: *Takes into account the environment, not only geocoordinates. Usually limited to a certain area. Associated with AR/mixed reality.*

4. **Geolocation games.** Games which change game elements based on the user's physical location. Key features: *Players accurate location not necessary for gameplay, only takes into account the approximate location of the player.*
5. **LBMMORPGS.** Main gameplay consists of navigating to PoIs. Global. Multiplayer. Includes a shared game world with other players. Key features: *Multiplayer, character building, includes PoIs, navigational interface showing the local map and avatar matching players physical location, global.*

Each game in the data set was downloaded and played by the authors. It was decided based on previous similar studies that one author per game was enough for reliability in the categorization phase [41]. First, the games were viewed independently by one author, and if the category was ambiguous, a second author viewed the game, again independently. All the categories were defined after agreement in discussions.

2.3   Analysis

The current study uses diagrams to visualize the game mechanics of LBGs, which are obtained by looking at the main Gameplay loops [21]. This study shows detailed game mechanic analysis of three LBGMMORPGS: *Pokémon GO*, *HPWU* and *The Walking Dead: Our World* shown in Fig 1. The three games were selected as follows: the most popular game, a newly published game and a different kind of game. In creating the game mechanic diagrams the authors played the games recording the ways players interact with the game world. The interactions were linked to each other and central gameplay loops were derived from the information [21]. In order to then link gameplay in the five LBG sub-genres to potential benefits, the behavioral consequence of the required actions were looked at. Due to complexity of this approach, three main behavioral consequences were focused on: exercise, social interaction and cartographic practice.

3   Results

3.1   Available LBGs

Alavesa et al. [3] list 26 LBGs, Laato et al. [35] lists 56 games. The manual search on Play Store and App Store yielded 184 games, but this number was supplemented in December 2019 with a new search for most recently published games. All available games were tested and at this point the following games were removed:

- Games not be found on App Store or Play Store
- Games which were not available for some other reason

After downloading and testing the applications, the following games were discarded:
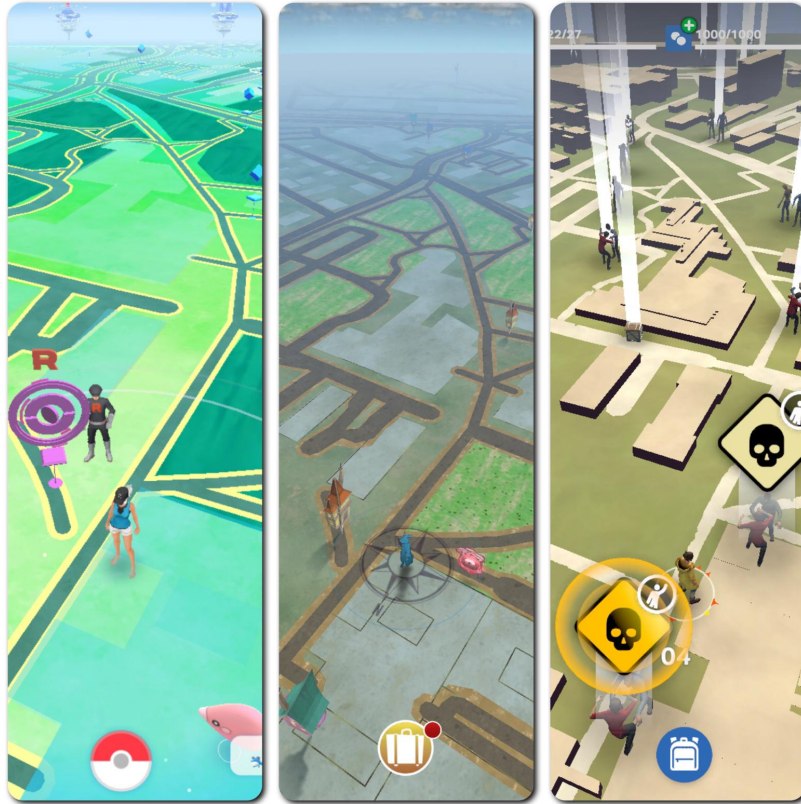
- Applications which were not games

Fig. 1. Screenshots of the three analyzed games.

– Games which were not available in English
– Games which were bugged beyond being able to play them.
– Games which were location-specific (only worked in a certain country, for example) and could not therefore be played.
– Games which lacked server-side support.

After the exclusion phase, 60 games remained (see Appendix A). Many of the found games only had genre tags such as "Adventure" or "Role playing" in Play Store. Currently there does not exist a tag for "Location-based game" which contributed to the fact that some less popular LBGs might have been overlooked by the search. A few borderline cases included *Sharks in the Park*, *Magical Park*, *A very Welly Christmas*, *Bespoke Work* and other similar augmented reality (AR) games. The games were excluded because even though they were AR games and hence location-based in a sense, their main gameplay did not revolve around the users' location in a major way.

3.2   LBG sub-genres

Based on the criteria presented in Section 2.2, the games were sorted into five sub-genres. For a full list of games and their sub-genres, see the Appendix.

3.3   Linking LBG Game Mechanics and Potential Benefits

There are several perspectives from which the potential benefits of existing LBGs can be analyzed. One particularly interesting approach is to observe the game story and look at what kinds of gameplay naturally follow from it, and, consequently, what potential benefits if any that gameplay fosters. Whereas some games like *Ingress* and *Draconius GO* have stories designed specifically for the games, the other popular games, for example, *HPWU*, *Pokémon GO*, *The Walking Dead: Our World*, *Minecraft Earth* and *Jurassic World: Alive* rely on pre-existing brands. However, even though the games are based on cross media franchises, they all still have unique stories designed to support the gameplay. It is not entirely clear how well the popularity of a brand correlates with the popularity of the game, but it is evident that some stories and brands translate better to a LBG than others. For example, the Pokémon brand started as handheld mobile games from the very beginning, and a key part of the brand was "travelling far across the lands, searching far and wide" to collect all available Pokémon, thus providing an ideal setting for a LBG [19]. Elements of *Pokémon GO* were present in many previous Pokémon games as well, for example, *SoulSilver* and *HeartGold* introduced a pedometer called Pokéwalker which encouraged players to walk with their Pokémon, measuring players' footsteps [62]. In fact, Alha et al., [4] found that the main reason players started to play *Pokémon GO* were previous experiences, with either the Pokémon brand or other LBGs.

The following three subsections present each a LBG: the most popular one, a new one and one with differing mechanics from the other two. A diagram of their game mechanics and a table linking observed gameplay to the three potential benefits: exercise, social interaction and cartographic practice are included from all three games. The first game, *Pokémon GO*, was chosen because of its popularity, because it has been found to foster exercise [6], social interaction [66] and cartographic practice [15, 49]. The second game, *HPWU* was released in June 2019, and is currently the latest addition to the set of LBMMORPGs. The game is co-developed by Niantic and Warner Bros Games San Francisco and is based on the Wizarding World of Harry Potter [64]. The third chosen game was *The Walking Dead: Our World*, as it is one of the more popular LBMMORPGS [35] but not developed by the current market leader Niantic. Being developed by NextGames instead, the game was first released in summer 2018 and is based on the popular Walking Dead franchise [24].

Pokémon GO. Fig 2 displays the game mechanics of *Pokémon GO*. It is evident that PoIs are the central part of the game design as almost all gameplay is linked to them. The development history of *Pokémon GO* also shows that the initial game design revolved even more heavily around PoIs, whereas, recent updates

have included other kinds of playing opportunities [47]. With regards to exercise, the game has three main game mechanics supporting it: (1) walking to hatch eggs and to collect buddy candy (2) moving around to find Pokémon spawns and (3) travelling to PoIs. It is not clear by the account of previous studies on *Pokémon GO*, which one of these three reasons, if any, is the main cause for the reported increase in exercise [6, 26, 72]. However, as all three are connected to each other, it is likely that they all play a significant role. Many recent updates on *Pokémon GO* have provided further game mechanics supporting harmonious social interaction between players, beginning from the addition of raid battles in 2017 [11, 47]. The vast amount of social features where players benefit from playing with others, provides opportunities to make lifelong friends, which can be seen as a long term benefit of playing LBGs. Having friends playing the same game also helps players sustain an interest in that particular game [51].
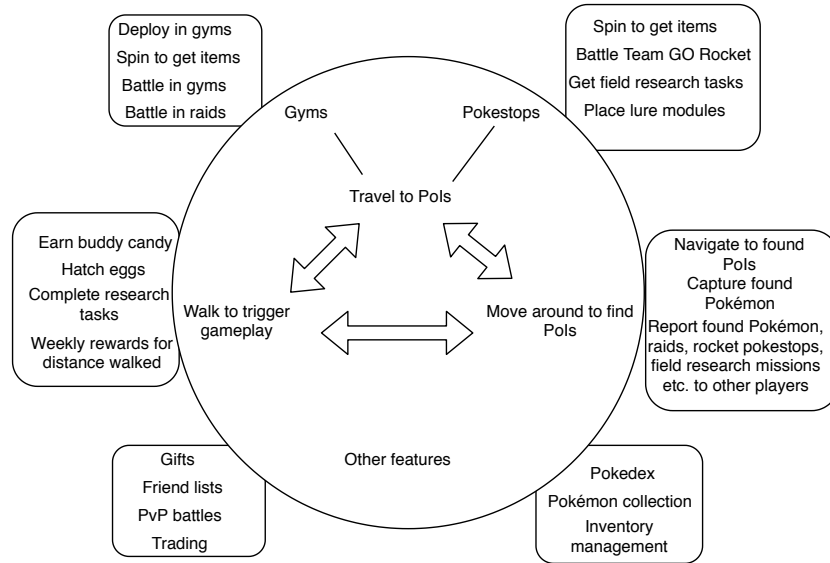

Fig. 2. Gameplay Diagram of Pokémon GO

In addition to the game mechanics displayed in Fig 2, special events such as Community Days and special Safari Zone events are being organized in the game [47]. These help players retain an interest in the game and, for example, Safari Zone events bring players physically together to meet each other. *Pokémon GO* can be played in different ways, and players have multiple reasons to continue playing the game [4]. It is therefore worth considering how various in-game goals affect the value derived from playing. For example, collecting all Pokémon, powering up a strong army of Pokémon and collecting gym badges are goals which the game provides for the player. These provide additional reasons

for players to play and consequently engage in the beneficial activities supported by the game mechanics, which are shown in Table 1. In addition to the direct game mechanics supporting potential benefits shown in Table 1, there are game mechanics which indirectly support the positive outcomes as seen in Fig 2.

Table 1. Pokémon GO game mechanics supporting the three observed potential benefits.

	Exercise	Social interaction	Cartography
Supporting game mechanics	- Travel to PoIs - Move around to find PoIs - Weekly reward for distance walked - Complete research tasks - Walk to hatch eggs - Walk to earn buddy candy	- Participate in raids - Battle in gyms - Place lures - Report available game content to other players - Trading - PvP battles	- Travel to PoIs - Move around to find PoIs - Report available game content to other players

Harry Potter: Wizards Unite. *HPWU* is based on the same database of PoIs as the two other Niantic games in Appendix A *Ingress* and *Pokémon GO* [33, 65], however it contains a partially different subset of them than *Pokémon GO* [34]. Therefore similar benefits and problems of PoI locations are present in the game as with *Pokémon GO* [15, 30, 34]. The game resembles *Pokémon GO* also in design, as it contains many of the same basic game elements, as depicted in Fig 3. These include walking to open portmanteaus, travelling around to find PoIs, travelling to specific PoIs, having a list of friends, levelling up the character, collecting items, engaging in minigames upon PoI encounters and testing abilities in battles among others. The phasing of the game is a lot slower than that of *Pokémon GO*, with more focus on individual encounters, animations and written story. Raids and gym battles of *Pokémon GO* are combined in *HPWU* and called Fortress battles, where players either individually or with a group of friends challenge foes of increasing difficulty. Clearing as strong Fortresses as possible can be seen as the goal of *HPWU*, as they are currently the only place where players can test their accumulated magical powers.

The game mechanics of *HPWU* which support the three main potential benefits are displayed in Table 2. As predicted by the analysis shown in Figs 2 and 3, also the game mechanics supporting potential benefits share a lot of similarities. In addition to the three potential benefits described here, *HPWU* arguably also encourages other kinds of healthy behavior. As the game is based on a brand which started out as children books [64], it is fitting that the game contains a lot of written story. This has the potential of encouraging players to read, and,

because of the mystery aspect of the story, also to discuss and speculate with one another about what is going to happen in the story next.

Table 2. HPWU game mechanics supporting the three observed potential benefits.

	Exercise	Social interaction	Cartography
Supporting game mechanics	- Travel to PoIs - Walk to open portmonteaus - Move around to find PoIs - Daily reward for walking 250m	- Battle in Wizarding Challenges - Report foundables to other players - Friend list - Place Dark Detectors	- Travel to PoIs - Report foundables to other players - Move around to find PoIs

The Walking Dead: Our World. Unlike *HPWU* and *Pokémon GO*, *The Walking Dead: Our World* utilizes PoIs generated automatically in cooperation with Google Maps [34]. The central gameplay of the game is presented in Fig 4. Contrary to *HPWU* and *Pokémon GO*, the game provides no rewards or gameplay for simply walking or travelling. Another difference is the lack of game mechanics pushing players to meet in the real world. The game does have extensive social features however. For example, it is one of the only analyzed games to include a chat feature. The team challenges and social features both have
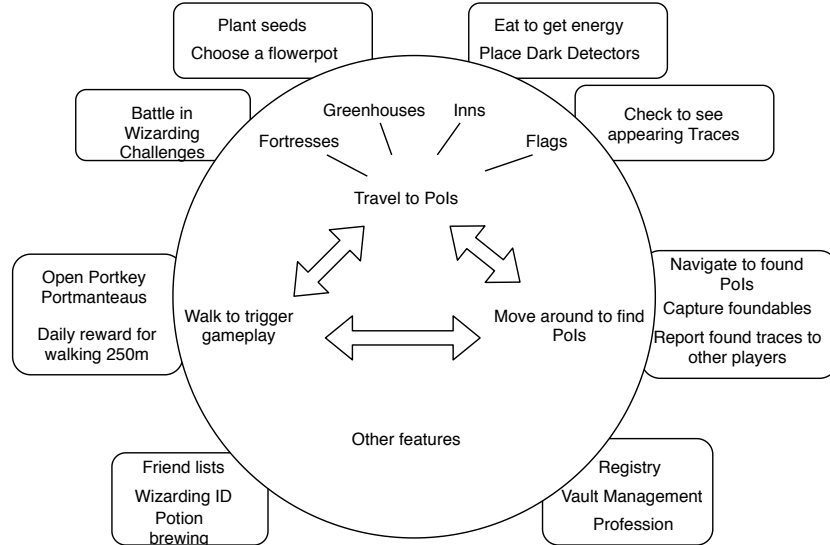

Fig. 3. Gameplay diagram of Harry Potter: Wizards Unite

their own tabs in the main UI of the game, making it evident that it is one of the central motivators for players to travel to PoIs and complete the associated minigames. The other two motives for doing so are completing individual tasks and obtaining rewards to power up the players' heroes, weapons and perks.
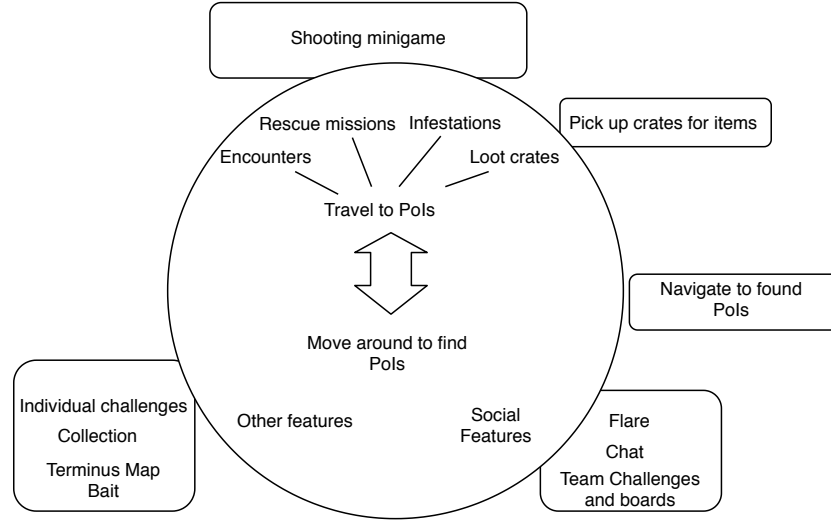

Fig. 4. Gameplay diagram of The Walking Dead: Our World

As the PoIs in the game are generic, it does not matter where the game is being played. Therefore unlike *HPWU* and *Pokémon GO*, the playing environment can be more freely chosen by the player and is not as heavily influenced by the LBG developer. This can be seen as a good thing, however, it also means less reasons for players to travel to new or specific places [34]. Table 3 shows the game mechanics mapped to the three potential benefits. Even though there are less game mechanics supporting potential benefits, this analysis does not take into account the magnitude of the potential benefits. Therefore, hypothetically speaking, *The Walking Dead: Our World* may be a lot more effective in fostering beneficial outcomes for its players than any other LBGs. For this reason, studies on individual LBGs and their outcomes will still be needed in the future.

3.4   Connecting LBG game mechanics and potential benefits

As discussed in the previous paragraph, the intensity of the support for potential benefits must also be taken into account. This is a complex problem and is not solved by existing frameworks such as the LM-GM [9]. With regards to social interaction, each of the analyzed games takes a different approach. *Pokémon GO* has heavy emphasis on meeting face-to-face. This is shown by the game having a large amount of social features, game mechanics which reward players from

Table 3. The Walking Dead: Our World game mechanics supporting the three observed potential benefits.

	Exercise	**Social interaction**	**Cartography**

Supporting game mechanics	- Travel to PoIs
	- Move around
	  to find PoIs
		- Flare
		- Bait
		- Team Chat
		- Boards (team
		  challenges)
			- Travel to
			  PoIs

cooperation, game mechanics which require players to be in the same physical location at the same time and game mechanics which reward players from sharing certain locations such as raids, Pokémon spawns, research tasks and team rocket encounters with one another [47, 66]. In addition, all these mechanics are linked to others, making the game flow well and feel more rewarding to the player. *HPWU* has fortress battles where players go to the same location at the same time, which is similar to raids in *Pokémon GO*, however as players can battle Fortresses at any time and easily alone, they arguably do not provide as strong a push towards meeting other players as raids. *The Walking Dead: Our World* is the only game to include a real chat. However, the game provides no incentives for players to physically meet each other. This design choice is undoubtedly intentional, and might be preferred by certain groups of players wishing for more privacy.
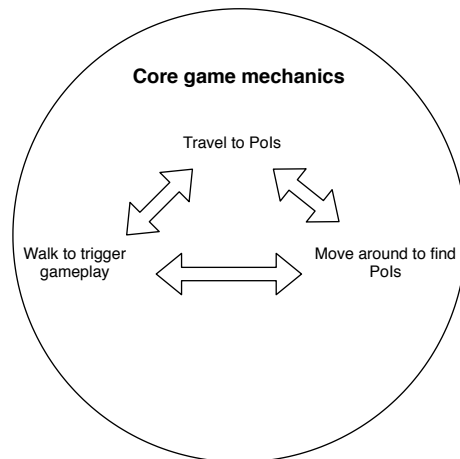
Fig. 5. The core movement based gameplay mechanics of Pokémon GO and HPWU.

With regards to exercise, *Pokémon GO* seems to again be the winner. Despite sharing the main threefold core gameplay supporting exercise with *HPWU* displayed in Fig 5, *Pokémon GO* provides more rewards from moving, has more

game mechanics linked to movement and provides wearable devices which automate some of the playing in order to free resources from the players to focus more on other things such as exercise and movement. *The Walking Dead: Our World* is the odd one out, providing only a single reason for exercise: move around to find PoIs. Depending on the play-style this reason alone can motivate some people to exercise more than they would normally or with any other LBG, however, simply based on the gameplay analysis, it can be conclude that the game has the least support for exercise.

With cartographic, navigational and geographical practice it is more difficult to estimate the impact of the games simply based on the analysis of the current study. However, the PoIs play a major role in this. If the player has a reason to navigate to a certain PoI, obviously this will require navigation and thus support the development of navigational and cartographic skills. If the player is being prompted to look at the map, this is another indicator of the game fostering these skills. Based on these presumptions the Niantic games are clearly better than alternatives due to the portal network and PoIs corresponding to real world locations [65, 33]. Another aspect from which to look at the problem is how the games motivate players to go to certain locations. *Pokémon GO* has a tracker for spawns, raids, gyms, team rocket invaded stops, spawns reported by other players and field research tasks obtainable from a certain stop to motivate players to go to certain locations. The other two games have more generic PoIs with currently very little reason to go to any specific location other than where players want to play themselves. Even though *HPWU* has traces which can be caught by multiple players, based on the authors experiences, these traces disappear too quickly for there to be incentives for players to share them with each other.

4 Discussion

4.1 Key Findings

The overwhelmingly most popular sub-genre in terms of amount of installs, amount of active players and amount of generated revenue are the LB MMORPGs. The analysis of the three case games and their mechanics show the importance of PoIs, as most if not all game mechanics in the analyzed games are linked to them. In games such as *Pokémon GO*, even many social features, which do not require travelling to PoIs, require players to be physically in the same location. There are two aspects of PoIs worth discussing: (1) The quality of the PoI itself [34] and (2) the environment the PoI is located in [65, 15, 30].

The Quality of PoIs It is of huge importance what the PoIs in LBGs represent [18]. Some games such as *The Walking Dead: Our World*, *Draconius GO*, *Minecraft Earth* and *Jurassic World: Alive* have PoIs which are not linked to any real world locations. They serve no other purpose than being PoIs in the game. On the contrary, the Niantic games *Pokémon GO*, *HPWU* and *Ingress* have PoIs which represent locations in the real world [65, 33]. Therefore, in the

Niantic games players are prone to travel to more meaningful places while playing, and to also learn about their surroundings and local environment [18, 49]. What is more, the PoIs in these games serve as social meeting spots. By linking game mechanics into high quality PoIs, and highlighting the importance of certain PoIs, the Niantic games undoubtedly manage what other LBGs do not, they encourage people to meet and talk to each other face-to-face [11, 66]. Even though the positive impact the games have on exercise might wear out [26] the friendships and social skills learned via LBGs will remain [51].

The Playing Environment. Another important element besides the quality of PoIs that arises from the analysis is the playing environment. Poor PoI placement is linked to security and privacy risks [56, 54] and some areas which ought to have PoIs are deprived of them [30]. Tregel et al. [65] suggest that historical places should be given top priority as PoIs, thus directing players to play in environments with historical and cultural value. Tregel et al. [65] proceed to list 20 more levels of PoIs, ranked by order of preference. Certain types of LBG gameplay, however, might bring a lot of players to the same location at once, for example, raids and ex-raids in *Pokémon GO*. The playing environment can be seen as part of the playing experience and the novelty value of the game. Thus, newer games might not be able to spark as huge enthusiasm in the players as older games, as the players have already experienced their neighborhood walking around playing. This can be one of the reasons why *HPWU* did not reach even close the popularity of *Pokémon GO* at launch, even though augmented reality can in theory bring novelty value to familiar environments [15]. Other explanations why *Pokémon GO* reached popularity far greater than *HPWU* might include differences in the attractiveness, popularity and suitability of the brand, the lack of encouragement in *HPWU* to travel to new places, the game itself and its enjoyability, the higher technical requirements of *HPWU* compared to *Pokémon GO* and LBG players' engagement to prior games and thus their lack of willingness to start playing yet another game.

4.2   Limitations

The research design of the current study consisted of (1) searching all available LBGs on Play Store and App Store (2) sorting the apps into LBG sub-genres and (3) Analyzing the game mechanics using an adaptation of the gameplay loops methodology and linking the identified game mechanics to potential benefits. Each of the three parts of the research methodology have their limitations.

Limitations of the LBG Search. Both Play Store and App Store lacked a genre tag for LBGs, therefore there was no automated scripting options available for systematically being able to find all available games. Thus, many sources were utilized in addition to the online app stores' own search engines. Nonetheless, it is possible that this study missed some crucial LBGs. In addition, due to linguistic and location challenges, not all spatially-aware games nor all games in another language than English could be included in the final data set.

Limitations of the Sub-genre Classification. There is an ongoing debate whether game genres should be based on ludology or narratology [10, 14]. The current study took the ludological approach, and based on Laato et al. [35] came up with five LBG sub-genres and their characteristics. The sub-genre classification not only helps in identifying the kind of game that is being discussed, but based on the current work, it also helps predict the potential benefits playing the game. There is currently a lack of studies on how potential benefits of a certain LBG translate to other games of the same sub-genre. Therefore future studies are required to confirm the translating -effect in this context.

Limitations of the Analysis The analysis consisted of observing the game mechanics of three popular LBGs as well as linking potential benefits to them. This methodology was based on the Gameplay loops [21] framework. Then again, when looking at the behavioral consequences of LBGs and linking them to these game mechanics, there is inevitably some margin for error. Games and surrounding culture are complex and can be studied in further detail for more accurate results.

4.3   Implications of Results and Future Work

Developers have tried many strategies to make LBGs pervasive and mixing the game with reality. One of the strategies is the use of AR-elements through the mobile device's camera, a solution which is present in at least *Pokémon GO*, *HPWU*, *Minecraft Earth* and *The Walking Dead: Our World*. However, according to a study by Alha et al. [4] AR-elements are not among the main contributing factors to why people play LBGs. *HPWU* and *Pokémon GO* also have the weather and location that effect the gameplay (in the form of spawns of Pokémon and Traces). In addition to these features, LBGs can use PoI placement to influence where players are going to be playing [15]. However, some games such as *The Walking Dead: Our World* and *Moomin: Move* have generic PoIs with no unique names or other unique info, allowing players themselves to choose where they play. From an educational and social standpoint this decision might not be optimal, as players are not given subtle pushes to move out of their comfort zone, see new places or meet with people.

The meeting of new people and social playing in general can be seen as revolutionary in LBGs compared to other video games and board games. Despite some LBGs, such as *The Walking Dead: Our World* or *Orna* taking the traditional approach of offering mostly gameplay that requires online communication with other players, other games such as *HPWU* and *Pokémon GO* support players meeting in the real world [11, 66]. Therefore, unlike traditional video games where people interact online, LBGs can bring people together to meet face-to-face. The social play and engagement will have an effect on the playing experience of the individual, especially with respect to emotional contagion [28]. When people play together, they share their feelings, both positive and negative, and their moods transfer or at least affect others [28]. This aspect is particularly interesting with respect to the future of LBGs. As social elements intertwine with

the game mechanics, for example in *Pokémon GO*, new kinds of phenomenon are likely to emerge. Social features, especially competition against other players have also been found to have a major role in players enjoyment of a game [68]. In the long run, social relationships and peer communication become the main reason why players keep playing certain games [51].

The importance of the real world environment in LBGs is one final aspect that makes the games unique, and in this, PoIs were mentioned to play a key role. The quality of PoIs not only seems to be linked to potential benefits, but also to the popularity of the games [34]. However, with such a small set of analyzed games, further evidence is required as to whether indeed the quality and locations of PoIs are key factors in the success of an LBG. The classification system for LBG sub-genres provided good results based on which both game mechanics and potential benefits were predicted. This could also be seen in the naming of the games, as many scavenger hunts had "hunt" or "chase" in their name, whereas movement-based games often had "run" or "sprint" or similar terms in their name.

5   Conclusions

Altogether this study found 60 LBGs which were divided into five sub-genres using a ludological approach. Each sub-genre had their own defining characteristics. The most popular sub-genre was LB MMORPGs and game mechanics of three popular LBGs were presented. Three main game mechanics supporting exercise were identified in the games: (1) Move around to find PoIs (2) Move directly to certain PoIs visible on the game interface and (3) Walk a certain distance. All three were present in both *HPWU* and *Pokémon GO*, however, the third analyzed game *The Walking Dead: Our World* only showcased the first one, moving around to find PoIs and to some degree also the second one. The game mechanic (2) of navigating to certain PoIs visible on the game UI was identified as the one primarily responsible for learning outcomes related to cartography, navigation, place attachment, topography and geography. Social interaction was supported the most in *Pokémon* GO, with several game mechanics bringing people physically together and offering benefits from cooperation. *The Walking Dead: Our World* was the only game to include an in-game chat, however, the game had no gameplay pushing players to be physically in the same location.

As PoIs are in a major role in the most popular LBGs, and were also prominently featured among the gameplay linked to potential benefits, their quality and locations need to be considered when designing serious games with location-based features. Unlike with traditional video games, in LBGs the playing location can have a major influence on the gameplay and consequently on the positive and learning outcomes. In addition to game mechanics directly supporting learning, there was indirect support in the games for various implicit benefits. For example, in order for *Pokémon GO* players to do well in battles they had to capture stronger Pokémon, and to do that they would have to participate in raids, which required them to navigate to certain PoIs. To take down strong

raid bosses, players have to cooperate with one another, thus, the game ends up supporting all three major potential benefits studied: exercise, social interaction and cartographic skill development.

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Appendix

Table 4. The games included in the study and their genres part 1.

Game name	Genre
ActionBound	Scavenger hunt
ActionTrack	Scavenger hunt
Agents of Discovery	Scavenger hunt
Bruin Hunt	Scavenger hunt
Clan Race	Scavenger hunt
ClueKeeper	Scavenger hunt
Eventzee	Scavenger hunt
Goosechase	Scavenger hunt
HotCold GPS Treasure Hunt	Scavenger hunt
Huntzz	Scavenger hunt
Locandy	Scavenger hunt
Munzee	Scavenger hunt
Ojoo	Scavenger hunt
Operation Freddy	Scavenger hunt
PlayingMondo	Scavenger hunt
Priatki	Scavenger hunt
Scavify	Scavenger hunt
Social Scavenger	Scavenger hunt
TaleBlazer	Scavenger hunt
The Clan Race	Scavenger hunt
TotoRun	Scavenger hunt
TrailHit - return of the light	Scavenger hunt
TrezzureHunt	Scavenger hunt
Turf Hunt	Scavenger hunt
Agent-X	LB MMORPG
Apocalypse Hunters	LB MMORPG
Blackout Age - LB Survival Craft	LB MMORPG
Dacadoo GO	LB MMORPG
Draconius GO	LB MMORPG
Global Supremacy	LB MMORPG
Harry Potter: Wizards Unite	LB MMORPG
Ingress	LB MMORPG
Jurassic World: Alive	LB MMORPG
Maguss	LB MMORPG
Minecraft Earth	LB MMORPG
Moomin Move	LB MMORPG
Orna	LB MMORPG
Pokémon GO	LB MMORPG
Resources-GPS MMO Game	LB MMORPG
Roams-GPS Village Builder Online Game	LB MMORPG
The Walking Dead: Our World	LB MMORPG
THERE	LB MMORPG
Sprint	Movement-based game
Strut	Movement-based game
The Walk	Movement-based game
Turf	Movement-based game
World of Pixels	Movement-based game
Zombies, Run! (1 & 2 & 3)	Movement-based game
E-Bikefest Mountain Quest	Spatially-aware/Location bound
Global Outbreak	Spatially-aware/Location bound
Oddfellow's Secret	Spatially-aware/Location bound

Table 5. The games included in the study and their genres part 2.

Game name	Genre
Cashsquare - Business trading game	Geolocation game
City Domination	Geolocation game
Greed City - Idle, Business Tycoon Manager	Geolocation Game
LandLord Tycoon	Geolocation game
Merchant	Geolocation game
Mirror land	Geolocation game
QONQR: World in Play	Geolocation game
Revenge of the Gang	Geolocation game
Turf Wars	Geolocation game