UNIVERSITY OF TURKU

# DESIGNING LOCATION-BASED GAMES

## How to support players' social interaction, physical activity and learning about their local environment

Samuli Laato

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*This work is dedicated to my wife Iris.*

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## ABSTRACT

The earliest academic studies on location-based games (LBGs) were conducted in the early 2000's, but the recent upsurge in the popularity and success of commercial LBGs has created a need to re-examine the genre in light of new empirical evidence. In 2016, Pokémon GO brought the LBG genre into a spotlight by being downloaded hundreds of millions of times and generating over 4 billion USD in lifetime revenue to date. Since then, new games such as Jurassic World: Alive, The Walking Dead: Our World and The Witcher: Monster Slayer have emerged. Understanding phenomena related to LBGs is important for various stakeholders from game designers to urban designers and educators.

In this dissertation we take an inductive approach to LBG design by gathering evidence from popular commercial LBGs with six original research articles (Studies I-VI). The studies focus on game mechanics that are unique to the LBG genre, and how reported positive outcomes of playing LBGs can be tied to these mechanics. Through the six studies we derive a game mechanics -focused design framework for LBGs, which we name *the Triune PoI System*, where PoI stands for point of interest. The system consists of three central components: exploration, discovery and navigation, and at the heart of these lies moving to trigger gameplay. The Triune PoI System highlights the importance of LBGs to provide multimodal motivation for players to move and play, and the crucial importance of the playing locations, the PoIs for scaffolding positive outcomes.

We demonstrate how the following benefits of playing LBGs (1) physical activity; (2) social interaction; and (3) learning and discovery; are ultimately tied to the Triune PoI System (Studies I-IV). We also investigate the effects of aggressive marketing and LBG game mechanics on players' well-being (Study V). Here we identify that aggressive marketing can exhaust players, but that the overall LBG playing intensity had a strong significant association with psychological well-being in our sample. We also demonstrate that nostalgia and imagination play crucial roles in scaffolding perceived meaningfulness of playing LBGs (Study VI). Finally, we propose that the popularity of LBGs may be explained by them embodying aspects of the hunter-gatherer lifestyle that are missing in the urban way of living.

KEYWORDS: location-based games, augmented reality, pervasive games, geo games, interaction design, technology design, game design

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## TIIVISTELMÄ

Varhaisimmat akateemiset tutkimukset paikkatietoon pohjautuvista peleistä julkaistiin jo vuosituhannen alussa, mutta pelien viimeaikainen suosio ja kaupallinen menestys antavat aihetta tarkastella paikkatietoon pohjautuvien pelien suunnittelua uuden empiirisen todistusaineiston valossa. Vuonna 2016 julkaistua Pokémon GO:ta on ladattu satoja miljoonia kertoja ja sen suosion inspiroimana on julkaistu sellaisia paikkatietoon pohjautuvia pelejä kuin Jurassic World: Alive, The Walking Dead: Our World sekä The Witcher: Monster Slayer. Näiden pelien ja niihin liittyvien ilmiöiden ymmärtäminen voi olla hyödyllistä monille eri tahoille, kuten pelisuunnittelijoille, kaupunkisuunnittelijoille ja koulutuksesta vastaaville.

Tässä väitöskirjatutkimuksessa lähestytään paikkatietoon pohjautuvien pelien suunnittelua induktiivisesti kuuden alkuperäisartikkelin avulla. Tutkimuksessa selvitetään mitkä ovat paikkatietoon pohjautuvien pelien keskeisimmät pelimekaniikat ja miten raportoidut positiiviset vaikutukset nivoutuvat niihin. Tulokset osoittavat, että suosittujen paikkatietoon pohjautuvien pelien keskiössä on ns. *”Triune PoI System”*, joka koostuu 3+1 komponentista: tutkiminen, löytäminen ja navigointi; sekä liikkuminen. Toisin sanoen pelaajat lähtevät tutkimaan ympäristöään, löytävät sieltä mielenkiintoisia kohteita ja navigoivat niiden luokse. Lisäksi pelien keskeisenä elementtinä on pelkästä liikkumisesta palkitseminen.

Tutkimuksessa osoitetaan, että liikunta, sosiaalinen vuorovaikutus ja oppiminen on suosituissa peleissä, kuten Pokémon GO:ssa, keskeisesti sidottu Triune PoI Systemiin. Lisäksi selvitetään mitä vaikutuksia kaupallisten paikkatietoon pohjautuvien pelien markkinoinnilla ja mikrotransaktiomekanismeilla on pelaajien hyvinvointiin. Tutkimuksessa havaitaan, että markkinointi saattaa väsyttää pelaajia, mutta kokonaisuutena paikkatietoon pohjautuvien pelien pelaamisella ja hyvinvoinnilla on tilastollisesti merkitsevä vahva yhteys. Lisäksi osoitetaan, että nostalgia ja mielikuvitus tukevat tunnetta pelaamisen merkityksellistä. Lopuksi ehdotetaan, että paikkatietoon pohjautuvien pelien suosiota saattaa selittää niiden tarjoamat metsästäjä-keräilijäelämän aspektit, joista urbaanissa miljöössä elävät ihmiset jäävät arkielämässään paitsi.

ASIASANAT: paikkatietoon pohjautuvat pelit, lisätty todellisuus, pervasiivinen peli, geopeli, vuorovaikutusmuotoilu, teknologiasuunnittelu, pelisuunnittelu

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11th of April, 2021
*Samuli Laato*

SAMULI LAATO

I graduated as a master of software engineering (tech.) from University of Turku in 2016. I first worked as an educational game developer (2015-) before starting my PhD studies in autumn 2017. During 2017-2021 I worked also in four other projects: (1) UNIPS where we developed online courses on pedagogy for university teachers, (2) GrowingMind where I continued developing educational games, (3) AI Academy, where we created an online course on AI and cybersecurity; and (4) AIGA which focused on AI auditing and governance.

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# Abbreviations

| | |
|---|---|
| PTS | The point of interest triune system |
| ExDiNa | Explore, Discover, Navigate. |
| LBG | Location-based game |
| PG | Pervasive game |
| AR | Augmented reality |
| MMORPG | Massive multiplayer online role playing game |
| OSM | OpenStreetMaps |
| PoI | Point of Interest |
| SDT | Self-determination theory |
| FoMO | Fear of missing out |

# List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals. Samuli Laato was the first author in Studies I-VI and was responsible for the research design, data collection and writing of the manuscripts. He was also responsible for data processing with the exception of Study V and major parts of Study II. All co-authors provided crucial feedback and contributed to the manuscripts in various ways.

I Laato, S., Hyrynsalmi, S., Rauti, S., Islam, A.K.M.N., and Laine, T.H. Location-based Games as Exergames- From Pokémon to the Wizarding World. International Journal of Serious Games, 2020; 7(1): 79-95.

II Laato, S., Inaba, N., Paloheimo, M., and Laajala, T.D. Group Polarisation Among Location-based Game Players: An Analysis of Use and Attitudes Towards Game Slang. Internet Research, 2021; ahead of print.

III Laato, S., Rauti, S., Laato, A., Laine, T.H., Sutinen, E., and Lehtinen, E. Learning History with Location-Based Applications: An Architecture for Points of Interest in Multiple Layers. Sensors, 2021; 21(1): 129.

IV Laato, S., Pietarinen, T., Rauti, S., and Sutinen, E. Potential Benefits of Playing Location-Based Games: An Analysis of Game Mechanics. In: Lane H.C., Zvacek S., Uhomoibhi J. (eds) Computer Supported Education. Revised selected papers of CSEDU 2019. Communications in Computer and Information Science, 2020; 1220: 557-581.

V Laato, S., Islam, A.K.M.N., and Laine, T.H.. Playing location-based games is associated with psychological well-being: an empirical study of Pokémon GO players. Behaviour & Information Technology, 2021; ahead of print.

VI Laato, S., Rauti S., Islam, A.K.M.N., and Sutinen, E. Why playing augmented reality games feels meaningful to players? The roles of imagination and social experience. Computers in Human Behavior, 2021; ahead of print.

# 1 Introduction

*"We walk, we explore, we find, we get a reward."* -Mattias Thurén

Most humans live in urban, industrialized societies. Our way of living radically differs from that of our hunter-gatherer ancestors. We are more sedentary, we exercise less and we spend less time gossiping and telling stories to each other [1]. By contrast, we have at our disposal all the advantages of technology and the industrialized society from healthcare and education to various sorts of entertainment. The negative consequences of the urban lifestyle may be seen, for example, in the form of the obesity epidemic that is largely attributed to a sedentary lifestyle and consumption of fast food [2]. Through comparing the hunter-gatherer way of living to the urban lifestyle, we also notice two other potential issues in the form of people's unwillingness to go meet other people in the real world [3] and being grounded to a relatively small area on a daily basis, and hence, missing out on enthusiasm from discovering new areas and places [4].

Technology has potential to assist in these struggles, by providing guidance, motivation and even opportunities for people to live a more healthy life. Location-based games (LBGs) are developed for mobile devices and make use of internet connectivity and satellite navigation to transform the players' physical location as a central game mechanic. Thus, moving around in LBGs happens by moving around in the real world. From this starting point, there is a plethora of ways LBGs can be designed and implemented. LBGs have recently gained a lot of traction in the scientific community by reported improvements on physical activity (e.g., [5; 6]), increased social interaction [7; 8] and even well-being [9]. Following these reports, some scholars have predicted that LBGs such as Pokémon GO could be a game changer in the global physical inactivity crisis [10] and furthermore, help people stay mentally healthy and active during times such as the COVID-19 pandemic [11]. These reported benefits alone warrant further research on LBGs and their influence on human behavior. The issue is that the phenomena are extremely complex and influenced by a myriad of factors ranging from player personality [12], playing location [13; 14] and game mechanics [15] to the outdoor weather and time of the year [16].

Due to the complexity of video games and LBGs, it is impossible to formalize all factors influencing an individual game and its outcomes [17]. Recent work on LBG design suggests that simply including game elements with positive outcomes does

not guarantee playing will feel worthwhile, nor that players will play the game [18]. In fact, LBGs can potentially have adverse consequences in that the game steals away time from other, more fruitful pursuits [19]. Thus, LBG designers need to carefully consider various tensions and trade-offs in their design [18]. A thing that in particular differentiates LBGs from other video games is the inclusion of the physical world as part of gameplay [17]. As moving in the real world is a central game mechanic, factors such as the players' physical shape [17] and the playing location [14] need to be considered. While a significant amount of academic research has been conducted on ad hoc LBGs for research purposes (e.g., [20; 21; 22], there is a research gap on how to connect positive outcomes identified in popular commercial LBGs to their game mechanics [15].

In this dissertation, we focus on LBG design from the perspective of looking at the most popular commercially available LBGs. We study the outcomes of playing these games, observe their game mechanics and connect the outcomes to the game mechanics. This work consists of six studies. The first three studies look at how LBGs (1) promote physical activity (Study I); (2) increase face to face social interaction (Study II); and (3) enable the discovering of and learning about new places (Study III). We then turn to observe how these positive aspects may be related to specific game mechanics (Study IV), and what kind of a contribution LBGs have on the overall psychological well-being of players (Study V). Finally, we discuss other game design aspects involved in LBGs such as story, AR features and imagination (Study VI).

# 2 Background

## 2.1 Clarification of terminology

By definition, LBGs are AR games that make use of the player's physical location and integrate it to gameplay [23]. To do this technically, the games harness mobile devices and an internet connection, and capture the user's location via satellite navigation sensors such as GLONASS or GPS. Over the years there have been many kinds of LBGs and also a wide variety of terminology that has been used to describe them [24]. Thus, some clarification on this matter is needed.

LBGs can be conceptualized to be a sub-category of pervasive games [25]. However, there are many other terms that have been used to describe LBGs. Looking at the most popular LBG Pokémon GO, the game has been discussed in the scientific literature as a location-based AR game [26], a pervasive game [27; 28], a mobile augmented reality game [29], an augmented reality smartphone game [30], an LBG [31] and a location-aware (collection) game [32]. In addition, in the broader literature there are many other terms describing LBGs. These include context-aware games [33], geogames [34; 35] and augmented reality; hybrid-reality; and mixed reality; games. Note that these are not all synonyms for LBGs, rather LBGs can be classified in terms of other game genres as well. Furthermore, the general public has come up with some slang terms for these types of games including the GPS-game. In this work, we stick to using the term LBG as we feel it is a balance between being short yet descriptive compared to alternatives.

The LBGs we study in this dissertation are all massive multiplayer online games. This means players share the game world with other real players and interact with one another through the game world - mediated by their in-game characters.

## 2.2 Popular LBGs

Pokémon GO is currently the most popular LBG out there in terms of number of active players and amount of generated revenue, but there exists over 50 commercial LBGs that are currently available in the Google Play and iOS App Stores [15]. In addition, educational and other serious LBGs have been developed (e.g., [20; 36]). In this section we discuss six popular LBGs that are studied, or whose players are studied in this dissertation. These games are Pokémon GO (focused on in Studies

I, II, IV, V and VI), Harry Potter: Wizards Unite (focused on in Studies I and IV), Ingress Prime (focused on in Study II), The Walking Dead: Our World (focused on in Study IV), Orna and Jurassic World: Alive.

### 2.2.1 Pokémon GO

Developed by Niantic in cooperation with the Pokémon Company, Pokémon GO was released in summer 2016 worldwide. The game became extremely popular, and with little advertising was downloaded over 500 million times during the first few months after release [26]. Pokémon GO can be considered the first mainstream LBG game, vastly exceeding the popularity of previous entries in the genre [33] and creating a new renaissance for location-based gaming. A screenshot from Pokémon GO appears in Figure 1.

The core idea of Pokémon GO is to *"travel across the lands, searching far and wide"* [4] in order to discover, capture and collect pokémon creatures. Upon launch, only 1st gen pokémon were available in the game (151-6 = 145, Mew, Mewtwo, Ditto, Zapdos, Articuno, Moltres) but later updates have added new pokémon and the current number of available pokémon already exceeds 600. Previous work on the Pokémon franchise have suggested that the pokémon creatures play a major role in why people are engaged with Pokémon games, and that this may be related to biophilia i.e. human innate desire to catalogue and get to know other living life-forms [37]. In addition to collecting pokémon, Pokémon GO includes territorial conflict in the form of capturing and controlling geographically distributed virtual PoIs [38] and a set of other mechanics. These mechanics are analyzed in further detail in Study IV.

### 2.2.2 Harry Potter: Wizards Unite

Harry Potter: Wizards Unite was released in summer 2019 for both Android and iOs. Developed by Niantic in cooperation with Portkey Games and Warner Bros. San Francisco, it is the third major global LBG by the company and is based on the popular Harry Potter franchise and books by J.K. Rowling. The game is in many ways similar to Pokémon GO. Instead of pokémon, here players move around to find magical traces which players are tasked to collect. Perhaps the biggest difference in comparison to Ingress and Pokémon GO is that the game does not have any competitive game elements. In fact, players cannot interact with one another in the game world in any other way than cooperating in a fortress minigame and planting magical seeds at greenhouses. A screenshot from Harry Potter: Wizards Unite appears in Figure 1.


**Figure 1.** A screenshot from Harry Potter: Wizards Unite (left) and Pokémon GO (right) taken by the author.

### 2.2.3 Ingress Prime

Ingress Prime (known previously as Ingress) was the first LBG developed by Niantic and was released in 2013 for Android and in 2014 for iOS. The game consists of navigating to geographically distributed virtual PoIs that correspond to real world locations, capturing them and creating triangles between three PoIs to get points. The more people live inside the area the player captures the more mind units (points) they get. There are two factions in the game which compete with one another over mind units. A screenshot from Ingress Prime appears in Figure 2.

Upon release, there existed very few PoIs in the game. However, Niantic enabled players to submit their own PoIs for Niantic to review and subsequently add to the game [39]. The database created by Ingress players was later utilized in the later games of Niantic: Pokémon GO and Harry Potter: Wizards Unite [14; 39].


**Figure 2.** A screenshot from Ingress Prime (left) and Orna (right) taken by the author.

### 2.2.4 The Walking Dead: Our World

The Walking Dead: Our World, based on the Walking Dead franchise, was developed by the Finnish company NextGames and released in summer 2018. While the above described three Niantic games construct their world on top of their own virtual PoI database, The Walking Dead: Our World makes use of the Google Maps API to pseudo-randomly create generic PoIs. By contrast, the game has a better PoI coverage in rural areas [14]. Players in The Walking Dead: Our World are tasked to move around to find PoIs which initiate a minigame. Players collect cards of weapons and heroes which they can then level up to become more powerful. In this way, the game closely resembles Pokémon GO and Harry Potter: Wizards Unite. However, The Walking Dead: Our World lacks rewards from simply walking.

### 2.2.5 Orna

Orna is a one man project published by Cutlass Software and released in summer 2018. The game follows a similar pattern than Pokémon GO, The Walking Dead: Our World and Harry Potter: Wizards Unite in that the player navigates in the real world to find enemy encounters. Clicking on an enemy initiates a small minigame which gives the players rewards. The game also contains territorial conflict in the form of dividing the globe into areas which players can own indefinitely unless challenged by other players. A screenshot from Orna appears in Figure 2.

### 2.2.6 Jurassic World: Alive

Developed by Ludia Inc. and released in spring 2018, Jurassic World: Alive follows a familiar pattern. Players move around in the real world to discover dinosaurs, and tapping them initiates a minigame. Players are tasked to discover and collect various dinosaur species. Collecting enough of a certain species gives the player the ability to upgrade and mutate dinosaurs into new forms. In this regard Jurassic World: Alive is similar to the above described games, but the game is also different in other aspects. For example, Jurassic World: Alive does not have territorial game mechanics and virtual PoIs that are connected to real world objects. But then again, the game does have a quite elaborate dinosaur fighting mode where players can battle against each other with dinosaurs they have captured or evolved.

### 2.2.7 Synthesis

The six games that are present in this study all share a set of similarities. First, they are massive multiplayer online games and players' share the same game world. Second, moving around in the game happens by moving in the real world. Third, the games include virtual geographically distributed PoIs where players are tasked to navigate to. There are also notable differences. For example, the Niantic games are built on a database of virtual PoIs that correspond to real world objects [14; 39], while the others resort to pseudo-randomly generate PoIs. Pokémon GO and Harry Potter: Wizards Unite also contain some pseudo-randomly generated PoIs in addition to the fixed ones.

## 2.3 Popularity and influence of LBGs

According to Statista, the overall video game market value in 2020 was 159 billion USD with a projected growth to 200 billion by the year 2023 [40]. The LBGs' share of this is still relatively small (around 1 billion in 2019) [41]. However, in 2020 even after four years of its initial release, Pokémon GO is generating almost a billion USD

of revenue each year [41].

LBGs, in particular Pokémon GO, have received a lot of media attention. One of the reasons for this is that it is played outdoors, and hence, the players can be seen walking around in the streets. Educators have also taken advantage of this. For example, an activity was proposed for social science students to observe Pokémon GO players and take notes of their behavior [42]. Through following players on-campus and during summer holidays, they could compare geographical (and cultural) differences in player behavior [42]. LBGs have also the ability to influence their players' movement patterns [13], and for example, the game Ingress hosts regularly events called Anomalies which gather up to thousands of players to parks and other major venues in cities [43]. Because of these, LBGs are of interest to the tourism business [9], but as there are multiple LBGs and their popularity varies over time (e.g., one game might be popular for a year, but then die out), it is difficult to draw reliable inference on the influence of LBGs generally on education, human movement and other domains.

The LBG scene is a mixture of academically developed ad hoc games (e.g., [20; 22]) and commercially developed products such as Pokémon GO and Jurassic World: Alive. Typically the academic projects are more experimental and are built to study specific phenomena, whereas the commercial products are played voluntarily. From an academic perspective, there is value in both studying ad hoc games and studying commercial games. While ad hoc games created by researchers are typically only studied by individual study groups, commercial LBGs can be studied by several groups of scientists around the world, making the research results comparable and subsequently more reliable. A good example here is Pokémon GO, which has been studied an order of magnitude more than any LBG developed for academic purposes [6]. Accordingly, it makes sense to approach LBG design from the perspective of commercially successful games.

## 2.4 Previous work on location-based game design

### 2.4.1 Game mechanics specific to LBGs

Liberati conceptualizes LBGs to add a layer on top of the paramount observable reality [44]. The AR content created by LBGs can, at least in theory, replace real world physical objects and obfuscate our understanding of the differences between physical and virtual [45]. In addition to adding something to the real world, and being influenced by events in the real world, what differentiates LBGs from other video games are essentially the use of movement and location as part of the playing.

Previous work had discussed a wide range of movement-based game mechanics for LBGs. These include navigating to objects, following a specified path, following a moving object and triggering gameplay through movement [46]. In addi-

tion, studies have discussed the possibility to implement territorial control which involves players travelling to a specific geographical virtual PoI and claiming it in their name [47; 48; 38]. By directing players to specific geographical locations, LBGs can also facilitate face to face social interaction between players [7] as a repeating core game mechanic.

Kim et al. [18] list four tensions that arise in commercial LBG design. First, accuracy and reliability of in-game data vs variability of rewards, meaning that the more elaborate rewards LBGs try to offer, the more cheating opportunities emerge. Second, engagement vs unhealthy obsession, meaning that if LBG developers make a too addictive and intensive game, (for example, through leveraging aspects such as territoriality too much [47; 48; 38]) players may become obsessed and exhaust themselves over short term instead of being engaged in the long term. Third, how much sociality is enough, meaning that some players may not like too heavy an emphasis on social interaction. Fourth, to what extent the real life and the game can be linked, meaning that for global LBGs, it is difficult to create experiences that would work equally well across all demographics [18]. In fact, there may even be a danger that some LBG features working well in one country (or context) may suddenly be dangerous in another.

### 2.4.2 Creating scalable LBGs

One of the major challenges in LBG development relates to making them scalable, that is, create games that work not only in a limited geographical area but can be released to the global population and be operated for extended time periods [49]. As solutions, past work has suggested the use of crowdsourcing [39; 50] as well as harnessing open map data [51; 52].

The first solution to consider is the use of open map data. Free solutions such as OpenStreetMaps (OSM) and proprietary solutions such as Google Maps have both been used by LBG developers [51]. These platforms are constantly being developed, but have their limitations when considering using them solely as the backbone of LBGs. Primarily, they do not currently offer adequate support for identifying real world PoIs that would be meaningful in-game PoIs for LBGs [14; 51]. There is also the issue that once LBG players would realize the connection between the open data source and the game they are playing, players might engage in cartographic vandalism in order to obtain advantage in the LBG. This has actually been reported to have happened in the case of Pokémon GO [53].

Pioneering work on crowdsourcing on gamification suggests that cooperation was preferable over competition in a gamified location-based parking spot reporting app [50]. However, inter-team competition was found to combine positive aspects of both competition and cooperation [50]. Another important work on how to motivate LBG players to participate in crowdsourcing comes from Neustaedter et al. [49] who

focused on lessons learned from the popular geocaching app. They list ways that make it easier for players to contribute, out of which four are still relevant in global LBGs as we understand them in 2020.

- Lightweightness. It has to be easy and low-effort for players to create content.
- Uniqueness. Players may feel more motivated if they can contribute to the game world, leave their mark in the game world and experience unique situations.
- Game customs. Players have to be able to understand in-game customs, evolve them over time and even use their knowledge of customs to create new exciting content.
- Maintenance through monitoring. Players can be harnessed as a resource to monitor and maintain law and order in the game world.

To summarize, in order to create scalable LBGs, crowdsourcing the creation and maintenance of the PoI database to the players shows great promise. However, the challenge here is that the crowdsourcing needs to be somehow linked to the LBG itself, in order to create a self-sustaining loop where players take care of the PoI database. The biggest pitfalls here include cartographic vandalism [53] where players intentionally damage the integrity of the PoI database to gain advantage for themselves; as well as maintaining players' motivation to contribute [50].

## 2.5 Research questions

LBGs and video games more generally can have various positive and negative outcomes. Among the positive, for example, are delivering meaningful eudaimonic experiences [54] and bringing players together for social interaction [7]. LBGs can be viewed as serious games, in that they serve a role that goes beyond entertainment [43], as they facilitate, for example, exercise [5]. In the following we formulate six research questions related to LBGs that connect selected outcomes of playing and the general design of LBGs. Each research question presented here corresponds to one of the core studies (Studies I-VI) that constitute this dissertation.

### 2.5.1 Physical activity

In urban societies people on average are not naturally getting enough exercise [10]. To compensate, people oftentimes go out jogging or go to the gym. This requires will power, and as humans have a natural tendency to preserve their energy, many times we need to go against our own primal urges to exercise. Because exercising has turned into a motivational problem, several solutions aiming to make exercise easier

have been proposed. Gamification approaches, harnessing social pressure [55] or giving players' rewards for jogging [56] are just among few of these solutions.

LBGs are unique in that they can offer multiple motivating mechanisms for physical activity at the same time. They combine rewards from walking or moving [56] and socializing [55] with goal-oriented moving i.e. travelling to specific locations [46]. There are two studies which have compared the exercise provided by LBGs to non-players. Hino et al., [16] discovered that there was no major difference between players and non-players during summer-time, but during winter, LBG players moved more. Interestingly, Beach et al., [19] noticed that when going out for exercise, playing Pokémon GO was linked to less strenuous exercise.

Past work on LBGs has identified four game mechanics through which players can be nudged to move: (1) prompt them to navigate to an object; (2) prompt them to follow a path; (3) prompt them to follow a moving object; and (4) trigger gameplay through movement [46]. In general, if LBGs are able to tie their central gameplay to one of these four game mechanics, the hypothesis is that playing the LBG will lead to increased exercise. After that, it is only up to the game to make sure it keeps players engaged to sustain a source of daily exercise. Work on the impact that LBGs such as Pokémon GO have on players' physical activity has reported a sharp increase in activity after downloading the game, but which then slowly decreases over time to almost base level [5]. However, these studies may be biased in that they include in their data players who lost their interest or just quit the game. For example, the previously mentioned study by Hino et al. [16] showed that players who kept on playing LBGs in Japan were in particular more active than a comparison group during winter time.

An issue with understanding the impact of LBGs on physical activity is that the literature on the topic is disjointed, and often times disconnected from game mechanics. Several literature reviews have been published on the impact of Pokémon GO on physical activity, all of them reporting an increase in mild exercise in the form of increased distance travelled and increased number of steps taken [57; 58; 6; 59]. However, when players stop playing, the improvements on physical activity also disappear [59]. Thus, Pokémon GO in particular may not lead to the adoption of any permanent behavioral change.

Individual LBGs may also motivate exercise to varying degrees. Therefore, when a new LBG comes out, it is difficult to predict what kind of an impact it will have on players' physical activity. To address this research gap, we aim to derive the general characteristics of LBGs as exergames, moving beyond the research done in the context of individual LBGs. This will be in primary focus in Study I. Accordingly, we formulate the following research question.

**RQ1:** What are the characteristics of LBG as exergames, i.e. games that motivate exercise? (Study I)

### 2.5.2 Social interaction

There are undeniable social benefits from playing multiplayer games, or simply discussing games with friends. However, too strong a social presence in the online world can also lead to video game addiction [60]. An interview study with adolescents showed that other real players were one of the four most significant factors impacting the perceived meaningfulness of a game [54]. There are many ways in which games can be social. These include online multiplayer games, LAN (local area network) meetups and console gaming where players come physically to the same place to play and AR, pervasive and mixed-reality games and LBGs that integrate the game world with paramount reality [44]. Because LBGs contain both online and offline elements, they can be viewed as games that bring players together both through the internet and the real world. In this sense the games are unique, as they facilitate two types of interactions that are usually discussed separately [60]. Here, we also discuss the two kinds of social interaction separately.

While LBGs are played outdoors, they have several online components, and even gameplay that can be played by being stationary such as Fortress battles in Harry Potter: Wizards Unite and the Global Battle League in Pokémon GO. In addition to the actual game, players regularly form chat groups where they engage in conversations with other players about the game, events and what to do in the game [61; 62]. These conversations can be utilized, for example, in the context of Pokémon GO to agree on raids, trades and community meetups. The online component of LBGs may be less significant depending on the game in question. In particular, games that have less interaction possibilities between players may also provide fewer incentives for players to form online chat groups. Some LBGs such as Orna and The Walking Dead: Our World provide in-game chats for players. However, not all players use this and may still prefer to communicate through other online sources including Reddit [61], Telegram and WhatsApp [62].

The importance of face to face social interaction was highlighted in 2020 when the COVID-19 pandemic forced governments to issue restrictions on the social lives of citizens to curb the spread of the disease [63; 64; 65; 23]. A longitudinal study demonstrated that social isolation measures were linked to overall increase in anxiety and negative feelings [66]. Even without the COVID-19 pandemic, phenomena such as *hikikomori* (severe social withdrawal) have been observed within urban societies [67]. The possible reasons for social anxiety and withdrawal are several. A study by Jeong et al., [60] found that people with high real world social self-efficacy were less likely to develop video game addiction, but by contrast, people with high online self-efficacy were more likely to play video games and develop symptoms of addiction. LBGs are an interesting case example in this debate, as while they are video games, they direct players to go outside and expose themselves to the social norms of the real world [68]. The ability of LBGs to motivate people to go outside

has prompted scholars to suggest that games such as Pokémon GO may be useful interventions for curbing *hikikomori* [3].

Research on LBGs' ability to bring players together for real world interaction has focused on individual mechanics such as raids [7] as well as the overall impact of the games [15; 8]. Slingerland et al., [69] suggest that collaboration in LBGs can be particularly engaging and that it can motivate other beneficial outcomes such as exploration of the local neighborhood. Community identification can also boost players' willingness to control virtual territory in LBGs [48]. For these reasons, it is important to understand how LBGs can scaffold social interaction, bring players together in the real world and enable players to form lasting friendships with one another. We summarize these goals into the following research question that we set for our work on understanding the aspect of social interaction in LBG design.

**RQ2:** What kinds of effects do playing LBGs have on players' social circles and social behavior? (Study II)

### 2.5.3 Learning and discovery

Past work has provided evidence that LBGs can scaffold players' learning about not only their immediate environment, but about the history of that environment as well [20]. In order to support players' learning of their local environment, players need to be either directed to pay attention to or talk about the environment. Colley et al., [13] demonstrated that LBGs can influence player movement via the placement of PoIs. Another study showed that players can become attached to buildings and objects in their environment, if those places have meaning in the virtual world of LBGs [70]. Taken together, if LBGs aim to teach players about the environment they are playing in, PoIs and their fidelity need to be considered [14]. We already discussed PoI generation approaches in Section 2.4.2- from purely algorithmic approaches to crowdsourcing. However, what needs to be additionally considered is what support various PoI databases offer for LBGs and how LBGs can make use of different PoI approaches.

LBGs can gather players socially around PoIs for extended periods of time to perform actions such as raiding or gym battles in Pokémon GO [7], fortress battles in Harry Potter: Wizards Unite [71], drone-battling dinosaurs in Jurassic World: Alive or infestations in The Walking Dead: Our World. During such events, players may also look around to see where exactly are they standing. Another way for LBGs to motivate players to pay more attention to their surrounds is AR features which are added in many of the popular LBGs [45]. In some games such as the now discontinued Minecraft Earth and The Walking Dead: Our World the AR features require players to find a flat ground for the feature to work. In Pokémon GO for example, players may engage in taking AR screenshots to share with their friends

on social media [72]. Getting a good screenshot also requires players to look around and find a beautiful place. LBGs oftentimes also present players with warnings, stating things such as ”be aware of your surroundings”, indicating that players should never immerse themselves with the game to the degree that they forget the real world place they are in. Specific PoIs can have unique names that correspond to the real world object/place they represent, and thus players gain knowledge about their environment through the LBG application [14]. LBGs may also motivate to travel to specific PoIs, highlighting the significance of that particular place [46]. Of course in addition to all these LBG-related motivations that players may have to look around and get to know the place they are in, we must consider all the motivators related to the real world.

Taken together, all these factors imply that while playing LBGs, players may have plenty of motivation to look around and familiarize themselves with their playing environment. As LBGs attach additional meaning to real world places, this may lead to increased place attachment [70] and even territorial control where players travel to specific real world places just to control virtual territory associated with them [48; 47]. These studies strongly advocate for the importance of PoIs in LBGs in the process of learning about the real world environment and discovery of new places. In fact, studies have found significant differences in the quality of PoIs between various LBGs [14], but it remains an open question what kind of impact this has on the playing experience. Due to the lack of real world data collection opportunities, such a thing is difficult to study with a systematic or objective setup. However, what can be investigated is how the quality of PoIs could be improved so that they would be optimal for learning about the local environment and discovering new places. Thus, in this thesis our goal is to increase the understanding about learning and discovery in LBGs through focusing on answering the following research question.

**RQ3:** How to create points of interest that enable players to learn about their local environment? (Study III)

### 2.5.4 Connecting playing benefits with game mechanics

So far in this section we have discussed three potential benefits associated with the LBG genre: (1) physical activity; (2) social interaction; and (3) learning and discovery. In order to be able to infer whether such effects are universal across LBGs or merely specific to the few case games in which context they have been studied, it is essential to link these potential benefits to concrete game mechanics. Such an approach has been advocated in particular among educational games and serious games [73]. For this, we propose the following research question.

**RQ4:** What are the game mechanics in LBGs to which the observed potential benefits can be linked to? (Study IV)

### 2.5.5 Game mechanics, marketing and well-being

In addition to the positive outcomes, commercial LBGs seek opportunities to maximize their revenue. Pokémon GO, for example, has been successful in terms of monetization, generating almost a hundred million dollars in global revenue each month [41]. Marketing strategies may include tactics such as leveraging social pressure (e.g., in the form of fear of missing out) and tempting people in various ways to make micro transactions. For example, several mobile games implement artificial time limits and other factors that disrupt progression. Players can bypass these barriers with micro transactions. As progression has been identified as a core driver of why players play Pokémon GO [74], this strategy can be considered feasible also in the LBG context. Consequently, understanding the influence of these tactics on players' well-being is important.

Another set of factors related to players' well-being are the game mechanics and the core gameplay loops that players execute. The game mechanics can be numerous, but previous work on LBGs has grouped them into three main categories: (1) individual; (2) competitive; and (3) cooperative [75]. Here it is crucial to point out that not all LBGs contain, for example, competitive game mechanics. As an example, Harry Potter: Wizards Unite only allows players to cooperate with one another. Understanding the impact of various game mechanics on players' engagement as well as the positive outcomes of LBGs can be regarded as a key goal for research. Accordingly, we state our fifth research question.

**RQ5:** What associations do LBG game mechanics, playing intensity and factors related to aggressive marketing have on players' psychological well-being? (Study V)

### 2.5.6 Imagination, shared narratives and AR features

As LBGs are also AR games through augmenting digital content on top of the paramount reality [44; 29], the role of AR features and imagination needs to be discussed in LBG design. We already discussed that an AR mode working through the mobile device camera, which superimposes digital content through the camera lens to the real world, can have the positive impact of directing players' attention to their surroundings. However, these types of AR features also serve another crucial function. They help bring the AR content alive in that it, at least in theory, feels more real to the players [45]. Alavesa and Xu showed that players actively enjoy sharing AR screenshots taken while playing on social media [72] connecting AR-features

also to the social dimension of LBGs.

In the case of the Pokémon franchise, the relationship between the player and the pokémon creatures has a crucial role [4]. There are many factors that can influence this relationship. For example, Balmford et al. [37] proposed that biophilia, the natural tendency of humans to catalogue and get to know other living lifeforms, could explain the success of the Pokémon franchise. Previous work also indicates that nostalgic feelings towards the Pokémon franchise are important in starting to play Pokémon GO [74]. By answering how biophilia and nostalgia impact players' imagination while playing, and subsequently affection towards in-game content we contribute to LBG design by considering the role of the story. Based on the above, we present the final research question of this dissertation.

**RQ6:** What is the role of AR-features, imagination and shared narratives in the perceived meaningfulness of playing LBGs? (Study VI)

## 2.6 Dissertation overview

In summary, to answer the six research questions, we carried out six studies. These are depicted in Fig. 3. Studies I-III investigate three positive outcomes of playing LBGs: exercise, social interaction and learning about the local environment. Study IV connects these outcomes to LBG game mechanics and central gameplay loops [76]. Studies V and VI support the findings by taking into account the role of aggressive marketing, AR-features, shared narratives and imagination in LBG design.

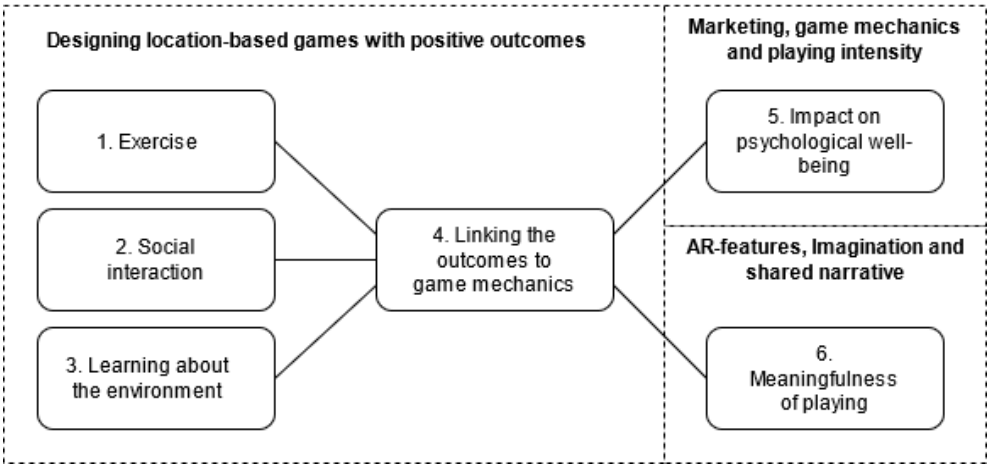


**Figure 3.** The six studies included in the thesis and how they are connected to each other.

# 3 Materials, Sample Validity and Ethical Considerations

## 3.1 Participants and other data sources

This thesis utilizes multiple methodological approaches and data sources. In studies I, II, V and VI we used cross-sectional survey data from self-selected voluntary participants. All participants were LBG players, in our case of either Pokémon GO, Ingress or Harry Potter: Wizards Unite. Study II additionally made use of large scale chat data analysis of semi-open communication channels and participant interviews. Studies III and IV focused on collecting technical data of selected LBGs. In Study III we used in particular two map sources: OpenStreetMaps and the Ingress Intel Map. Study IV was built on game mechanic analysis and ethnographic observations on how LBGs are played in practise.

The sample in study I was sourced from social media groups (Facebook, WhatsApp, Telegram) dedicated to the game Harry Potter: Wizards Unite. These social media groups were formed already prior to the official release of the game by mostly players of Pokémon GO and Ingress. The members were therefore primarily familiar with the predecessors of Harry Potter: Wizards Unite and active members of those communities, which may have introduced some bias to the sample.

Study II used three data sources. First, communication channels of three Pokémon GO teams (Valor, Instinct, Mystic) were retrieved in 2019. Two additional chat channels (one common for all teams, and one sub-channel of team Mystic) were obtained. Altogether, these chat channels contained 242,852 words dating from summer 2016 until spring 2019. This was longitudinal field data specific to a certain cultural region in South-Western Finland, and specific to a particular game, Pokémon GO. A subsequent survey (N=185) was sent to members of both Pokémon GO and a related game Ingress through the same chat channels that were observed in the first stage. After this, selected participants (N=25) were interviewed. These were recruited using the authors' extended networks and comprised of the same people who responded to the survey in the previous stage. The sample in Study II has internal validity, but is still culturally and geographically limited to a specific area and specific player groups. Furthermore, as the social phenomena observed in this work were tied to two games (Ingress and Pokémon GO) the findings need to be understood in the context of specific game mechanics that these games have. In particular, static teams and

inter-group territorial conflict over resources [48; 38].

Study III contained no human respondents. It was based on an analysis of PoIs in popular LBGs and in OSM. Similarly, Study IV was based on a technical analysis of popular LBGs.

Study V was based on data collected from Finnish Pokémon GO players with a survey distributed on Facebook (N=855). This dataset was collected during the early stages of the COVID-19 pandemic in April, 2020 and may contain some minor biases due to this circumstance. However, with regards to the control variables in the study (age, gender) the sample can be considered reliable and diverse, and it aligns with other studies which have used data from the same source [74]. Interestingly, over half of respondents (56,2%) were max level, meaning the sample consisted of highly active players. This may also be a source of bias in the sample.

For Study VI, we initially sent the survey first to a small local group of LBG players (n=15) for comments on the understandability of the survey before distributing it to Reddit, where we obtained a global sample of Pokémon GO players (N=511). As opposed to the sample in Study V, here the majority of respondents were male (66%). Furthermore, a majority of respondents came from the USA (43%) which shows a geographical bias. Despite these shortcoming, the sample can be considered a reliable presentation of Pokémon GO players who actively use Reddit.

## 3.2 Advantages and bias risks within the empirical studies of this dissertation

In summary, the samples and analyzed LBGs in Studies I-VI contain some inherent advantages over previous work, but also potential biases. The advantages are summarized in Table 1.

**Table 1.** Advantages of the research approaches

| **Advantage** | **Description** |
|---|---|
| Popularity of the analyzed games | Compared to studies focusing on ad hoc LBGs, our work has the advantage of studying LBGs that are voluntarily played and enjoyed around the earth |
| Comparability of the findings | As we focused on LBGs that were well-known across the research community, our findings could build on and be compared to previous research on the same games |
| Participant integrity | While participants were self-selected, they maintained anonymity and were given the opportunity to provide truthful and accurate responses |
| Methodological diversity | We used a wide range of data sources in this thesis from technical information, chat log data and online surveys to participant interviews |

The empirical studies included in this dissertation also contain the potential biases that need to be considered when generalizing the findings. We summarize these in Table 2.

**Table 2.** Risk of bias of the research approaches

| **Risk of bias** | **Description of the risk** |
|---|---|
| Heavy focus on specific games. | To counter this, two studies dealt specifically with the issue of generalizability of the findings (Studies I and IV). |
| Geographical and cultural bias. | Samples in Studies I, II and V were all sourced from a sample of Finnish players. |
| Age group bias. | All participants in studies I, II, V and VI were adults. |
| Self-selection bias. | Participants in studies I, II, V and VI had to volunteer to participate in the study. |
| Cross-sectional data. | Cross-sectional data were utilized in Studies I, II, V and VI. This poses an issue for establishing causality. For example, Study V investigated the relationships between playing intensity and psychological well-being. With longitudinal data we could have investigated whether this relationship was causal, however, here we merely reported an association. |

## 3.3 Ethical considerations

Studies III and IV were purely technical analyses with no human participants. However, studies I, II, V and VI contained human participants. In each of these three cases, participants were self-selected and their permission was explicitly asked about whether they agree to participate in research or not. All participant data were collected in our case through the online survey tool Webropol and never stored outside the University of Turku computers and servers. Participant anonymity was ensured in all reporting.

In Study II we collected chat data from semi-open discussion channels. Due to the potentially sensitive information in this dataset, we decided to not report any specific sentences from it, since an informative reader could theoretically link the sentence to a specific person. Especially as we were dealing with a very recognizable slang word ”jym”. Instead, we reported only frequencies of the slang term use, and whether it was discussed as a topic or as a subject.

# 4 Overview of the studies

## 4.1 Physical activity (Study I)

**Laato, S., Hyrynsalmi, S., Rauti, S., Islam, A.K.M.N., and Laine, T.H. Location-based Games as Exergames- From Pokémon to the Wizarding World. International Journal of Serious Games, 2020; 7(1): 79-95.**

The purpose of this study was to investigate whether the well documented effects of Pokémon GO on physical activity [57; 58; 6; 59] apply to a novel similar game. With this approach, the study provides evidence towards the generalizability of findings in the context of Pokémon GO. Theoretically this study is based on comparing Harry Potter: Wizards Unite with other LBGs, primarily the most popular LBG Pokémon GO.

In this work, following prior literature on LBGs, we derived five common characteristics related to exercise provided by LBGs.

- Increases mild exercise.
- Can be a gateway for exercise for inactive people.
- Provides multi-layered motivation for exercise, including in-game rewards and social features.
- Its' playing can be integrated as part of daily commute and other travelling.
- Shows promise of other health benefits besides exercise, such as social well-being.

Based on these characteristics, we formulated a survey for players of Harry Potter: Wizards Unite. For exercise, we used the Godin-Shephard leisure time physical activity questionnaire [77], to make it comparable with studies on Pokémon GO that also have used the same instrument [78; 79; 80]. The survey also contained other questions such as asking players to report their initial perception on which game motivates exercise more, Harry Potter: Wizards Unite or Pokémon GO. The study sample (N=312) was sourced from Finnish Harry Potter: Wizards Unite social media channels on Facebook and Telegram in late June 2019, a week after the launch of the

game. The Godin-Shephard self-reported leisure time physical activity results were analyzed using a paired samples t-test.

The results of this study showed that Harry Potter: Wizards Unite was also able to significantly increase the mild exercise of players in a similar fashion as Pokémon GO [57; 58; 6; 59]. The participants' self-reported results on the impact of playing Harry Potter: Wizards Unite on their daily dose of exercise are depicted in the reproduced table from Study I in Table 3. The table shows a significant ($p < 0.001$) increase in mild exercise, but no significant change in moderate or strenuous exercise. In addition, 45% of respondents still felt Pokémon GO made them exercise more, 23% felt Harry Potter: Wizards Unite made them exercise more and 32% saw no difference. Players also reported to move slower while playing than they normally would, something that supports the work of Beach et al., [19] who had similar findings in the context of Pokémon GO.

**Table 3.** Change in physical activity before and after playing Harry Potter: Wizards Unite, as measured by the Godin-Shephard leisure time physical activity questionnaire.

| | **Mean (Pre)** | **Mean (post)** | **Significance 2-tailed** |
|---|---|---|---|
| Mild | 8.02 | 10.50 | $P < 0.001$ |
| Moderate | 2.85 | 2.93 | P=0.80 |
| Strenuous | 0.41 | 0.42 | P = 0.92 |

These results provide further evidence that global LBGs where players navigate to PoIs and explore their environment, have a positive impact on mild exercise. Together with previous work and literature reviews on this topic (e.g. [6; 81]) this suggests that LBGs similar to Harry Potter: Wizards Unite, Pokémon GO, Ingress, The Walking Dead: Our World and Jurassic World: Alive specifically scaffold mild exercise, not moderate or strenuous exercise [19]. Thus, for more demanding exercise, LBGs may offer little support, unless building the gameplay more heavily towards rewarding from it such as is done in Zombies, Run! [56]. Seeing these findings in light of the hopes that LBGs are a game changer in global inactivity [10], they may indeed provide support and motivate people to leave their house [16; 3], but other forms of exercise providing exertion and moderate and strenuous exercise is needed. Finally, further analysis is needed on what specific mechanics cause this increase in physical activity, and to this we answer in Study IV.

## 4.2 Social Interaction (Study II)

**Laato, S., Inaba, N., Paloheimo, M., and Laajala, T.D. Group Polarisation Among Location-based Game Players: An Analysis of Use and Attitudes Towards Game Slang. Internet Research, 2021; ahead of print**

The aim of this study was to investigate LBG players' social behavior through an analysis of game-related terminology and slang. Theoretically, we utilized the social identity theory [82] and linguistic ideology [83] approaches to understand whether the divide of players into static teams causes group polarization that could be seen at the level of the players' language use. With this approach, Study II takes a unique stance among the extant literature (e.g. [75; 8]) on player behavior in the LBG context.

While in Study I we observed players of Harry Potter: Wizards Unite, here we focused on players of two LBGs: Pokémon GO and Ingress Prime. We contacted five semi-open communication channels on WhatsApp and Telegram and obtained a data set containing 242,852 words worth of messaging between Pokémon GO players across three teams. Focusing on a specific slang term "jym" we carried an automatic search on all five channels to identify the number of times the word was used. For a more specific look on how the word was used, we traced each unique use of the word and read the surrounding conversation to establish whether "jym" was used naturally or discussed as a subject. Following this chat data search we sent a questionnaire to Ingress Prime and Pokémon GO players (N=185) to probe attitudes towards this specific slang word. Finally, we interviewed selected players (N=25). Therefore, methodologically this study used three interlinked and supporting approaches: (1) chat data search; (2) online survey; and (3) participant interviews.

Our results showed that there exists statistically significant differences in language use and slang term preference between the players' teams. Following the social and linguistic identity, this can be understood to be the result of players being divided into static teams and consequently the formation of social sub-groups. A particularly polarizing word "jym" was actively used in a few chats, but merely discussed as a subject in one group. A follow-up survey (N=185) revealed that a particular Pokémon GO team harbored negative sentiment towards the word, whereas the other two teams were more welcoming. When interviewed, reasons given for the negative sentiment included "jym" being used with improper grammar, it being associated to a specific small sub-group of highly active "enemy" players and "jym" as a slang word being included in Ingress PoI submissions. Consequently, we demonstrated that player sub-groups may be identified via observing game slang use and preference, and furthermore that LBGs are able to influence with whom players spend time and connect with, with simple game design decisions such as introducing static teams and inter-team conflict.

These findings support previous work in that inter-team conflict can be engaging [50; 84]. However, we also demonstrate that this may have the downside of causing group polarization where the artificial divide of players into static teams in LBGs influences players to form prejudice towards members of opposing teams. To counter this, inter-team cooperative action is needed. Pokémon GO solved this issue largely by diminishing the importance of inter-team territorial conflict and by intro-

ducing raids to their game [7]. The findings also imply that LBGs should support the formation of player communities outside the immediate game context. Previous work has shown that players were actively discussing COVID-19 and game-related phenomena on Reddit and Telegram [11; 85; 61], which demonstrates that the player communities outside the game collectively react to new phenomena, and are united with each other. Thus, players may seek solace in LBG player communities and feel connected [8]. As this connection holds true not only in the online setting but outside as well [7], LBGs show serious potential in curbing ”hikikomori” [3] and other social anxiety and withdrawal related behaviors.

## 4.3 Learning and discovery (Study III)

**Laato, S., Rauti, S., Laato, A., Laine, T.H., Sutinen, E., and Lehtinen, E. Learning History with Location-Based Applications: An Architecture for Points of Interest in Multiple Layers. Sensors, 2021; 21(1): 129.**

The aim of this study was to address the research question of how to create points of interest that enable players to learn about their local environment. By nature, this research problem is complex and difficult to systematically address. While various kinds of educational LBGs have been developed (e.g., [20; 36]), these solutions have been tailor-made to a specific area or region. In the Background section of this dissertation, we addressed the difficulty of scaling LBGs to be global, and arrived at the conclusion that crowdsourcing the creation of a stand-alone PoI database is the best solution [14; 39]. ”Crowdsourcing” is done to ensure high fidelity, and ”stand-alone” is there to avoid cartographic vandalism that may arise if LBGs would be linked to any real world map such as OSM [53].

Here in Study III, we continued to build on top of this backdrop, and through comparing existing solutions (OSM and the Niantic PoI database) to selected real world locations, we identified benefits and shortcomings of both solutions. We then engaged in an iterative design process to come up with a PoI database solution that could be used as a backbone for LBGs. Finally, we contacted experienced LBG players and academic LBG researchers (N=9) to participate in an expert evaluation study of the proposed system. A video explaining how the system works was recorded by the research group, which was then subsequently sent to the expert participants. The given feedback was analyzed using clustering, and final adjustments were made into the proposed PoI database based on this.

The proposed PoI system has a few distinctions from currently available alternatives. First, it makes use of situation PoIs on multiple historical layers. This way it can support LBGs that guide players through various historical eras, not only the current temporal layer which OSM and the Niantic PoI database provide. Second, due to the high knowledge-requirements associated with providing historically accu-

rate information, the system offers a ”fast track” for Universities and other accredited institutions to make edits. This approach was inspired by Bergström [42] who explains a study activity for students involving ethnographic observations of Pokémon GO players. In a similar way, students of archaeology and history could, under the guidance of their supervisors, contribute to such a database as a learning project. Utilizing participants from on-site has the benefit of them being the experts of the specific location. This way people can share what they know with others [49] and that can also feel motivating for players. If such a database would be accepted into popular use by several LBGs, the contributors could gain fame and recognition. In addition, at least in Finland, one of the three main responsibilities of a University is societal influence. The proposed database would offer a way to do so. The expert evaluation following the initial proposition helped hone the details of this solution and also suggested improvements such as adding color-coding to PoIs to distinguish specific types of PoIs from one another.

This research had a few interesting implications. First, while there exists over 50 commercially available LBGs [15], only three of them make use of a crowdsourced database of PoIs. As PoIs are in such a major role in these games, this seems odd. This study suggest more companies should focus on having PoIs linked to real world locations, as it provides players a better support for learning real history while playing among other advantages. Second, there exist shortcomings in the current crowdsourcing approaches of the Niantic PoI database and OSM. One of these is that PoIs only exist in one temporal layer: the present. This makes the learning of history while playing difficult, a benefit of LBGs that has been discussed in previous academic works [20; 36]. This could be addressed simply through adding multiple temporal layers of PoIs. While perhaps the visualization of such a system could be confusing, the potential benefits are also worthwhile. The main limitation of this study is that it is merely an evidence-based proposal, and funding would need to be acquired to fully implement it.

## 4.4 Connecting the benefits to game mechanics (Study IV)

**Laato, S., Pietarinen, T., Rauti, S., and Sutinen, E. Potential Benefits of Playing Location-Based Games: An Analysis of Game Mechanics. In: Lane H.C., Zvacek S., Uhomoibhi J. (eds) Computer Supported Education. Revised selected papers of CSEDU 2019. Communications in Computer and Information Science, 2020; 1220: 557-581.**

The aim of Study IV is to connect the potential benefits of (1) exercise; (2) social interaction; and (3) learning and discovery; to specific game mechanic found in LBGs. As a starting point, we searched IoS App Store and Google Play Store for

LBGs using a mix of words associated with LBGs (e.g., “location-based”, “mixed-reality”, “AR”, “geolocation”, “hybrid-reality”, “spatially-aware”). This process resulted in us finding 60 available unique LBGs. However, it is almost certain that this list is not exhaustive. The search tools for discovering LBGs through these stores were limited, and even after supplementing our dataset with games found in outside repositories, websites and discussion forums, we were sure to have missed some games.

The selection of LBGs (N=60) were all downloaded and played by the authors. They were subsequently categorized into five distinct categories following the identification of the central gameplay loops [76]. These categories were: (1) scavenger hunt games; (2) movement-based games; (3) spatially-aware games; (4) geolocation games; and (5) location-based MMORPGs. The last category was the one that fitted our conception of a modern global LBG, and included games widely discussed in this thesis such as Jurassic World: Alive, Pokémon GO, Ingress, Harry Potter: Wizards Unite and Ingress Prime. From this category, we identified the main gameplay loops and gameplay tied to them. We analyzed three unique games. In Figure 4 we show the core game mechanics of Pokémon GO as they were in 2019 and gameplay associated with these.

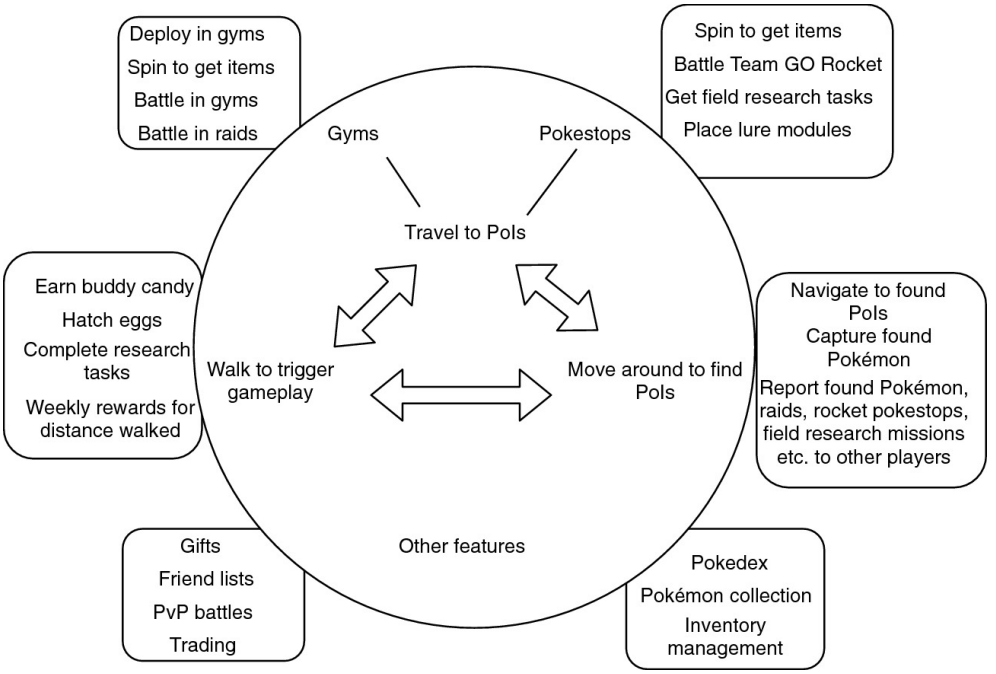


**Figure 4.** The core gameplay loop of Pokémon GO, and how additional gameplay is tied to each of the three main activities. Copied as it is from Study IV.

In order to tie the potential benefits to game mechanics, we need to understand

and explain the findings from Studies I-III using the visualization in Figure 4. We see that besides the "Other features" at the bottom of the Figure, all main gameplay is tied to the three core movement-related game mechanics, which also support each other. For example, if players go out exploring to find new places, they automatically also walk to trigger gameplay. And when exploring if they find a place, they can directly travel to that place. The benefits that LBGs have on exercise (detailed in Study I) can be explained through this core movement-focused gameplay loop that consists of (1) travelling to PoIs; (2) exploring to find PoIs; and (3) walking to trigger gameplay. As long as the player executes this gameplay loop by walking, cycling or running, they will receive exercise. Social interaction in the form of face to face meetings and learning about the local environment are both very much tied to the PoIs visualized at the top of Figure 4. However, it is of course possible to also explore with a friend or find a social contact while exploring. Similarly discovery is possible through these means. In short, the social benefits and learning and discovery are all related to moving, whether it is moving to specific places (PoIs) to meet people, moving around with the chance of random positive encounters with people or new places or travelling around with friends.

Out of the four movement-based mechanics identified by Ferreira et al., [46], following a path and following a moving object were not present. Instead a new feature, exploring to find content was discovered. We can summarize that with the current empirical evidence, that LBGs wishing to scaffold the observed benefits of Pokémon GO and beyond should build on the core gameplay loop depicted in Figure 4, and try to bind positive and engaging activities to that loop.

## 4.5 Psychological well-being and the role of game mechanics (Study V)

**Laato, S., Islam, A.K.M.N., and Laine, T. H. (2021). Playing location-based games is associated with psychological well-being: an empirical study of Pokémon GO players. Behaviour & Information Technology, 1-17. Ahead of print**

The aim of this study was to investigate how game mechanics, (operationalized as cooperative, competitive and individual mechanics in accordance to Riar et al. [75]), influence players' well-being. Furthermore, we study the role of aggressive marketing tactics of LBG developers that invoke FoMO and deficient self-regulation in players, and how they are connected to players' well-being.

In 1969, Bradburn published a paper where he argued that well-being and sadness are not the opposite ends of the same emotional state, but are in fact separate [86]. There exists factors influencing only the well-being but not sadness, and also factors influencing only sadness but not well-being [87]. Following Kano's satisfaction model [88] there can also exist a third group of factors that have impact on both. The

idea that positive and negative affect are separated and influenced by separate factors also aligns with findings from affective neuroscience [89; 90]. Thus, following the two-factor-theory of well-being and Kano's satisfaction model [88], we measured outcomes on both psychological well-being (positive) and gaming fatigue (negative).

Drawing from previous literature, the two-factor-theory on well-being as well as self-determination theory (SDT) [91; 92] we formulated ten hypotheses. We looked at the associations between deficient self-regulation and fatigue (hypothesis 1) and well-being (hypothesis 2). Similarly, we looked at the associations between FoMO and fatigue (hypothesis 3) and well-being (hypothesis 4). Together, these four hypotheses were aimed to investigate whether the aggressive marketing done by LBG developers can have negative impact on players either in the form of reducing the positive affect (well-being) or in the form of boosting negative affect (gaming fatigue).

Subsequently, we formulated six hypotheses (hypotheses 5-10) on the associations with cooperative, competitive and individual game mechanics and the two dependent variables, well-being and fatigue. Our reasoning here was that, for example, while competition between human players can be motivating, it can also increase gaming fatigue due to the involved stress and pressure. We also wanted to see whether a certain aspect of the game (say cooperation) would be a stronger predictor of well-being than another aspect (individual play). Finally, we wanted to see the effects of playing intensity on well-being and fatigue. We included this as a control variable in our research model. The final proposed research model is displayed in Figure 5.

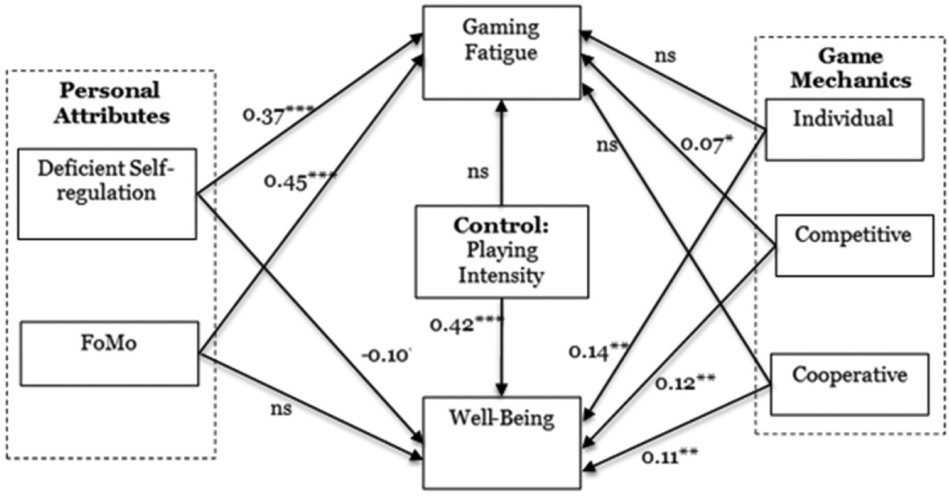


**Figure 5.** The research model

In the survey development we used validated constructs from previous literature.

However, as we were surveying Finnish Pokémon GO players, the survey had to be translated from English to Finnish and ultimately back to English again. To this end, two researchers were involved. Researcher number 1 (me) conducted the first translation of the items into Finnish. Another researcher (my supervisor Teemu) then translated the items back to English. We compared the original items to those that had been translated twice and noticed a few issues in the items with regards to accuracy. Together, the researchers then worked on the items to ensure the Finnish translations accurately matched the original items.

The survey was distributed to Finnish Pokémon GO players primarily through a Facebook group called "Pokémon GO Finland" under the permission and help of the group admins during April, 2020. The survey received 855 full and accepted responses. We checked the validity and reliability of the sample using the SmartPLS software (version 3.3.2) After we had made sure our data meets the requirement criteria given proposed by Fornell and Larcker [93] we continued to assess the structural model.

To our surprise, playing intensity showed a significant ($p < 0.001$) and strong ($\beta = 0.42$) relationship with psychological well-being, but no relationship with gaming fatigue ($p > 0.05ns$). We noticed that the frequency of engagement with all game mechanics (cooperative, competitive, individual) also showed associations to well-being. Competitive mechanics additionally showed a small but significant ($\beta = 0.07; p < 0.05$) associations with gaming fatigue. Much stronger effect sizes were observed among the construct capturing the aggressive marketing strategies of LBG developers. Both FoMO ($\beta = 0.45; p < 0.001$) and deficient self-regulation ($\beta = 0.37; p < 0.001$) showed strong significant associations to gaming fatigue. However, neither of the two constructs had a significant relationship with well-being. Thus, we show that the aggressive marketing does not hurt the positive psychological outcome of LBGs, but can cause fatigue on players. This finding provides further support for the two-factor theory of well-being [87].

The key findings of this study can be summarized as follows. First and foremost, we discovered a significant and strong relationship between playing intensity and psychological well-being, which implies that playing LBGs is a beneficial pastime. We showed that aggressive marketing strategies do not get in the way of the well-being, but can exhaust players. We also showed that there were no significant differences between engagement with LBG game mechanics when grouped into three broad groups: cooperative, competitive and individual, except for a small minor effect of engagement with competitive mechanics on gaming fatigue.

The implications of this research on LBG design are numerous. Developers can leverage social pressure such as FoMO to get people to make micro transactions, but they need to be wary of not exhausting players with aggressive marketing. Delicate balance is needed here. Furthermore, as there were no significant differences between groups of game mechanics, further work on the specific factors that contribute

to players' well-being is needed. Two of these factors could be nostalgia and meaningfulness [94] and investigating these in further detail is warranted. This we tackle in Study VI.

## 4.6 Imagination and meaningfulness (Study VI)

**Laato, S., Rauti, S., Islam, A.K.M.N., and Sutinen, E. (2021). Why playing augmented reality games feels meaningful to players? The roles of imagination and social experience. Computers in Human Behavior, Ahead of print**

The purpose of this study was to investigate the roles of nostalgia, biophilia and imagination in the formation of players' affection towards in-game content, in particular, the pokémon creatures in Pokémon GO. Subsequently, we looked at how the affection towards the fictional pokémon creatures and social factors predict perceived meaningfulness of playing.

A starting point for Study VI conceptualization was the biophilia hypothesis of Wilson and its connection to the Pokémon franchise [37]. Balmford et al. [37] suggested that the human built-in desire to collect, catalogue and get to know other lifeforms may explain why people around the world are so fascinated about Pokémon. We operationalized biophilia in this work into two subsequent constructs: (1) love and care for nature [95]; and (2) affection towards the fictional pokémon creatures. There are many ways for a LBG like Pokémon GO to scaffold an affection between the player and the pokémon, which include the use of AR-features [72], pokémon having unique stats called individual values (IVs) and ability to assign personal nicknames to pokémon. However, all these still require players to use their imagination. Having prior experiences with the Pokémon franchise could of course help players imagine pokémon. Thus, we measured the effects of nostalgia (hypothesis 1) and love and care for nature (hypothesis 3) on using imagination while playing, and the effects of all three (hypothesis 2,4 and 5) on forming an affection to the fictional pokémon creatures.

We wanted to ultimately study the formation of perceived meaningfulness in players. Harari [1] suggests that shared fictional narratives are paramount in scaffolding inter-person relationships and social trust. They enable humans to cooperate effectively and unite under common shared beliefs [1]. For these reasons, we wanted to include social factors in this study. In particular, we looked at how social self-efficacy (hypothesis 6) and community identification (hypothesis 7) influence meaningfulness of playing. Finally, we measured the relationship between affection towards the fictional pokémon creatures and meaningfulness (hypothesis 8). The final research model is depicted in Figure 6.

We had to develop the constructs of imagination while playing and affection towards the pokémon creatures for this study, but the rest of the constructs could be

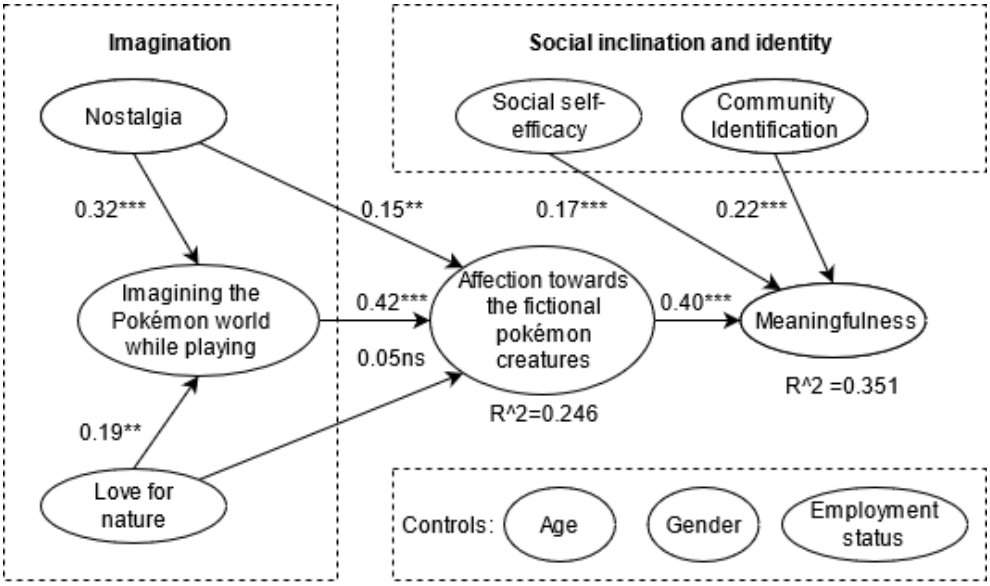


**Figure 6.** The proposed research model including the results.

borrowed from previous literature. In the construct development process we followed the guidelines of Moore and Benbasat [96]. Here we utilized the help of both senior information systems scholars for commenting on the items and two groups of Pokémon GO players for card sorting exercises where the players were asked to sort developed items into categories based on what they represented [96]. After the construct development process was finalized we drafted a survey on the Webropol tool and contacted reddit/r/pokemongo moderators for survey distribution. The survey was online for five days in June 2020 during which it received 511 full accepted responses.

Similarly to Study V, we checked the validity and reliability of the collected data before proceeding with the data analysis. During this process we noticed that several items of our constructs did not meet the criteria of having a loading value higher than 0.7. These items were removed, but we were still left with a minimum of three items per construct. After the data had passed validity and reliability checks including a check for goodness of fit, we proceeded to evaluate the proposed model. The findings are shown in Figure 6.

Among our sample, nostalgia was a significant predictor of both imagining pokémon while playing ($\beta = 0.32, p < 0.001$) and affection towards the fictional pokémon creatures ($\beta = 0.15, p < 0.01$). We measured nostalgia using the childhood brand nostalgia construct of Harborth and Pape [97], which measures in particular childhood experiences with Pokémon GO. Thus, these findings regarding the effects of nostalgia mean that if people were exposed to the Pokémon franchise early on in their

childhood and had positive experiences about it, they are more capable and more willing to attach additional meaning to pokémon creatures also in other Pokémon games, in this case, Pokémon GO. Perhaps surprisingly, the love and care for nature scale [95] did not show a significant relationship with affection towards the pokémon creatures ($p > 0.05ns$) in our sample. This may simply be the result of us using a slightly different conceptualization of the biophilia discussed by e.g. Wilson and Balmford et al. [37], but it may also imply that people do not relate the digital pokémon creatures to real living organisms after all. However, further work on this topic is warranted.

With regards to the predictors of meaningfulness, both social factors, social self-efficacy ($\beta = 0.17, p < 0.001$) and community identification ($\beta = 0.22, p < 0.001$) showed a significant relationship. This finding contributes to the various studies of sociality in LBGs [75; 8] and also connects to the findings we presented in Study II. Other real players have been identified as a source of eudaimonic gratification in video games in general [54] and our work show that they also drive the perceived meaningfulness of playing. There are multiple potential reasons for this, but to simplify, humans are inherently social creatures and we find meaning in social activities. Furthermore, the primal emotional PLAY system is a social system and deeply gratifying [90]. Finally, affection towards the pokémon creatures in Pokémon GO had a significant relationship with the meaningfulness of playing ($\beta = 0.40, p > 0.001$). Altogether our research model explained 25% of the variance of the affection towards pokémon construct and 35% of the variance of the perceived meaningfulness construct.

In order to motivate players to execute the gameplay loops identified in Study IV, players have to perceive playing to be somehow meaningful. Here in Study VI we demonstrated that the fictional narrative in LBGs is crucial, and that AR game design could leverage nostalgia and even primal instincts such as a biophilia to ultimately scaffold meaningfulness. We also discovered that imagination is actually an essential component in the formation of affection towards story components of LBGs. Thus, when LBG designers create AR features in their games, they need to be wary that the AR does not get in the way of players' imagination.

# 5 Discussion

## 5.1 Design considerations for LBGs

Based on the findings of this dissertation, in particular of those presented in Study IV, we summarize the core triune of LBG game mechanics and formalize it as the Explore-Navigate-Discover Triune PoI System or simply the Triune PoI System. At the heart of this lies moving to trigger gameplay. This Triune PoI System is depicted in Figure 7.

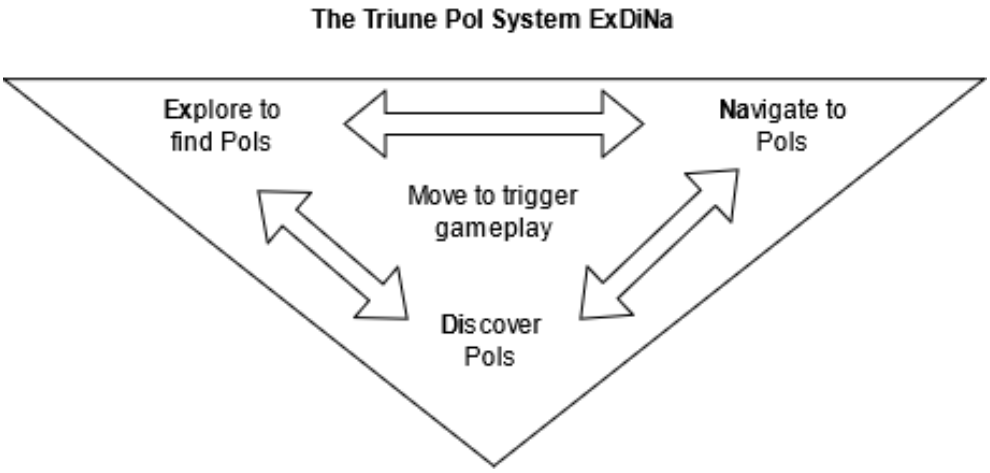


**Figure 7.** The Explore, Discover, Navigate Triune (ExDiNa Triune) aka the Triune PoI System of LBG core game mechanics. Moving to trigger gameplay is present in all three aspects and is situated in the center.

It is crucial that moving has inherent value for LBGs, as that motivates the execution of the core triune to which most game mechanics in LBGs should be tied to. Furthermore, game mechanics can be tied to moving itself. Examples of this include hatching eggs in Pokémon GO and opening portkey portmanteaus in Harry Potter: Wizards Unite.

We are summarizing further design considerations arising from the Studies I-VI in Table 4. This list is not exhaustive, as some aspects such as territoriality [48; 38; 47] were not studied in this particular thesis. One of the potentially negative outcomes of LBGs currently is the consumption of fast food while playing [98], and thus

attention should be paid in LBG design how to scaffold a healthy diet. Furthermore, as LBGs are still video games, design that works in regular non-location-based video games can also be applied here. That being said, the list covers the key aspects of supporting exercise, social interaction and learning, as well as the additional aspects of psychological well-being and perceived meaningfulness of playing.

**Table 4.** Design considerations for LBGs

| Goal | Consideration |
|---|---|
| Scaffold mild exercise | Connect core game mechanics to the ExDiNa Triune PoISystem. |
| Social interaction | Bring people together with events at meaningful PoIs.<br>Create a shared fictional narrative for players through the game. |
| Learning | Create PoIs that correspond to real world structures.<br>Attach information to the PoIs about the structure. |
| Avoid mental exhaustion | Avoid extreme competition.<br>Avoid excess FoMO. |
| Meaningfulness | Make use of nostalgia.<br>Support players' imagination. |

From Figure 7 and Table 4 we notice that a few design aspects are in a crucial role. These are in particular the gameplay loops and the PoIs. Below we summarize key features related to these two aspects.

- **Points of interest** The PoIs are in a central role of LBG gameplay loops. Players explore their environment to find PoIs, they return to PoIs to control them [48; 38] and PoI locations even determine players' daily movements [13]. PoIs are places where people get together for social interaction [7] and places where players can learn about a particular real world object or structure [51]. Through crowdsourcing, LBG companies can organize the creation and maintenance of a PoI database in a non-costly fashion [39; 49]. All serious LBG developers should look into having a PoI database that has a strong connection to the real world, and also think about game mechanics that make use of this database.

- **Gameplay loops** The central gameplay loop of LBGs should be tied to exploration in order to prompt players to find new areas. This increases long-term engagement as players do not get bored because of novelty they derive from the changing real world environment. Exploration supports the two other aspects of the ExDiNa Triune PoI System: discovery and navigation. These mutually supportive mechanics keep players moving and finding new interesting things that keep them engaged. At the same time, controlling territory can also be

engaging [48; 38]. Territoriality also requires players to navigate to specific locations and through exploration players may find new places to control.

To summarize, through integrating navigation and travelling to the central gameplay loops, LBGs naturally scaffold physical activity. Through having high-fidelity PoIs connected to the real world, LBGs naturally scaffold learning about the local history. LBG designers should make full use of the ExDiNa Triune PoI System depicted in Figure 7, as it is the core gameplay loop [76] in the most popular LBGs and one that naturally scaffolds positive outcomes for players.

## 5.2 An overarching theory for understanding LBGs: The hunter-gatherer perspective

As we discuss LBG design, it is crucial to involve the perspective of an overarching theory that could explain why people engage with LBGs. This kind of an approach could also identify further benefits from playing LBGs. To this end, we look at the human evolutionary history and in particular the hunter-gatherer lifestyle.

Instead of looking at our entire evolutionary history, which is important for evolutionary biology, some branches of evolutionary psychology and affective neuroscience [89], we focus on the hunter-gatherer era, which was the primary way homo sapiens and their humanoid ancestors acquired nutrition before the agricultural revolution began some 12,000 years ago [1]. The postulation of evolutionary psychology focusing on the hunter-gatherer period postulates that our brains and bodies have evolved under conditions where it has been important to, for example, know the nature around us and be in touch with other animals and know how they behave. It also means that our bodies need to be capable of running and communicating at the same time, and that social relationships are of paramount importance for survival. The central postulate we make in this thesis is that LBGs are able to capture some aspects of the hunter-gatherer lifestyle that humans are missing in the urban society. This idea has already been put forth in previous work (e.g. [48; 38; 4]) but here we discuss it with respect to LBG design and our findings from Studied I-VI.

Humans have an emotion-based SEEKING system [90] that directs behavior and provides rewards when we find new fertile areas. Nairne lists five domains of memory that have been specifically important for survival in the hunter-gatherer era: (1) survival; (2) navigation; (3) reproduction; (4) social interaction; and (5) kin recognition [99]. Reflecting these five domains to the design considerations given in Table 4 and the ExDiNa Triune in Figure 7, we notice several similarities. First, humans have been found to experience biophilia, the natural tendency to want to spend time with other lifeforms. Biophilia, subsequently, has been connected to playing Pokémon games [37], as also evident from Study VI. LBGs can also more generally draw on the survival dimension through implementing territorial control and conflict

**Table 5.** Mnemonic correspondence of hunter-gatherer memory in LBGs

| Memory area [99] | Mnemonic target in LBGs |
|---|---|
| Survival | Territoriality, seeking resources... |
| Navigation | Navigating to PoIs |
| Reproduction | Meeting other players in the real world |
| Social Interact | Social game mechanics scaffolding cooperation |
| Kin recognition | Teams/Factions |

game mechanics [48; 38; 47]. Second, LBGs simulate navigation through prompting players to explore as well as find places they already know [14; 51]. This area is more stimulated when players go play in an area they are previously unfamiliar with. Third, the reproduction area can be stimulated by bringing players together in the real world. Players meet other real people in real life through playing, something that does not occur when playing sedentary video games. Players may become excited about new interesting relationships they form while playing. Fourth, social interaction is scaffolded through game mechanics which prompt players to cooperate with one another in inter-team conflict (See Study II). Players can also form relationships with one another through sharing knowledge about the game and its fictional world [4]. As LBGs are played in the real world, players may even engage in discussions with non-players. Fifth and finally, an inter-team setup serves to boost both cooperative and competitive elements, and subsequently directs players to distinguish opponents from allies [62]. However, players may also identify to be a part of the LBG community at large [85; 61] regardless of their in-game team. This kind of an identification is possible as players recognize fellow players among the rest of humanity. We summarize how LBGs link to the memory areas given by Nairne [99] in Tablbe 5.

Currently very few cultures are able to live life in the hunter-gatherer lifestyle [100]. One of the last hunter-gatherers, the San people of northern Namibia were forced to abandon their culture in the 1970s as the land where they lived was claimed. Humans have adopted to living in the urban way, but we have not lost our evolutionary history [1; 101]. The successful LBGs we see today are not simulating the hunter-gatherer lifestyle. Rather, they are capturing some of the positive aspects of that lifestyle and incorporating them into gameplay. In conclusion, we propose in this dissertation that the hunter-gatherer lifestyle and human evolutionary history could be used as inspiration for LBG design, and also as a way to explain the success of the most popular LBGs.

## 5.3 Other contributions and implications

While initially Pokémon GO was studied as a game that motivates for physical exercise [5; 6], later work and that of this thesis (Studies II and III) have shown the game to have beneficial effects for social interaction, learning and discovery as well. The positive outcomes can be linked to specific gameplay loops which players execute over and over again, motivated by various factors that have been identified in previous work including (1) randomness; (2) progression; (3) imagination and story; (4) social influence; and (5) fear of missing out; among others [74; 26; 102]. Previously, successful commercial games simply had to engage players through compelling narratives, meaningful challenges, and a sense of achievement. However, with the rise of multiplayer elements and online games, the relationships players have with game communities and developer-constructed identities become far more central to enjoyment and retention. [103]. The benefits of LBGs on exercise, social interaction and learning and discovery can be viewed as fundamental intrinsic benefits to the genre. Through basic gameplay loops and structure, these things are omnipresent regardless of the game story [4] and more nuanced precise mechanics.

This thesis contributes to the understanding of meaningful game experiences and the importance of imagination in this process [54] through Study VI. We believe that the story/narrative is largely overlooked in uses and gratifications of specific LBGs (e.g. [26]) because it is difficult to measure and may only begin to manifest later on in the cycle of playing the LBG. Thus, studies utilizing data collected from a game early on in its cycle (e.g. [74; 78]) may fail to understand the role of stories and narratives for long-term engagement.

This study also has practical implications. We imply that LBGs can be used to teach about local history, but there is large variance in the quality and quantity of PoIs in existing databases [14; 51]. As PoIs in OpenStreetMaps and the Niantic Wayfarer system are crowdsourced, the quality of PoIs depends on the activity of the local contributors. There is also the question about the importance of the system through which the crowdsourcing is done. As Neustaedter et al. [49] demonstrate, factors such as how easy it is to contribute, how elaborate contributions participants are able to make and how participants are motivated all have impact on the outcome.

LBGs can also potentially scaffold social interaction (Studies II and VI), exercise (Study I) and psychological well-being (V). For these reasons, practitioners looking to treat depression or individuals seeking to get started with exercising could turn into LBGs for help. While Pokémon GO has been hugely successful [41], it remains to be seen how LBGs perform in the future. With our thesis we hope to positively contribute to LBG design, primarily through the identification of the Triune PoI System ExDiNa (see Figure 7 and the derived design considerations).

## 5.4 Limitations

As a dissertation that builds on various methods and data sources, this dissertation has several limitations that need to be considered. We already discussed the limitations of the samples in detail in Section 3. Thus, in this section we focus on general-level limitations other limitations.

The data collection methods do not allow full control of the sample. This indicates that biases may emerge in the findings. We see, for example, that the gender ratios of respondents in Studies V and VI are reversed, highlighting the limitations of our sampling technique. To counter this, we can compare our findings to other similar studies (e.g., in Study VI we compare the work to previous studies on engagament with Pokémon GO). Still, this is a limitation that needs to be considered when interpreting our results.

The dissertation suffers from the lack of empirical verification of the proposed design considerations, such as those displayed in Figure 7 and Table 4. However, this is a limitation that cannot be avoided at this stage. While academics have created ad hoc LBGs for research (e.g. [21; 22]) these games suffer from crude graphics, which have been found to hinder players' enjoyment [104]. They are also not scalable [49] in that they are played only in a limited area. Creating such a game would not prove the design considerations presented in this work. To solve the cost-issue, we had to rely on studying existing commercial LBGs which were also the basis for deriving the presented design considerations together with prior research and selected theoretical approaches. Unless significant funding can be arranged for academically developed ad hoc games, we encourage future work on serious games to also draw from commercially available high production value games when possible, as academically developed games have the limitations mentioned above.

Another limitation of this dissertation lies in the complexity of LBGs. The research on Pokémon GO alone covers almost every research discipline from medicine, sociology, psychology and education all the way to information technology [6]. For this reason, some simplifications had to be made. For example, the impact of a specific menu layout on the playing experience could not be studied. As a single factor this would probably not amount to much, but in bulk the small things have enormous impact. Past studies have approximated the above mentioned layout issues with constructs such as usability, which also include the dimension of whether the application serves its intended purpose [105]. Such approximations are of course necessary when discussing such complex artifacts as LBGs. In this dissertation we took the similar approach and used constructs (in Studies V and VI) such as playing intensity to capture the overall playing intensity of LBG players. We also harnessed qualitative data and exploratory analyses (Study II) to investigate phenomena where we had no prior understanding of the situation. Even here, however, we were forced to make assumptions and simplifications. These problems are of course always present in non-exact

science such as user studies and game design.

## 5.5 Future work

It is difficult to forecast the future, but we know that the video game industry is rapidly expanding [40]. We also know that LBG technologies are being innovated and developed in both academia and industry. As new game design ideas and implementations emerge, the popularity of LBGs should continue growing as it has since the games first saw light in early 2000s [24]. With new games and new real world data of their success, we can further learn about how technologies can engage humans. At the same time, advances in evolutionary biology and psychology can bring insight into how engaging games could be created.

We are yet to see LBGs that fully capitalize on the hunter-gatherer way of living. Actual hunting in the form of running after animals which was practised by the San tribe in South-Western Africa [100] has not been implemented to any LBG to date. Games such as Jurassic World: Alive and Pokémon GO feature creatures that are captured or shot, in a stationary mini-game. Zombies, Run! features running as a central gameplay. If we return to the obesity epidemic [2], LBGs have only addressed the other antecedent of obesity: lack of exercise. Future work could involve exploring how LBGs could improve players' eating habits, quality of food and amount of food that people eat. There are multiple ways for games to support a healthy lifestyle, but one of the first steps is to create solutions for quantifying our food consumption [106].

LBGs also show promise for a better, more in-depth link between the game and the real world [45]. Connecting the digital reality with the paramount reality [107; 44] enables new kinds of experiences for players, but also possibilities of using LBGs to benefit the society. One avenue of course is to use LBGs to direct human movement [13; 61; 62]. Another is to integrate beneficial real world actions as part of the LBG play. For example, in countries such as Finland there are forests filled with mushrooms and berries that could be picked. LBGs could also help in picking up trash from the nature. They could help people find parking spots [50] or even generate electricity. Things such as dynamo gyms (i.e. gyms where weights are equipped with dynamos that generate electricity) could provide green energy and exertion at the same time. Connecting these kinds of innovations to an LBG could make the activity feel even more meaningful for players as it connects the actions into the game's story and social structure.

To summarize, there are several future work avenues for LBG design. First, using evolutionary psychology and other scientific theories to come up with new design ideas and test them in a real world empirical setting. Second, developing LBG technology to enable more immersive playing experiences, and to, for example, allow the inclusion of eating habits as part of the LBG experience. Third and finally,

gamifying habits that are beneficial for the society.

# 6 Conclusions

The sensational Pokémon GO has brought people across the world together for a collective location-based experience. It is a commercial success story [41] that rekindled an interest in LBGs. Other LBGs soon followed suit and while none of them have managed to be as popular as Pokémon GO, new entries such as Dragonquest: Walk and others are showing great promise. In summary, it seems LBGs are here to stay and we have yet but scratched the surface of location-based gaming.

One of the strengths of this dissertation is that it employed various research methods, data sources, approaches and theoretical viewpoints to inductively understand LBG design. For this reason we were able to provide insights and answers to theoretical concerns and LBG design drawing from real world empirical data. In particular, we formalized the Triune PoI system ExDiNa (see Figure 7) that describes the core game mechanics of LBGs to which most gameplay should somehow be tied in order for LBGs to scaffold positive outcomes for their players.

As technology develops, it is likely that new ways will emerge to utilize the environment in LBG design. In the future we may see examples of LBGs harnessing sensor data about our lives to gamify activities that go beyond the gamified transit/commute [13] that LBGs currently provide. Furthermore, we could see PoI database solutions in multiple layers such as what was proposed in Study III, more integrated social gaming experiences and support for physical activity that goes beyond the mild exercise shown in Study I. Until then, LBGs remain a unique genre among video games that has still but scratched the depths of its design possibilities.

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# Original Publications

**Samuli Laato, Sonja Hyrynsalmi, A.K.M. Najmul Islam & Teemu H. Laine**
**Location-based Games as Exergames- From Pokémon to the Wizarding World**

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# Location-based Games as Exergames - From Pokémon To The Wizarding World

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***Abstract***

*Exergames, i.e. games which aim to increase player's physical activity, are a prominent sub-category of serious games (SGs). Recently, location-based games (LBGs) similar to Pokémon GO have gained the attention of exergame designers as they have been able to reach people who would otherwise not be motivated to exercise. Multiple studies have been conducted on Pokémon GO alone, identifying positive outcomes related to, for example, exercise and social well-being. However, with substantial findings derived from a single game, it is unclear whether the identified benefits of playing Pokémon GO are present in other similar games. In order to broaden the understanding of LBGs as exergames, this study investigates the gameplay features and initial reactions of early adopters to a game called Harry Potter: Wizards Unite (HPWU) which was launched in summer 2019. A questionnaire (N=346) was sent to HPWU players to measure the effects playing the game has on their physical activity. During the first week of play, an increase in mild physical activity was recorded among HPWU players, similar to what has been reported with Pokémon GO. Also almost half of respondents (46,82%) reported to play the game socially, showcasing how LBGs can generally have a positive impact also on players' social well-being.*

**Keywords:** Harry Potter: Wizards Unite, exergame, location-based game, Pokémon GO, exercise, social well-being,

## 1 Introduction

Exergames are a prominent sub-category of serious games (SGs) and are developed with the aim to motivate personal exercise [1]. By definition, exergames are more than just gamified exercise [2] and are defined as a combination of exertion and video games [3]. As technology has evolved and the use of mobile devices, mobile data and location signals have become ubiquitous, several location-based exergames have emerged [4–7]. Location-based games (LBGs) are mobile games where the user's physical location influences the game world. Typical examples of such games are *Pokémon GO*, *Harry Potter: Wizards Unite*, *Ingress (Prime)* and *The Walking Dead: Our World*. LBGs can be played solely on mobile devices, but can incorporate wearable technology as well [8]. These games are sometimes also referred to as pervasive games, mixed-reality games and location-based AR games (i.e. [9, 10]) among others. It can

be argued that LBGs are automatically AR-games, as they augment a virtual world on top of the paramount reality [11]. Therefore, in this study we simply use the LBG term.

One of the goals of several exergames is to provide players an additional layer of motivation to move [12, 13]. For example, multiplayer elements have been proven good at this as they can increase players' engagement in the game and consequently their playing retention [14, 15]. Exergames can also be used to guide users towards more meaningful and effective physical activities [16, 17]. On the other hand, players can get bored on individual exergames quickly before significant improvements take place. One countermeasure for this is continuously updating the game [18]. Another issue is that typically exergames are mainly played by those who already have a strong intrinsic motivation to exercise and are seeking ways to supplement or to enhance their physical activity [19, 20].

In 2017, Leblanc and Chaput [21] published a conceptual discussion arguing that LBGs, such as *Pokémon GO*, can help in the global inactivity crisis, as contrary to other games, the playerbase of the games includes people with no prior motivation to move or exercise [7]. *Pokémon GO* was called *"the most successful population level physical activity program in modern history"* [21]. In fact, many prior studies have reported playing *Pokémon GO* to increase players' physical activity levels [7, 22–29], reduce sitting time [22, 30] and provide incentives to travel to new places [10, 31]. Playing *Pokémon GO* has also been found to have a positive impact on social well-being [32–37], make people less anxious to leave their house [38] and can thus potentially help people with social withdrawal issues [36]. Whatever positive outcomes *Pokémon GO* does have, the impacts on society are amplified by the enormous popularity of the game, having quickly reached over 500 million installations globally after its launch [39].

*Pokémon GO* did not remain the only LBG of its kind, as afterwards similar games such as *Draconius GO*, *The Walking Dead: Our World*, *Jurassic World: Alive*, and *Harry Potter: Wizards Unite* (HPWU) have been released [40]. Yet, *Pokémon GO* remains the most studied game out of all LBGs with, for example, Scopus currently, as of 21st of August 2019, having indexed over 200 scientific publications with "Pokémon GO" in the title. There even exists meta-studies and literature reviews on *Pokémon GO* studies [41, 42]. Despite the huge number of research conducted on a single game, it is unclear whether the observed effects on physical activity of playing *Pokémon GO* are present in other similar LBGs.

The aim of this study is to derive characteristics of LBGs as exergames. Previously, some researchers have attempted to extrapolate their findings on *Pokémon GO* to cover other similar games [9]. However, practical evidence, that the results and theories developed by observing *Pokémon GO* players would translate to other similar games, is currently missing. To address this, the current study draws predictions from studies observing the physical activity of *Pokémon GO* players and uses the knowledge to form the hypothesis of the outcomes of other similar games. As a case study, *HPWU*, which was released in 2019, is observed. The game is an ideal comparison case as it is from the same developer as *Pokémon GO* and utilizes the same set of digital points of interest (PoIs) [43], but is clearly different in, for example, story, goals and multiplayer design. Accordingly, the following research question is formulated: *"How does a new LBG Harry Potter: Wizards Unite compare to Pokémon GO in terms of effects on physical activity?"*. Answering the research question will provide evidence towards a more generalized understanding of the characteristics of LBGs as exergames.

The rest of this paper is structured as follows: First, *HPWU* is compared to *Pokémon GO* with references to previous studies. Results of a survey sent to *HPWU* players (N=346), including the Godin-Shepard leisure time physical activity questionnaire [44], questions about player movement and social play, are then presented in the results section. This is followed by discussion and conclusions.

## 2 Comparison Between Harry Potter: Wizards Unite and Pokémon GO

In this section we analyze *HPWU* by comparing it to *Pokémon GO*. Readers unfamiliar with *Pokémon GO* or wishing to know more can refer, for example, to the following studies [9, 23, 24, 42, 45].

### 2.1 The Concept and Features of Harry Potter: Wizards Unite

*HPWU* is a location-based augmented reality (AR) game [9, 11] based on the Harry Potter franchise [46]. The game was co-developed by Niantic and Warner Brothers Games San Francisco [47] on top of Niantic's planet-scale real-world AR platform [48], which provides, for example, a peer reviewed global database of PoIs [49]. The PoIs represent real-world objects; however, similarly to *Pokémon GO*, *HPWU* includes only a subset of the PoIs available in the Niantic's database [43, 49, 50]. The chosen PoIs are transformed in *HPWU* into *greenhouses*, *inns* and *fortresses*, which are displayed on the game map user interface as seen in Figure 1 (left), with each type of building having its own unique functionality. In addition, *HPWU* has pseudo-randomly created PoIs labeled *traces* and *ingredients*, which, unlike PoIs based on real-world objects, appear and disappear quickly. Players can click traces to initiate minigames where they need to cast spells (Figure 1, right). Completing traces yields the player collectible items, which, in addition to expanding the players collection, are used to level up and to improve the player's character. These elements of collection and player progression have also been identified as the primary motivator for players to keep playing *Pokémon GO* [45, 51].

Clicking traces in the *HPWU* world map initiates a minigame where the player is tasked to draw a spell on the screen as quickly and accurately as possible. After a spell is cast, based on a server-side determined probability, the spell either succeeds or is resisted. Figure 2 (left) depicts the message that is displayed when *HPWU* players need to recast their spell. As a rule, the more common trace encounters have a higher chance of succeeding, whereas rare and powerful encounters often require multiple attempts to resolve. This draws obvious parallels to *Pokémon GO* and the ball throwing minigame [28]. Randomness and keeping the brain guessing have been linked to sustained player interest [52], and reusing the same effective psychological formula of *Pokémon GO* in *HPWU* should therefore provide similar positive effects on sustaining player engagement in the game. This choice, however, may have a negative impact on exercise, as players are forced to halt walking and wait for the magic animations to end in order to see the outcome of their spell. *Pokémon GO* players who were observed on a Greenway walking course for one hour and compared to non-players, were found to stop more, and the exercise they completed was not as effective as that of non-players' [53]. Arguably this phenomenon is amplified in *HPWU* were the animations last significantly longer.

In addition to travelling to PoIs and interacting them, *HPWU* offers a variety of other gameplay features. One of these is opening *Portkey Portmanteaus*, which can be found on the ground whenever the player has room for them in their inventory. This gameplay feature is movement-based, as Portmanteaus require 2km, 5km, 7km or 10km of walking in order to open. This feature is similar to hatching eggs in *Pokémon GO*, and movement-based exergames such as *Zombies, Run!* [54]. The game also contains things to do while stationary, including a potion-brewing minigame, glancing through collections, inventory management and customization options for the player's avatar and profile. All the game activities are tied to the Wizarding World created by JK Rowling, boosting the immersive effect of the game [55]. Even though the story and the world behind the game are completely different from *Pokémon*


**Figure 1:** *Two screenshots from HPWU*


**Figure 2:** *Screenshots from HPWU showing the trace minigame and a progression pop-up*

*GO*, the games share a lot of similarities in their design. These similarities include:

- Main UI based on a real world map

- Main gameplay consists of navigating to PoIs
- Spawns/traces trigger an encounter minigame
- Walk to hatch/open things
- Friend lists
- Lures and dark detectors
- Multiplayer, shared game world with others
- Daily tasks and special tasks
- Inventory management
- Challenge raids/fortresses with friends

### *2.2 Why People Play Location-based Games*

Even though there are many observed health benefits in playing *Pokémon GO*, few studies have linked these positive effects to concrete game design decisions. Alha et al., [45] and Rasche et al., [51] look at why people play LBGs by dividing the problem into three categories: (1) reasons to start playing (2) reasons to continue playing, and, (3) reasons to stop playing. In order to evaluate the sustain of health benefits of playing LBGs, the most interesting part to understand is why players keep on playing LBGs. Both studies found that a sense of progression was the highest contributing factor in why players kept on playing *Pokémon GO* [45, 51]. However, Alha et al., [45] list 11 additional general reasons why players keep on playing LBGs, which can be further split into smaller segments. This speaks of the complexity of the motivational issues, and simplifying motivational theories too much, especially on intrinsic motivation, can be harmful for the understanding of the phenomenon [56]. Also other approaches have been used to explain player engagement in LBGs such as intentions to reuse and gratifications derived from playing [9].

### *2.3 The Role of the Brand*

Harry Potter and Pokémon are both huge global brands, however, they are quite different from one another, providing different story elements and affordances for immersive gameplay [57]. The Pokémon franchise is all about traveling from place to place by foot, collecting Pokémon, and continuously meeting new people [58]. The main target audience of the brand is young people [59]. However, as evident with *Pokémon GO*, a big proportion of the players are adults [45]. The Wizarding World of Harry Potter does not share all these characteristics, as the story concentrates on the school of Hogwarts and does not really promote any sort of physical exercise [46]. Therefore, it is likely that the brand and the story behind *Pokémon GO* seems to spur people to exercise more effectively than the Wizarding World, thus, *HPWU* might not offer as strong an incentive for players to walk long distances as *Pokémon GO*.

### *2.4 Differences Between Social Features and Motivation for Exercise*

Social elements in games can foster relationships [60–62] and also provide incentives for exercise [2]. With regards to social features, what is interesting is the omission of player vs player conflict in *HPWU*. Firstly, there are no teams unlike in *Pokémon GO*, and secondly, all multiplayer elements can be classified as harmonious. This kind of a design prevents the birth

of ingroup and outgroup thinking and emergence of prejudice towards other players [61, 63–65]. On the other hand, the game might lack some of the motivational factors caused by the challenge given by having human opponents [9, 45, 62].

Evidence was found that *HPWU* emphasizes physical activity less compared to *Pokémon GO*. *Pokémon GO* awards walking over 50km during a week, whereas *HPWU* has a daily task of walking 250m, accumulating to 1.75km during a week. Additionally, the trace encounter animations in *HPWU* are longer than the animations of *Pokémon GO*, and the animations can be prolonged by magic resisted messages shown in 2, thus forcing *HPWU* players to stop more while playing.

**Table 1:** *Comparison of the game mechanics of Pokémon GO and HPWU motivating physical activity and social interaction*

| | **Harry Potter:Wizards Unite** | **Pokémon GO** |
|---|---|---|
| **Game Mechanics Motivating Physical Activity** | -Walking to open portmanteaus | -Walking to hatch eggs |
| | -Travelling to PoIs | -Travelling to PoIs |
| | -Rewards from walking certain distances | -Rewards from walking certain distances |
| | | -In-game research tasks and events that encourage to travel to new areas |
| | | -The in-game scanner showing nearby Pokémon encourages to travel to them |
| **Game Mechanics Supporting Social Play** | Fortress battles, friendlists | trades, communicating spawns, PvP battles, friendslists, gifts, gyms, raids |

Table 1 summarizes the information discussed above into the game mechanics in *HPWU* and *Pokémon GO* for motivating physical activity and social interaction. The two games are almost identical by technical implementation, which is unsurprising as they are based on Niantic's platform [48]. Both games share many of the same PoIs, however, there is more variance on where traces (*HPWU*) and Pokémon (*Pokémon GO*) spawn. Even though the minigames are different from one another (i.e. catching Pokémon versus spellcasting) they are both played by swiping the screen with one finger. This simple interaction makes physical exercise easier; the design decision to allow playing with only one hand is undoubtedly intentional, allowing players more focus to the real world instead of the screen. The main differences between the games seem to be on the intensity of the supported physical activity and on the affordances for social interaction. While *HPWU* has fewer game mechanics supporting social interaction, the game has no divisive teams nor mechanics which allow players to harm each other in the game world unlike *Pokémon GO*. Still, both games have a shared game-world with activities that motivate cooperation. These include lures/dark detectors, fortress battles/raid battles, and sharing trace/Pokémon spawn information. It is therefore beneficial for players to get in touch with other players. This leads to players forming chat groups and meeting each other in real life to play the game, thus potentially creating real life friendships.

### *2.5 Extracting Characteristics of Location-based Games as Exergames*

Based on studies on *Pokémon GO*, scholars have been able to make several predictions of what the characteristics of LBGs which revolve around navigating to points of interests via

using smartphones, such as *Pokémon GO*, *Ingress (Prime)*, *The Walking Dead: Our World* and *HPWU*, are. These characteristics are listed below with references:

- Playing increases mild exercise [7, 66]
- Can be a gateway for exercise for inactive people [7, 21]
- Provides multi-layered motivation for exercise, including in-game rewards and social features [9, 45]
- Playing can be integrated as part of daily commute and other travelling [49, 67]
- Shows promise of other health benefits besides exercise, such as social well-being [33, 37]

The current study focuses on LBGs as exergames, and thus, the first prediction is used to form the hypothesis that *HPWU* should also increase mild physical exercise for its players, but not moderate or strenuous exercise [7, 42, 66].

## 3 Survey Design

In order to empirically measure the impacts that playing *HPWU* has on exercise, a questionnaire was designed including the Godin-Shepard leisure-time physical activity questionnaire [44], which has also been utilized in studies with *Pokémon GO* [51, 66, 68], questions concerning how players move while playing LBGs, some questions about social play and several background questions. Altogether the questionnaire contained 17 questions. The Godin-Shepard pre- and post-test results were analyzed using the paired samples T-test. Other data is presented as descriptive statistics and graphs. The questionnaire was written in Finnish, but an English translation of it is available in Appendix A.

The questionnaire was sent to Finnish *HPWU* players a week after launch, and was available online between the 28-29th of June, 2019, and received 346 acceptable responses. Player anonymity was protected and all research data was safely stored at secured hard drives and is available in anonymized form upon request. The principles of the Declaration of Helsinki [69] were followed in data collection and handling, and only those participants who gave consent to use their data in research were included in the study. The platform through which the questionnaire was sent took technical measures to prevent the same person from answering twice.

## 4 Results

A total of 346 players in Finland responded and fully completed the questionnaire. Table 2 shows the gender and age distributions of the participants.

Among the respondents, 99% (n=343) reported to have played *HPWU* and 96% (n=333) to have played *Pokémon GO*. Many other games were present as well, which shows that LBG players are likely to try out new games of the genre with similar gameplay, e.g. such which includes walking and navigating via a real map -based interface. The results are shown in Table 3. The large proportion of *HPWU* players who had also tried playing *Pokémon GO* (96%) highlights the fact that LBGs seem to attract a certain group of people and previous experiences with LBGs can be a predictor of future engagement in the games of that genre. This is further supported by findings from previous studies. For example, the study of Alha et

**Table 2:** *Descriptive Statistics*

| **Gender** | **Number of participants** | **Percentage** |
|---|---|---|
| Female | 271 | 78,3% |
| Male | 68 | 19,7% |
| Other | 7 | 2,0% |
| **Age** | | |
| Less than 18 | 2 | 0,6% |
| 18-24 | 38 | 11,0% |
| 25-34 | 161 | 46,5% |
| 35-44 | 85 | 24,6% |
| 45-60 | 57 | 16,5% |
| Over 60 | 3 | 1,0% |

**Table 3:** *Which LBGs have you played?*

| | **n of replies)** | **Percentage** |
|---|---|---|
| Harry Potter: Wizards Unite | 343 | 99,13% |
| Pokémon GO | 333 | 96,24% |
| Ingress | 124 | 35,84% |
| Jurassic World: Alive | 64 | 18,5% |
| Draconius GO | 61 | 17,63% |
| The Walking Dead: Our World | 50 | 14,45% |
| Landlord Tycoon | 6 | 1,73% |
| Other | 24 | 6,94% |

al. [45] found that the main reason for players starting to play LBGs was previous experiences with either the brand of the game or other similar games.

When respondents were asked what LBG they have played the most during the first week after the *HPWU* launch, only 85 % replied *HPWU*. The 15% of players quickly after trying the game moved back to other LBGs with 10% playing more *Pokémon GO*, 3% playing more *Ingress* and 1% of players going back to *Jurassic World: Alive* and *The Walking Dead: Our World*. Consequently, 91 % of players reported to have played *Pokémon GO* simultaneously with *HPWU*, 20 % reported to play *Ingress* simultaneously with *HPWU*, and 5 % reported to play *The Walking Dead: Our World* simultaneously as shown in Figure 3. These results provide further evidence that a social group is forming among these games that goes beyond a single game, that is, LBG players. These are people who gravitate towards LBGs and play several games, jumping to new games as they are released and communicate with other players via already established social networks of players.

### *4.1 Effects of HPWU on Physical Activity*

Interestingly, when those who also play *Pokémon GO* were asked to compare the two games and their effect on physical activity, 46 % replied to move more with *Pokémon GO*, 31 % saw no difference and 23 % said to move more when playing *HPWU* as seen in Table 4. The slight preference for *Pokémon GO* can be explained by the game providing wearable devices to allow playing without having to look at smart phone screen all the time, but also by the faster tempo of Pokémon GO gameplay.

In the question about player's primary method of moving while playing, 75 % responded "walking", whereas 17 % responded a primary moving method which does not include exer-

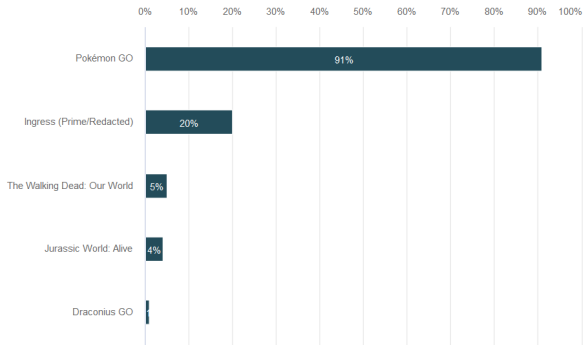


**Figure 3:** *What other LBGs do you play simultaneously with HPWU?*

**Table 4:** *When comparing HPWU and Pokémon GO, which game causes you to exercise more?*

| | n of replies) | Percentage |
|---|---|---|
| Pokémon GO | 149 | 45,29% |
| HPWU | 75 | 22,8% |
| No difference | 105 | 31,91% |

cise (i.e. "by car" and "stationary"). Previous studies have identified the exercise that LBGs provide to be mainly mild (walking or cycling) [7, 41, 42, 68], however, these results indicate that there is also a relatively large proportion of playing which happens while being stationary. This can either happen, for example, as a passenger in public transport or by playing while sitting at home. Thus, not all LBG play can be considered being exercise, even though players who primarily play while stationary might still occasionally exercise with the game.

**Table 5:** *Godin-Shephard leisure time physical activity questionnaire results (N=312) for change in physical activity before and after playing Harry Potter: Wizards Unite*

| | Mean (Pre) | Mean (post) | Sig. 2-tailed |
|---|---|---|---|
| Mild | 8,019 | 10,503 | P<0,001 |
| Moderate | 2,854 | 2,929 | P=0,804 |
| Strenous | 0,413 | 0,423 | P = 0,918 |

Godin-Shepard leisure-time physical activity questionnaire measures the number of times people exercise for more than 15 minutes during a 7-day period [44]. The questionnaire categorizes physical activity to mild, moderate and strenuous, and gives examples of multiple kinds of forms of exercise and to which category they belong to. In the current study, the questionnaire was adopted by asking players to fill in their typical week of exercise before *HPWU*, and their current week after the launch of *HPWU*. A 2-tailed paired samples T-test was then used to calculate the effects *HPWU* has had on players physical activity during the first week after launch (Table 5). Mild exercise i.e. casual walking increased by 23,7 % for *HPWU* players. Moderate and strenuous exercise had no statistically significant change. The results on the increased mild exercise are aligned with previous *Pokémon GO* studies [7, 42, 66, 68, 70, 71].

**Table 6:** *Compared to your normal walking speed, how does playing HPWU influence your movement?*

| | n of replies) | Percentage |
|---|---|---|
| I walk as fast as always, or faster | 28 | 8,09% |
| A little bit slower | 116 | 33,53% |
| Half slower | 52 | 15,03% |
| I have to stop all the time | 150 | 43,35% |

Despite the observed increase in mild exercise, also a seemingly contradicting result was given when asking participants about their walking speed while playing *HPWU* shown in Table 6. Almost half (43,35%) of respondents replied they need to stop all the time while playing and only 8,09% said to walk equally fast or faster. This would indicate that compared to regular exercise, *HPWU* actually has a negative effect. A similar result was also observed in a study of *Pokémon GO* by Beach et al., in 2019 [53]. Thus, when out exercising, it would seem to be better not to play LBG such as *HPWU* or *Pokémon GO*. On the other hand, if the option is to remain at home, LBGs can be the healthier option as they provide at least some exercise.

### *4.2 Effects of HPWU on Social Interaction*

As only the early adopters of *HPWU* were observed, the effects the game has on social interaction could only be lightly touched. The social interaction with other players has been in major role in Niantic's past LBGs, *Ingress* and *Pokémon GO*. However, in *HPWU* playing with friends did not give major advantage in the early players' levels. Thus, the result seen in Table 7 that 53% players play *HPWU* alone is not surprising. In *HPWU* when leveling up, playing with the friends will eventually give some advantage in fortress battles, but overall adding friends and playing with them does not have as an important role in *HPWU* as it does in *Ingress* and *Pokémon GO*. Yet, social interaction overall with other LGB players has created communities around the games and this could also be seen in *HPWU* – Players do have their own online forum, Telegram and Facebook groups where they can discuss the issues related to the game.

**Table 7:** *With regards to social company, how do you play HPWU?*

| | n of replies) | Percentage |
|---|---|---|
| Always with my friends | 5 | 1,44% |
| Mostly with my friends | 55 | 15,90% |
| Every now and then with my friends | 102 | 29,48% |
| Almost always alone | 184 | 53,18% |

Based on the frequent update cycle of *Pokémon GO* and other popular contemporary multiplayer online games, it can be speculated that *HPWU* could receive updates in the future adding more social features and rewards from cooperative play. The current results of social play, shown in Table 7, are most likely influenced by players' prior connections, as an overwhelming majority of the respondents reported to have prior experiences with LBGs. Most players also reported to simultaneously playing at least one other LBG in addition to *HPWU*. On the other hand, one peculiar property of LBGs is that as players move outside, they encounter people, prompting interactions with people who are not playing. Thus, a generalized statement can be summarized that playing *HPWU* outside does, at least to some degree depending on the social attitude and playing location of the player, increase social well-being.

# 5 Discussion

## 5.1 Key Findings

Observations made from the survey can be summarized in the following three points:

1. With regards to physical activity, *HPWU* showed a statistically significant increase in mild exercise but no change in moderate or strenuous exercise. However, when playing *HPWU* players moved slower than normal.

2. With regards to social activity, almost half of respondents reported to at least sometimes play the game socially. Furthermore, *HPWU* made players play in the real world, thus affording spontaneous interaction with bystanders who are not playing the game.

3. The results are aligned with studies on *Pokémon GO*, and, thus provide evidence towards a more general characterization of LBGs as exergames.

## 5.2 Implications of Findings

Despite differences in story and some differences in gameplay and implementation, *HPWU* and *Pokémon GO* are currently much alike. Together with games such as *Jurassic World: Alive*, *The Walking Dead: Our World*, *Ingress*, *Orna* and *Draconius GO*, the games have formed their own sub-genre of LBGs which uses a real life map as a navigational interface and main game window. The empirical evidence from the survey indicates that the several studies conducted on the effects *Pokémon GO* has on physical activity levels translate to other LBGs. However, the magnitude of the effects on physical activity can vary. Because LBGs seem to increase mild exercise, they have been proposed as a gateway to a physically active lifestyle, which can be especially important for those who have no prior motivation to exercise [7, 21]. Therefore the role of LBGs as exergames can be seen that of promoting light, casual exercise.

But even though we are discussing exergames, there are many connected potential benefits of playing LBGs besides exercise such as social well-being and being a healthy outdoor activity. Almost half of the respondents reported to sometimes play the game socially. The social features of *HPWU* and *Pokémon GO* are currently quite different, and thus, some of the studies on the social aspects of *Pokémon GO* are unlikely to translate to *HPWU* [33, 37, 61]. The social effects of *HPWU* were also difficult to observe on their own, as an overwhelming majority of *HPWU* players reported to have played or were still playing *Pokémon GO* and other LBGs. This indicates that many of the new *HPWU* players were already connected with each other via experiences with previous LBGs.

The social interaction that LBGs support can have value on its own, but it can also be a motivating mechanism for exercise [2]. This is important, as a common challenge for exergames is how to maintain user interest [12]. *Pokémon GO* studies reported players' initial enthusiasm diminishing over the course of a time period of one month [25, 70]. This can be countered to some degree by updating the game [18], but completely new LBGs such as *HPWU*, which we focused on, can also have a role in rekindling the motivation to move in players. The majority of LBG players seem to prefer *Pokémon GO* over *HPWU*. There was big hype for the game, as the initial report showed *HPWU* created 28 million dollars during the first four days after launch, which has since quickly shrunk to a couple of million dollars per month [72]. When compared to the 180 million dollars *Pokémon GO* made at launch and the tens of millions it is still making over three years later, it is evident *HPWU* never managed to reach the popularity of *Pokémon GO* and is also losing interest more quickly. Besides revenue generated via in-app purchases, the amount of downloads and active installs show the success of *Pokémon GO* compared to *HPWU*. There are multiple possible reasons for this,

including: (1) Affordances of the brand (2) Better utilization of PoIs (3) Pokémon GO has faster-paced and more fluent gameplay (4) *Pokémon GO* has the possibility to use wearable devices (5) *Pokémon GO* provides more diverse gameplay opportunities (6) *HPWU* requires a high-end smartphone to work at all (7) *HPWU* lacks competitive multiplayer elements and thus challenge (8) *HPWU* minigames force players to halt walking with long animations and constant "magic resisted" messages (9) *HPWU* is more aggressive than *Pokémon GO* in marketing in-app purchases and (10) *HPWU* has monetized the basic gameplay, forcing players to purchase spell energy in order to play unless they live next to inns. These theorized reasons could be further explored in future work, as it is interesting how two seemingly similar games can be received so differently by players.

### *5.3 Limitations*

Many studies have extrapolated findings on single LBGs to consider a larger set of LBGs [9, 45]. This study compared two similar games and provided evidence supporting this extrapolation. However, there are multiple aspects this study did not cover and as games tend to be unique and highly complex. For example, the gameplay experience and flow experience have been mentioned in previous studies to impact engagement [12]. Most likely studies of individual games will always be needed regardless of identified general characteristics of the game's sub-genre.

The survey this study conducted also had its own unique limitations. Firstly, the participants most likely represent early adopters and enthusiasts, and are not as such representative of the overall playing population. In addition, longitudinal studies are needed, as have been conducted with *Pokémon GO* [24], as studies have found beneficial effects of *Pokémon GO* on physical activity to decrease [73], or even completely diminish [70] over time. The respondents were self-selected and an extremely large proportion (over 95%) had played *Pokémon GO* before, which might also be caused by the distribution channels chosen for the survey. Because of this, for example, the activating effects and sense of novelty [74] in playing LBGs might have already been used up by *Pokémon GO*.

The self-reported nature of the questionnaire arguably makes it less reliable than sensor data-based information, however, in studies of *Pokémon GO*, both questionnaire data i.e. [51, 68] and sensor data i.e. [7, 29] have been utilized with similar results. Finally, as LBGs are subject to be updated with new features, findings which are specific to a certain version of the game (i.e. *HPWU* release version in this case) might become outdated at some point. The large proportion of female (76,7%) participants in the survey was peculiar, however other LBG studies have also had a female majority in participants [23, 45]. Then again, other studies reported roughly equal numbers of male and female players [28]. The large number of female participants can also be explained by the chosen questionnaire distribution method.

### *5.4 Future Directions*

Health and welfare sector practitioners looking for exergames to activate physically inactive individuals can look for solutions from LBGs beyond *Pokémon GO*. Meaningful multiplayer gameplay seems to be important for player retention in LBGs, as evident from studies observing why people play LBGs [9, 45]. The games currently seem to support mild exercise, thus, an important topic for future research will be to come up with gameplay that supports also strenuous physical activity and other forms of exercise besides walking. To that end, it is important to reflect in which other ways than those currently present in *HPWU* and *Pokémon GO* could LBGs incorporate exergame attributes in their design. Hence, four strategies are proposed:

- Look into what other similar games have done. For example, *Zombies, Run!* has sound-based gameplay which is ideal for running and interval practise [54].
- Derive inspiration from what personal trainers and physiotherapists are utilizing and try to gamify or adapt the used approaches to fit the currently available exergames. For example, currently the games mainly feature walking as the form of physical activity. Could some gameplay be created that supports muscle training? An example of this could be fitness boxing games or the new Nintendo Switch game *Ring Fit Adventure* [75].
- Look at the affordances of the brands and franchises in question. For example, a major part of the Pokémon franchise is throwing pokéballs. Yet, this is not harnessed in the game design of *Pokémon GO*. If incorporated, it could provide opportunities for gameplay which provides muscle training.
- Use design techniques such as co-design with stakeholders to come up with new inspiring gameplay [76].

## 6 Conclusion

The aim of this study was to derive characteristics of LBGs as exergames. This was investigated by comparing the effects of playing *Pokémon GO* on physical activity to another similar game, *HPWU*. The launch of the game in 2019 provided a unique opportunity to measure before and after physical activity levels of players. 346 *HPWU* players responded to a survey and a statistically significant increase in mild physical activity (23,7%) was observed via the Godin-Shepard instrument. The increase in physical activity was similar to that which was observed at the launch of *Pokémon GO* in 2016. This indicates that similar LBGs, not only *Pokémon GO*, can be regarded as games playing of which increase and support mild physical exercise i.e. walking or slow cycling. Furthermore, the results revealed that almost half of the players were playing the game socially with others. One important benefit of LBGs such as *Pokémon GO* and *HPWU* seems to be that of a gateway towards exercise and social life for physically and socially inactive people. For others, they provide a healthy and fun social outdoor activity.

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**Samuli Laato, Nobufumi Inaba, Mauri Paloheimo & Teemu D. Laajala**

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II

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**Abstract. Purpose:** This study investigates how game design, which divides players into static teams, can reinforce group polarisation. We study this phenomenon from the perspective of social identity in the context of team-based location-based games, with a focus on game slang.

**Research design:** We performed an exploratory data analysis on an original dataset of n=242,852 messages from five communication channels to find differences in game slang adoption between three teams in the location-based augmented reality game Pokémon GO. A divisive word "jym" (i.e., a Finnish slang derivative of the word "gym") was discovered, and players' attitudes towards the word were further probed with a survey (n=185). Finally, selected participants (n=25) were interviewed in person to discover any underlying reasons for the observed polarised attitudes.

**Findings:** The players' teams were correlated with attitudes towards "jym". Face to face interviews revealed association of the word to a particular player subgroup and it being used with improper grammar as reasons for the observed negative attitudes. Conflict over (virtual) territorial resources reinforced the polarisation.

**Practical implications:** Game design with static teams and inter-team conflict influences players' social and linguistic identity, which subsequently may result in divisive stratification among otherwise cooperative or friendly player-base.

**Originality:** The presented multi-method study connecting linguistic and social stratification is a novel approach to gaining insight on human social interactions, polarisation and group behaviour in the context of location-based games.

**Keywords:** location-based games, polarisation, social identity theory, language, slang

## 1. Introduction

Polarisation poses a threat to our society in the form of escalating conflicts on both individual and group levels (Quershi et al., 2020). Therefore, understanding the underlying mechanisms through which technology can influence group polarisation is important. In this study we approach this research problem from the perspective of social identity (Tajfel, 1974) in the context of location-based games (LBGs) such as Pokémon GO and Ingress. LBGs have recently gained attention for being popular among a wide, intergenerational audience (Saker and Evans, 2021) and being able to scaffold social connectivity between players (Bhattacharya et al., 2019; Vella et al., 2019). Both Ingress and Pokémon GO divide players into static teams which compete over virtual territory (Laato et al., 2021; Söbke et al., 2017). These factors make the games an ideal study context for studying group behaviour and polarisation.

The human social subgroups are influenced by factors such as workplace, hobbies, socioeconomic status and location of residence. Consequently, group polarisation is defined as a characteristic of these subgroups to move towards more extreme viewpoints (Sunstein, 1999). In LBGs as players are given a team with whom they cooperate against other players, an in-group vs out-group setting may emerge (Brewer, 1999). While the

teams may guide the formation of players' social circles, it is not clear how strong this effect is and whether it will lead to group polarisation. One way to probe who might belong to a specific subgroup is to look at language use (Ksiazek and Webster, 2008). In this context a relevant research problem is to explore whether the static teams and inter-group conflict provided by LBGs can be seen at the level of players' language use.

To study these trends, we conducted exploratory research on the differences in language use between three static teams in the LBG Pokémon GO. Altogether, we looked at five asynchronous communication channels across three static teams to identify main differences in use and attitudes of game-related terminology and slang. We further explored these trends by collecting survey data from participants in the researched communication channels, and further investigated interesting findings by interviewing selected candidates. In addition, there was notable overlap between the player communities of Pokémon GO and a related LBG Ingress. For this reason, we also involved Ingress players in the survey and interview stages of our research. Taken together, in this work, we utilise three datasets: (1) Chat analysis (n=242,852 messages); (2) a survey (n=185); and (3) face-to-face interviews (n=25). The rest of this manuscript is structured as follows. First, we present the theoretical lens for this work, which is the social identity theory (Tajfel, 1974) and social influence theory (Kelman, 1958). Subsequently, we look at the literature on social communities in LBGs and language acquisition in gaming communities respectively. We then present our methodology followed by the results, discussion and conclusions.

## 2. Background

### 2.1 Theoretical lens: the social identity approach

Formed in the 1970s, social identity theory explains the role of self-conception and related cognitive processes and social beliefs in an in-group and out-group setting (Hogg, 2016). The origin of the theory can be traced to an experiment by the psychologist Henri Tajfel where he sorted participants into groups based on their performance in a short estimation test. He instructed participants in each group to divide money between all groups and found out that systematically participants favoured their own group, distributing them more money (Tajfel, 1970). These findings have since been reproduced and expanded in several independent studies, even with clearer artificial divides (e.g., Bagby and Rector, 1992; Jetten et al., 1996; Locksley et al., 1980). The social identity approach has been expanded to cover aspects of collaborative behaviour and regulation, including collective behaviour, self-enhancement and reducing uncertainty and de-individualisation of out-group members (Hogg, 2016). From an evolutionary psychology perspective, the formation of social identity and in-group thinking has enabled humans to collaborate better, increasing trust and providing satisfaction when aligning with group behaviour (Brewer et al., 2006). It has guarded from trusting possibly hostile groups of humans by generating prejudice against out-group members (Brewer, 1999).

The theory proposes two motivations for out-group discrimination: (1) a desire for cognitive coherence and structure; and (2) a need for positive self-esteem (Abrams and Hogg, 1988). The reasoning behind the first motivation is that for effective collaboration to occur, humans need to be able to make predictions of their group members' behaviour. A shared religion, ideology, culture and habits contribute to increasing the power of these predictions. By contrast, behaviour of perceived out-group members is more difficult to predict, resulting in increased cognitive load and work needed to establish seamless collaboration (Beer et al., 2013). Studies suggest human self-esteem is increased by positive multimodal social feedback (Harris and Orth, 2020), but also via dominating perceived out-group members (Abrams and Hogg, 1988). At the extreme ends of this spectrum, this natural mechanism can produce narcissistic self-evaluation and out-group hate (Cichocka et al., 2017). Overall, the social identity theory is a useful framework for understanding polarisation at the group level (Mackie, 1986). In the online context, the social identity approach has been used to explain video game players' team commitment (Liao et al., 2020) and engagement in social networks (Cheung et al., 2011). Players were found to perceive the existence of group norms in online games, and acceptance of these norms correlated with team commitment (Liao et al., 2020).

Related to social identity theory and often discussed together with it is social influence (Hogg, 2016). The social influence theory was originally introduced in the 1950's by Kelman. He divides social influence into three categories: (1) compliance, (2) identification and (3) internalisation (Cheung et al., 2011; Kelman, 1958). According to Kelman, *compliance* refers to accepting influence in hopes of a favourable reaction from an individual or group; *identification* refers to behaviour motivated by the desire to establish or maintain a satisfying relationship to an individual or a group; and *internalisation* is intrinsically motivated action, where a

person accepts influence because they feel content and ideas induced in the proposed action are compelling (Kelman, 1958). Individuals have been found to accept influence from their perceived in-group members and to be motivated to impress them (Hamari and Koivisto, 2015), but reject and oppose influence from out-group members (Hogg, 2016). This finding is important in the context of the current study, as it implies that words associated with a specific team could be collectively rejected by their opponents. In this context, language preference can be used as a proxy to study group polarisation (Ksiazek and Webster, 2008; Peirce, 1995).

### 2.2. Social Communities in Location-based Online Multiplayer Games

Prior research suggests that computer mediated social networking may amplify group polarisation (Quershi et al., 2020; Sia et al., 2002). Before online gaming became prominent, players would meet physically at e.g., arcades or LAN (Local Area Network) parties, where computers were connected locally via short network cables and routers or switches (Ackermann, 2012). Arcade halls, LAN-parties and traditional athletic sports require attendance in a pre-specified location and time. By contrast, modern multiplayer online game communities are not limited by the spatial dimension as they are played over the internet from all over the world (Williams et al., 2006). Multiplayer online gaming is also free from the temporal dimension in the sense that because the games are globally available, they typically have players active at all times.

LBGs such as Ingress and Pokémon GO are a mix between offline and online playing (Leorke, 2018). While the games are always played online, they are also played by walking in the real world. Thus, they are tied to the physical location of the players (Liberati, 2019). LBGs can be regarded as gamification as they are mixing game elements with the real world (Hamari, 2019), and while playing, the opportunity of non-game related face to face encounters is present. This may boost the reported phenomena that social connections in online games can lead to the establishing of real-world friendship (Schiano et al., 2011). Several LBGs including Pokémon GO, Orna, Walking Dead: Our World, Harry Potter: Wizards Unite, and Ingress provide game mechanics where players gain significant advantage from cooperating, subtly pushing players to interacting with others (Riar et al., 2020). The game design, available goals and game mechanics in these games have major influence on what kinds of social interactions and social phenomena arise during play (Bhattacharya et al., 2019; Morschheuser et al., 2017; Riar et al., 2020).

From a social standpoint, LBGs are unique among other multiplayer online games in that players do not retain anonymity. Despite players having pseudonyms in-game, LBG players can be seen by others walking and playing in the real world, which removes the online disinhibition effect (Suler, 2004). This can reduce the likelihood for cyberbullying and toxic behaviour, which present rampant problems in multiple fully online multiplayer games (Blackburn and Kwak, 2014; Kordyaka et al., 2019; Kwak et al., 2015). The presence of social regulations on behaviour might contribute to more harmonious interaction and better understanding between players (Vella et al., 2019). In fact, social identity theory (Hogg, 2016) and in particular the contact hypothesis originally proposed by Allport (1954) suggests that simply establishing discourse with out-group members may curb prejudiced opinions and help people feel empathy towards each other.

As playing in LBGs is tied to a physical location, players are likely to share interests, habits and culture that is associated with geographical location. This can make social interaction more harmonious due to players sharing common interests (Wright and Jacobs, 1994). While the positive effects of LBGs on social connectivity (Vella et al., 2019), we-intentions and altruism (Riar et al., 2020) have been studied, the flip side of this phenomenon which is the polarising effect of the static teams is yet to be explored.

### 2.3 Language Acquisition in Gaming Communities

Language use and preference can be used as predictors of social behaviour and group identity (Ksiazek and Webster, 2008). This idea is strongly present in the field of linguistic ideology, which seeks to understand social and cultural systems based on language use and preference (Irvine et al., 2009; Rumsey, 1990). As games are worlds of their own, slang terms and new words emerge among gaming communities. Examples of game-related words and phrases which have reached global online adoption include “get rekt”, “N00b”, “1337” or “l33t” (Blackburn and Kwak, 2014). These words can originate in written form and then spread to spoken language, or alternatively be first introduced to spoken language. In online gaming, the mechanisms for adopting such words are linked to the player communities, and the spread is accelerated, for example, when popular gaming personalities start using the words. This speaks of the social nature of language and the role of social hierarchies in language use (Irvine et al., 2009; Rumsey 1990). New game-related words and phrases

have reportedly spread via the chat on the popular live game streaming platform *Twitch.tv* (Olejniczak et al., 2015) as well as more subtly between players in online chat groups. What is interesting from the perspective of the current study, is that slang-terms used by players of opposing teams can receive negative connotations giving birth to negative attitudes towards the words and their users (Drake, 1980; Eble, 1996).

The processes through which potentially polarising language or slang emerges can be related to the natural evolution of language. Language develops organically as people balance the cost and effectiveness of their word choices (Ojutkangas et al., 2009). For example, if a particular word is tedious to pronounce or very long, players are prone to find replacements for it (Ojutkangas et al., 2009). Multiplayer games set a unique challenge to communities of non-English speakers when a translation of the game is not available. For example, in Finland, local Ingress and Pokémon GO communities use predominantly Finnish when discussing game related phenomena. As there is no Finnish localisation of the game, players casually mix English words into their sentences, which otherwise follow Finnish grammar. The Finnish language belongs to the agglutinative languages (Löfberg et al., 2003), and as foreign words might be difficult to pronounce, players often invent their own slang (Coleman, 2012). These slang terms can emerge in a single team, but never reach acceptance of the whole player base (Coleman, 2012).

One way to study language preference is to look at the active vocabulary of people. Actively used vocabulary has been used as a predictor of adopted social identity. For example, parents can feel a sense of loss when hearing their children use (slang) words that sound unfamiliar to them (Ochs, 1993). However, in addition to vocabulary, manner of speaking, intonation and other aspects of communication may also be indicators of social identity. As an example, individuals have been found to use abstract and general language when describing positive behaviour and more concrete and specific language when describing negative behaviour of their in-group members (Porter et al., 2016). This type of language use implicitly suggests that the positive behaviour is recurring and omnipresent whereas the negative behaviour is only something that has occurred on some very specific instances. With regards to an out-group, the language use is reversed (Porter et al., 2016). These implicit language patterns serve to protect the integrity of an individuals' in-group while giving rise to prejudice towards the perceived out-group members. Following our theoretical approach, another mechanism how language can predict social identity, especially in the context of multiplayer online games, is to look at players' attitudes towards game slang associated with opposing team members (Irvine et al., 2009; Ksiazek and Webster, 2008). However, before such analysis can be done, potentially polarising slang terms need to be identified.

## 3. Empirical Study

### 3.1 Case Games

For the empirical part of this study we focus on active player communities in two games: Ingress and Pokémon GO. The games were selected due to being the two most popular LBGs measured by the number of active installs (Laato et al., 2020b). Both games are available for Android and iOS and are developed by the same company, Niantic. The games share the same database of geographical points of interest (PoIs) but differ in game mechanics (Laato et al., 2019). As players in Ingress and Pokémon GO are split into static teams who are competing against each other over territorial resources, the games are suitable candidates for studying polarisation in our theoretical setting.

#### Pokémon GO Player Communities

Pokémon GO has accumulated a large body of academic research due to its massive popularity. Social interaction is currently promoted by Pokémon GO gameplay decisions in several ways. The game includes raid bosses, which are stronger in-game challenges that require players to unite, typically beyond team boundaries (Bhattacharya et al., 2019). Coordinating raids and sharing information about their locations is common practice in Pokémon GO communities (Bhattacharya et al., 2019). In addition to raids, Pokémon GO also features gameplay elements that require physical proximity of players, such as trading pokémon (Niantic, 2019). In addition, players can spend time playing together with their real-world friends regardless of team allegiance, as there are no negative repercussions from playing with friends (Paasovaara et al., 2017).

Pokémon GO has three teams: *Instinct*, *Mystic* and *Valor*, and players can only belong to a single team (Vella et al., 2019). The team choice is otherwise permanent but can be changed once per annum in exchange for in-game currency. As team members benefit from playing with each other and often have their own

exclusive communication channels, players end up more frequently bonding with members of their initially chosen team. Pokémon GO has been observed to have a diverse player base in regard to gender and age (Potts and Yee, 2019; Vaterlaus et al., 2019), breaking the previously observed trend that young men compose a vast majority of video game player-base (Burgess et al., 2012). The opportunity to interact with players who may come from a different socioeconomic, ethnic and age-related backgrounds, can be seen as an enriching social experience, which can have a positive impact on players' attitudes and understanding towards each other (Kircher and Fox, 2019).

**Ingress player communities**

Currently, there are two teams in Ingress, referred to as factions: Enlightened and Resistance. Players choose a faction at the very beginning and faction change is difficult, hence people tend to adopt their faction's social context and befriend players from the same faction (Morschheuser et al., 2017; Tokgöz and Polat, 2018). Cooperating with players from the opposing faction is forbidden in Ingress rules, which reinforces a division between the teams. The factions typically have their own exclusive chats where only members of the same team are allowed. Thus, the design of Ingress not only divides players into two teams (Sheng, 2013), but also influences the social relationships of players.

The problem of group polarisation due to the two Ingress factions has been loosely addressed by in-game social events such as First Saturdays, XM Anomalies and Mission Days, where players from both teams can meet each other in a friendly setting (Fragoso and Reis, 2016; Söbke et al., 2017). In addition, independent organisers have constructed, for example, outdoor museums using Ingress as a backbone, which are aimed at players of both factions (Shirai et al., 2015). Regardless, Ingress players appear enthusiastic about the social dimension of the game and acknowledge that the game requires competition between the factions as the gameplay becomes stagnant if one side is dominant (Riar et al., 2020; Söbke et al., 2017). In fact, previous studies highlight the positive effects Ingress has on team spirit, joint commitment and attitudes towards cooperation and even altruism (Morschheuser et al., 2017; Riar et al., 2020).

### 3.2 Study overview

Our overall research design is depicted in Fig. 1. First, an exploratory search was utilised in five communication channels to identify potential candidate slang words for a closer analysis (Fig. 1a). For this purpose, the largest team chat of each Pokémon GO team as well as two additional chats were studied. Comprehensive inspection of game slang use provides information regarding team influence and also brings clarity to the underlying social structures among players. A potentially polarising word "jym" i.e., gym was manually identified and then investigated. Its use was then sorted into two categories: (1) being the subject of discussion; or (2) being used casually during conversations (Fig. 1b). Consequently, a self-developed 8-item survey was sent to the observed chats in order to obtain information of players' attitude towards the particular slang term (Fig. 1c). Finally, selected players were interviewed face to face in a non-formal fashion by the authors, asking them about their perception and opinions towards the slang-word "jym" and inquiring how they formed their attitude towards the word (Fig. 1d). In summary, method-wise this study is divided into the following three parts:

1. **Aim:** Identify differences in language use between teams.
**Method:** Scan player communities and team exclusive chats for slang words and their frequency. Sort appearance of interesting words based on whether they are used naturally or if they were the topic of a discussion. (Fig. 1a-b)

2. **Aim:** Investigate and quantify statistical significance of use and attitudes towards identified slang words.
**Method:** Survey players in the same chats via a questionnaire focused on opinions and attitudes towards non-universal slang terms. (Fig. 1c)

3. **Aim:** Explain the observed relationships.
**Method:** Face to face interviews with select participants asking their personal reasons for using or not using the specified words as well as how they formed the reported attitudes towards the words. (Fig. 1d)

### 3.3 Scanning for Differences in Language use among Pokémon GO and Ingress Communities

Initial observations of Pokémon GO and Ingress communities from South-Western Finland during 2016-2019 resulted in identifying several slang terms related to the games (Fig. 1ab). In Ingress, these included words based on previous names of Ingress items. For example, *Aegis shield* was called *"axa"* (due to an old sponsorship deal) and the *CircleK* and *Lawson* power cubes were called *"sponssicube"*, which roughly translates into *"sponsorship cube"*. In Pokémon GO, slang words were discovered for gyms, Pokémon (e.g., *"monni"*, a word for a fish which rhymes with the latter part of the word pokémon) or activities, i.e., *"sahata"*, a verb which literally translates to "sawing", but which was used to describe taking down gyms. Primary focus at this stage was to find slang terms which were actively used by certain subgroups of players, but not by all players.

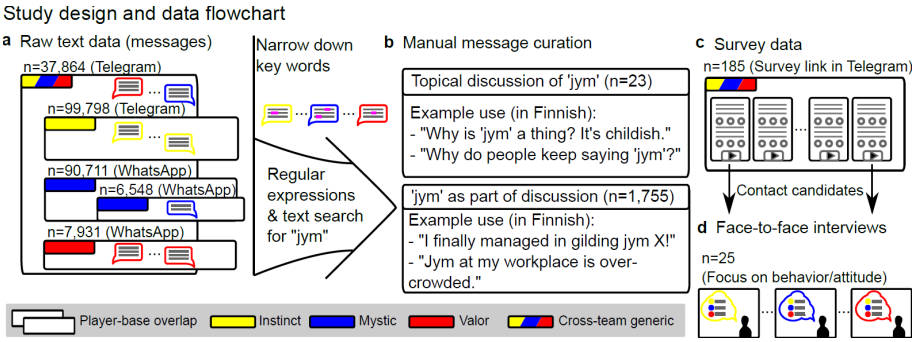


**Fig.1.** a) Primary exploratory data was derived directly from intra- and inter-team communication channels among Pokémon GO players, which was then b) subjected to aromatic and manual searches, which resulted in the word 'jym' emerging as a divisive agent. Afterwards discussion surround "jym" was manually read to establish whether the word was being discussed or used naturally c) A survey was posted to the same channels with a focus on the term 'jym', and finally, d) willing participants were interviewed face to face by the authors, further exploring reasons and background regarding attitudes towards the slang terms.

#### Chat Data Search

Five Pokémon GO chats in South-Western Finland were extracted and anonymised for further data analysis (Fig. 1a). First, the most popular chat of each one of the three Pokémon GO teams, Instinct (99,798 messages), Mystic (90,711 messages) and Valor (7,931 messages) were selected. Joining these chats was open for everyone under the condition that they belonged to the specified team. Additionally, a chat including members from all three teams (37,864 messages) and a special chat inside Team Mystic (6,548 messages) were included. The data from the chat groups was from the following periods: **Case 1 Instinct** (September 2016-April 2019), **Case 2 Mystic** (August 2017-March 2019), **Case 3 Valor** (July 2018- July 2019), **Case 4 cross-team chat of all three teams** (October 2017-January 2019), **Case 5 smaller Mystic chat** (May 2018-March 2019). The case 5 chat was selected post hoc as it represented early adopters of the "jym"-word. Access to Ingress chats could not be obtained due to the chats being perceived non-public by their members. Information regarding the collected chat data is displayed in Table I.

**Table I.** Chat messages collected for analysis

| Chat type | Number of messages | Collection time | Medium |
|---|---|---|---|
| Case 1 Instinct | 99,798 | 9/21/2016-4/29/2019 | Telegram |
| Case 2 Mystic | 90,711 | 8/14/2017-3/27/2019 | WhatsApp |
| Case 3 Valor | 7,931 | 6/20/2018-6/10/2019 | WhatsApp |
| Case 4 All teams | 37,864 | 10/18/2017-1/6/2019 | Telegram |
| Case 5 Mystic2 | 6,548 | 5/4/2018-3/27/2019 | WhatsApp |

Almost all discussion in the chats was in Finnish, with minor exceptions of conversation in other languages of which the most popular one was English. The non-Finnish messages were also included in the data analysis. The moderators of the chat channels gave permission to mine the data for linguistic trends. The data was carefully handled by the researchers and no external copies were ever stored outside the University servers. As the chat channels were publicly accessible to members of the specific team in the given geographical location, and no individual members could be identified, it was decided to be ethical to conduct an anonymous scan of slang words used in the chats. Research permission was asked by participants during a follow-up survey, however, not all members who had been posting messages to the chats during 2016-2019 could be reached in this manner. Therefore, no demographic data could be reported from the chat channels, only frequencies of the use of chosen slang words.

**Chat Data Analysis**

First, the frequency of the usage of the words for "pokémon", "gyms" and "raids" were searched for in the chats in order to detect any differences in the use of game-terminology. This part was done automatically. Following the findings, the most interesting word (which turned out to be "jym", a slang word for "gym") and its use were explored further by reading discussion surrounding the word and classifying the use of the word into *natural use* and *discussing the use of the word* (Fig. 1b). "Jym" was selected as the top candidate for closer analysis, as it appeared as a clearly divisive word both in attitude and active usage between the studied teams. This part was manually conducted by the second author.

### 3.4 Survey and Statistical Methodology

Following the results of the chat analysis, players' perceptions towards the divisive term "jym'' were probed further with a survey. "Jym" was also known among Ingress players, firstly because many of them also played Pokémon GO, and secondly because some players had submitted new portal candidates to the Niantic PoI database (Laato et al., 2019; Tregel et al., 2017), containing the slang-word "jym". This exposed Ingress players to terminology that was alien to their game. Due to overlap between the local Pokémon GO and Ingress player communities in terms of several players playing both games, Ingress players' opinions were considered as supplementary material in the survey. What made Ingress relevant to the study is that while Pokémon GO players had first-hand experience of "jym" (the term originated as game slang among Pokémon GO players), Ingress players had no meaning for the word in their playing context. In fact, they only knew about the word through portal candidates named "jym" as well as either playing Pokémon GO themselves or having connections to players who played Pokémon GO.

**Survey Description**

The online questionnaire probing players' attitudes and use of the word "jym" was sent to Pokémon GO and Ingress players in South-Western Finland on July 2019. Players who replied to the survey, but who did not give permission to use their answers in research, were excluded. The questionnaire was open for one day and distributed directly to the chats analysed in the current study, and contained the following questions:

1. Are you familiar with the term "jym"? (yes, no)
2. Are you actively using the term "jym" yourself? (yes, no, sometimes)
3. In case you do not say "jym", what do you say instead? (open question)
4. How do you feel about the term "jym"? (positive, neutral, negative)
5. State your team in Pokémon GO (Instinct, Mystic, Valor, I do not play Pokémon GO)
6. State your team in Ingress (Enlightened, Resistance, I do not play Ingress)
7. How old are you? (Below 18, 18-25, 26-40, 41-60, over 60)
8. State your username in Ingress and Pokémon GO. (open text field)

**Data Analysis**

The statistical analyses and presentation of the survey data were conducted in the R statistical software version 3.6.1 (R Core Team, 2020). In addition to the base installation, extending R-packages *corrplot* (v0.84), *ComplexHeatmap* (v2.0.0) (Gu et al., 2016), *hamlet* (v0.9.6), and *foreign* (v0.8-71) were used. Survey data was mainly trinary coded with value -1 indicating a negative response, value 0 indicating a neutral response or a missing value, and value +1 indicating a positive response. The conducted hierarchical clustering accompanying the rows and columns of the heatmaps was done using complete linkage coupled with the Euclidean distance. Default parameters were used for all plots and statistical analyses, including the Pearson correlation matrix plot for associations between interesting variables from the survey. Further, tabulated data for associations was subjected to statistical inference using Fisher's Exact Test coupled with Benjamini-Hochberg multiple testing corrections.

### 3.5 Interviews with Players and Additional Data

Participants who had extreme replies in the survey and selected participants who reported a negative attitude towards "jym" were invited for a face to face interview, or asked to give a comment online, for further investigation (n=25). These interviews were carried out in a non-formal fashion by the first three authors. All collected data was in Finnish but was translated into English by the first author in order to display exemplary quotes. All interviewed participants gave consent to use their replies for research.

## 4. Results

### 4.1 Chat Analysis Results

Frequency of slang terms for pokémon, gyms and raids were looked for in the chats. The words were observed in their basic form (including conjugations) and as compound words. In the case of words for pokémon and raids, no major differences between teams were observed. The frequency of gym slang terms in the five chats is displayed in Table II. "Torni" means a tower in English, and the word can be traced back to 2016-2017 when the graphical layout of gyms resembled that of a tower. "Sali" can be considered the most accurate translation for "gym" in Finnish. "Jym" is not a Finnish word, but it arguably fits spoken Finnish language better than "gym", as the letter "j" is easier for Finns to pronounce and its tone closely resembles that of the letter "g". However, "jym" was often used in written chats without conjugation, breaking the rules of Finnish grammar. What is especially interesting in this data is that "jym" was used actively in all other chats except that of team Valor.

**Table II.** Comparing "jym" usage with alternative terms

| | **Gym** | Compound word | **Sali** | Compound word | **Jym** | Compound word | **Torni** | Compound word |
|---|---|---|---|---|---|---|---|---|
| Case 1 Mystic | 1173 | 53 | 1675 | 58 | 393 | 4 | 16 | 0 |
| Case 2 Valor | 36 | 1 | 173 | 3 | 11 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Case 3 Instinct | 39 | 3 | 124 | 8 | 453 | 22 | 0 | 0 |
| Case 4 All teams | 370 | 9 | 677 | 13 | 536 | 4 | 11 | 0 |
| Case 5 Mystic2 | 113 | 9 | 72 | 2 | 393 | 39 | 0 | 0 |

All instances of "jym"-use were automatically searched (n=1,469 messages). All messages containing the word were manually read including the context. This allowed categorising the usage of "jym" into natural (i.e., adopted to use as part of language) and being the topic of discussion (i.e., commented on or criticised). The results are displayed in Table III. In proportion to the overall number of messages containing "jym", members of team Valor were overwhelmingly discussing the term instead of actively using it. There were 501 messages in the common chat concerning the word and also the most instances (n=10) when the word was discussed as a subject. The word was proportionally the most used in the smaller Mystic chat where the term was used 393 times but never discussed as a subject. This might be explained by that all participants in that chat (1) knew each other; (2) could be considered highly active players; (3) were also actively interacting outside the chat in both online and offline contexts; and (4) had been playing the game for longer than two years. These four factors indicate that the team members had time to bond and develop a social subgroup with their own mannerisms and group behaviour. This would have led the players to develop a social identity. Outward expression of such identity (i.e., the use of "jym") was discussed by team Valor, but never adapted in use, showcasing that a stratification of players into social subgroups could be seen already at this stage.

**Table III.** Appearance of "jym" in five analysed Pokémon GO chats

| | N messages containing jym | N times Jym mentioned | First appeared | Used naturally | Discussed as a subject |
|---|---|---|---|---|---|
| Case 1 Mystic | 245 | 393 | 10/25/2017 | 392 | 1 |
| Case 2 Valor | 10 | 11 | 1/8/2019 | 5 | 6 |
| Case 3 Instinct | 366 | 453 | 3/10/2018 | 443 | 6 |
| Case 4 All teams | 501 | 536 | 3/10/2018 | 522 | 10 |
| Case 5 Mystic2 | 347 | 393 | 5/4/2018 | 393 | 0 |

### 4.2 Survey Results

Following the exploratory chat search we sent a survey to the chat participants. The survey received 192 responses during the one day it was open. Out of all respondents, n=185 gave consent to use their answers for research purposes. The participant data including age and team distributions are displayed in Table IV.

Heatmap in Fig. 2 presents all the survey data and illustrates the main trends in it, with the rows and columns rearranged based on hierarchical clustering. As can be seen from the column annotations, Pokémon GO players from team Instinct (yellow) were both most positive in their attitude towards "jym" and were, as expected, consequently its most prominent users. By contrast, players from team Valor (red) were the opposite (yellow Instinct aggregating to the left, while red Valor aggregated to the right side of the column annotations). In connection with the lower portion of the data, players who had a positive attitude towards the slang word had a tendency to not use any other synonyms, while players exhibiting either a neutral or a negative attitude were using natural alternatives such as the literal Finnish translation ("sali") for its English equivalent ("gym"). Other words such as "portaali" (Finnish for "portal") or "torni" ("tower") were much more scarcely used. Some free text field answers were categorised as "confused" (n=6), which was associated with the survey participant not being familiar with "jym" prior to answering the survey.

In the survey, 26 % of respondents (n=51) replied they were actively using “jym”, and 6.5 % (n=12) answered that they sometimes used the word. The highest ratio of players using “jym” inside each team was in Team Instinct (43 %, n=22), followed by Team Mystic (28 %, n=18) and Team Valor (19 %, n=11). As expected, a trend was observed tightly connecting positive attitudes towards active use of “jym”. Team Valor, who were recorded to have the least players using the word, also had the highest number of players with a negative attitude towards the word (50 %, n=29). Mystic players were the most neutral with 25 % of players stating a negative attitude towards the word and 38 % of players responding they were indifferent towards the word.

Team Instinct was the leading “jym” term supporter with only 20 % of players having a negative attitude towards the word.

**Table IV.** Demographic data of participants

| | n |
|---|---|
| Age | |
| below 18 | 2 |
| 18-25 | 49 |
| 26-40 | 86 |
| 41-60 | 44 |
| over 60 | 3 |
| missing value | 1 |
| Pokémon GO team | |
| Valor | 58 |
| Instinct | 51 |
| Mystic | 64 |
| I do not play Pokémon GO | 12 |
| Ingress faction | |
| Resistance | 38 |
| Enlightened | 44 |
| I do not play Ingress | 103 |

We further systematically analysed associations between key variables that were extracted from the survey data. Fig. 3 left panel shows that perhaps counter-intuitively, there was no statistically significant association between the ordinal age category of the player and the frequency of usage of "jym" among survey participants. A systematic exploration for associations via a correlation matrix plot (Fig. 3 right panel) identified interesting trends in the data; firstly, as expected, having a positive attitude towards the word was highly associated with increased likelihood of using the word, while awareness of the existence of the slang word slightly increased likelihood of using it. Team Instinct showed both positive association with the attitude and usage of the slang term, while belonging to the team Valor had the opposite effect. In our study, the participants from the Ingress faction Resistance were associated with a slightly elevated age, and displayed a small but significant negative tendency to like and use the slang word. These findings were concordant with the visual inspection of the whole dataset readily presented in Fig. 2.

In order to conduct thorough statistical testing of associations in our data, we tested associations in tabulated data using Fisher’s Exact Test. Full results from this testing are shown in Supplementary Table I. This analysis showed a statistically significant association between players’ team in Pokémon GO and attitude towards "jym" ($p<0.05$), while the association between Ingress faction and attitude towards the word was statistically not significant ($p=0.09$). This lack of notable association may be partially explained by the relatively smaller number of Ingress players replying to the survey, resulting in lower statistical power. In addition, we investigated whether existing social connections had affected Pokémon GO players’ transition to Ingress and the selection of their faction and vice versa. However, the association between Pokémon GO team and Ingress faction turned out to be statistically insignificant ($p=0.10$). In addition, a highly significant correlation between using "jym" and having a positive attitude towards it was also reported ($p<0.001$). This clear effect was consistent with our previous observations of the attitude and usage towards the word in the chat messages. Altogether, the associations identified using Fisher’s Exact Test for tabulated data (available in Supplementary Table I) were concordant with the statistically significant correlations observed in Fig. 3 right panel.

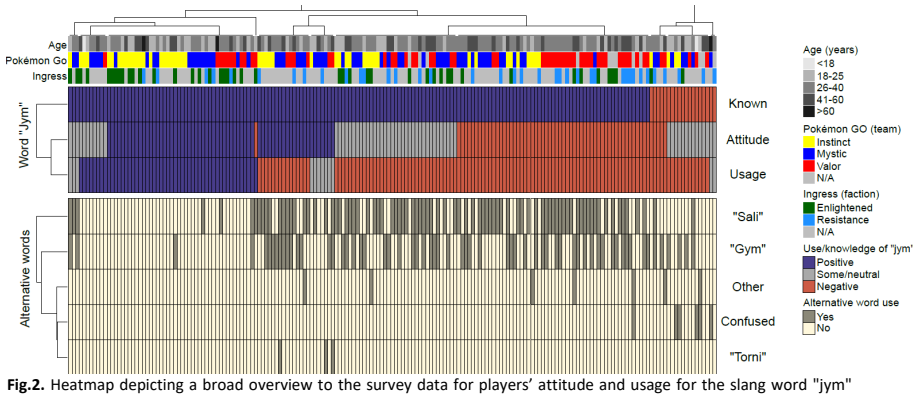


**Fig.2.** Heatmap depicting a broad overview to the survey data for players' attitude and usage for the slang word "jym" (upper portion) as well as reporting the usage of alternate words (lower portion). These alternatives were especially prominent in cases where opinion or awareness of the slang term was negative.

Out of the Ingress players who respondent to the survey, 50 % of team Resistance perceived "jym" negatively, while only 23 % of team Enlightened did. Team Resistance also had fewer players with a neutral attitude towards the word compared to Enlightened. All Ingress players with a positive attitude towards "jym" also played Pokémon GO. Out of those Ingress players who did not actively play Pokémon GO, 55 % had a negative attitude towards the word, 45 % had a neutral stance, and none reported having a positive attitude towards the word. Out of the 84 Ingress players who responded to the questionnaire, only 11 reported to never have played Pokémon GO. From the nine Resistance faction players who reported a positive attitude towards "jym", all played Pokémon GO (2 Instinct, 5 Mystic, and 2 Valor); similarly, all 18 Enlightened players who reported positive attitudes towards "jym", all were Pokémon GO players (8 Instinct, 5 Mystic, and 5 Valor). From the 10 Enlightened players who reported negative attitude towards "jym", 7 played Pokémon GO (2 Instinct, 1 Mystic, and 4 Valor); out of the 16 Resistance players who reported negative attitude towards "jym, 16 played Pokémon GO (1 Instinct, 6 Mystic, and 9 Valor). These findings indicate that positive attitudes towards the word in Ingress circles came from playing Pokémon GO and having relationships with Pokémon GO players.

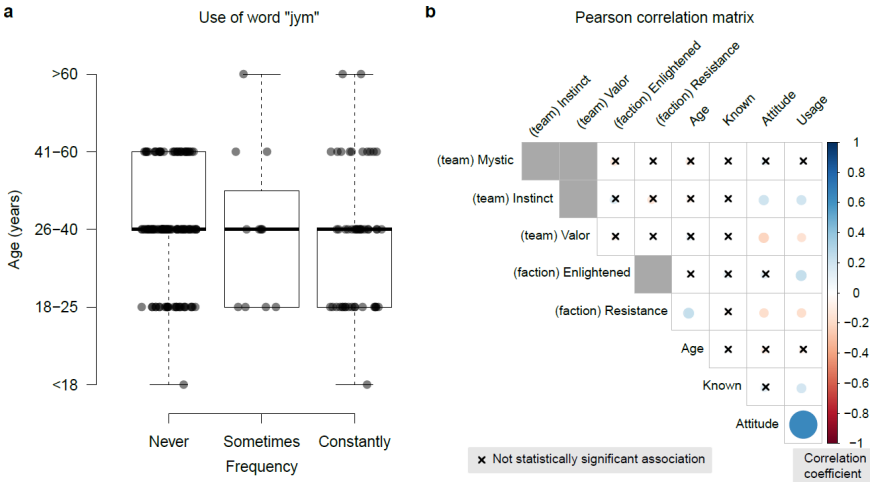


**Fig.3.** (left panel) Boxplot between "jym" word usage frequency and the quantiles within age groups, with jittered x-axis for purposes of visualisation; (right panel) Pearson correlation matrix plot for variables. Direction of the correlation is shown ranging from red (negative) to positive (blue). Grey boxes: mutually exclusive player groups; crossed-out boxes: statistically insignificant association.

### 4.3 Interviews with Players and Explaining the Negative Attitudes Towards "jym"

**"Jym" Was Associated With a Specific Group of Players**

Interviews with members of the teams (Mystic, Valor and Resistance) that had the most negative attitudes towards "jym", showed that the word was heavily associated with a certain group of active players from team Mystic. From here some players adopted "jym" into their common parlance while others rejected the word as evident from the chat and survey analyses. However, the word never lost its initial association to certain Mystic players, with whom seven interviewed team Valor members had previously had conflict with. One interviewed participant explains:

*"It's a word used by elitist blue and yellow players who have spread it to their own groups. In the reds some have also adopted it."*

Research on social identity and influence suggests that associated language may lead to forming prejudice towards its users (Maddox et al., 2012; Uhlmann et al., 2006). In our study, context words used by disliked players are likely to have caused lasting negative connotations. Therefore, newer players who adopted the word to use but had no prior personal conflicts, were prone to be seen in a negative light.

**"Jym" Violates the Finnish Grammar**

The second reason found for the negative attitudes towards the "jym" term, was that it was used in a way which violated the rules of Finnish grammar. This was explained by one interviewed player as follows:

*"JYM gets an immediate dislike-reaction from me and painfully reminds me of language that some people used that disparaged the Finnish language."*

Poor grammar is associated with incompetence, and for many employers it can be an indication of poor work ethics and quality of work (Wiens, 2012). The Finnish language belongs to the agglutinative languages meaning it is customary to conjugate words (Löfberg et al., 2003). However, with the word "jym" and similarly with the word "raid", this was often not done as demonstrated in the analysed chat logs. The Pokémon GO team that had the most negative attitudes towards "jym" (team Valor) also almost exclusively used "raid" with proper conjugations. Another linguistic peculiarity is the consonant "j" which gives a visually powerful and

slang-like intonation for the word, as in the Finnish language the written form of words corresponds to the way it is pronounced (Ojutkangas et al., 2009). Some of the interviewed players interpreted this as an intentional attempt to manipulate the language or even claim an elevated unique status among the player community, again linking the findings back to social identity. The idea that "jym" was a fabricated or unnecessary addition to Finnish was exemplified by, for example, the following comments:

*"We already had a good term for gyms."*

*"The word jym means nothing! I could as well start using a new word for a football field with my friends."*

As common language is an enabler of communication and cooperation, choosing to use new terminology can be viewed as subscribing to a new social identity. This can manifest as a sense of detachment from the community (Ochs, 1993). Thus, players using foreign terminology are more likely to be viewed as out-group members. This is one mechanism through which language use may reinforce a division between player subgroups.

**"Jym" was Included in the Names of In-game Objects**

The third reason for the birth of negative attitudes, and for some a reason for sustaining them, was that starting from as early as 2018, "jym" was included in portal candidate submissions (Tregel et al., 2017) made for the Ingress and Pokémon GO. Contrary to the first two given reasons, this theme related to conflict between Pokémon and Ingress players as one of our participants explains:

*"Bringing the "jym" word to the Niantic OPR* [Operation portal reckon – the Ingress PoI peer review system] *was polarising, but not between Pokémon teams. While Pokémon bets teams against each other, similar conflict is present between Pokémon players and Ingress players."*

Before the Niantic PoI candidate submission and evaluation system came to be known as Niantic Wayfarer in late 2019, Ingress players were in charge of peer reviewing portal candidates, which made "jym" known in the Ingress community. Subsequently, its use was not perceived in a positive light by the interviewed Ingress players and was commonly attributed to drive the PoI database to favouring Pokémon GO players over Ingress players. One of the interviewed participants states the following:

*"Planting "jym" to OPR included it to not only Pokémon GO, but to Ingress as well. This is an unauthorised entry to territory where Pokémon-specific slang has no place."* One accepted portal submission called "JYM" appeared in Southern Finland, and was a gym in Pokémon GO. This portal/gym in question was later renamed to "Puujärven ulkokuntosali" ("Outdoors Workout Gym of Puujärvi"), a more accurate description with proper Finnish grammar. The renaming of "jym" portals in Ingress can be regarded as evidence of the players' collective rejection of the term, as portal name edits are peer-reviewed by the community. The observed discussions about "jym" in the current study (see Table III) also show many perceived the slang-word as a joke or as an insult. In addition, Ingress rules forbid references to real names, faction names, group names etc. in portal titles. Therefore, "jym" as associated with Pokémon GO, was perceived as a violation of these rules by some players.

**Participants Who Deviated From the Majority**

A few counter-intuitive behavioural patterns were observed when comparing content between the chat and survey materials. A team Instinct member was found to have used the word 176 times in a chat, but counter-intuitively, stated a negative attitude towards the word. When interviewed, the person explained the following:

*"I use the word because others use it in many situations quite often. So it's a slang word used in Telegram and that's why I've started using it myself. However, the best term for gym in my opinion is the Finnish word "sali"."*

Other outliers were team Valor members who had a positive attitude towards the word. When exploring the reasons for this, it was discovered that the majority of them belonged to Enlightened in Ingress. Thus, it is likely they received positive influence towards the word from socialising with users in those circles. One team Valor member replying to have a positive attitude towards "jym" was discovered to have changed their team to Mystic later on, stating having more friends in the team as a reason for the switch. This finding would imply that language use could be a stronger predictor of social circles than the artificially divided teams in the case LBGs.

# 5. Discussion

### 5.1 Key Findings

We summarise our most important findings as follows. First, distinct linguistic subcultures emerged among Pokémon GO teams as evidenced by chat data analysis. Second, the players' team in Pokémon GO and Ingress correlated with the use of and attitude towards "jym". Third, three main reasons were associated with a negative attitude towards "jym": (1) "jym" was associated with a certain group of active players. This caused prejudice towards the word, which was further enhanced by how (2) "jym" was often used with improper grammar. The existing negative attitudes were escalated when players started (3) using the slang-term in PoI submissions for the Niantic games.

### 5.2 Theoretical Implications

Our study has theoretical implications on the literature on technology-induced polarisation, on language acquisition and game slang and on research on LBGs.

First with regards to group polarisation, we showed that the social identity theory provides a promising framework for understanding technology-induced polarisation in the context of LBGs. We found the case games to direct players to perceive their teammates as their in-group members and the opposing teams as out-group members. Chang and Goodman (2006) argue that LBG players can to some degree exclude themselves from social norms when they are playing by, for instance, wearing clothing that clearly indicates they are playing. However, in modern LBGs where playing is incorporated as part of everyday life, the powerful norms of the real-world guide behaviour (Chang and Goodman, 2006). Despite this, we recorded polarised attitudes towards game slang among players, suggesting that social norms do not at least entirely dampen the polarising effect of games. Consequently, our findings indicate that game design can be used to influence group polarisation. Game mechanics imposing a static team vs team conflict reinforces "us vs them" thinking, whereas based on the intergroup contact hypothesis (Allport, 1954), cooperative activities (such as raids in Pokémon GO (Bhattacharya et al., 2019)) can bring people together and dampen the polarisation effect. These findings are supported by similar results in the context of hobbies and sports events (Ricatti and Klugman, 2013).

Second, we contribute to the research on social media induced polarisation (Conover et al., 2011; Lee et al., 2014; Quershi et al., 2020), by demonstrating that language use and preference can be used to identify underlying polarisation. While previous research has already suggested that language is a manifestation of group identity (Ksiazek and Webster, 2008), we showed that this division may be particularly strong with new words and slang terms. We also highlight a linguistic issue that languages with few native speakers (e.g., Finnish) are facing: Finnish speaking people are increasingly using technology that is not localised, and thus, their native tongue is under constant pressure to change as new terminology and technology are introduced and used. Because new words are introduced to the language, there is a time period where not all terms are equally accepted and used. Coupled with the fragmentation of news media and polarisation observed in social media (Quershi et al., 2020), this may introduce challenges to communication within societies.

Finally, we contribute to the literature on LBGs by showing that static teams can cause inter-team conflict that carries over from the game to the real world and even language preference. While recent work on the topic has highlighted the importance of cooperative game mechanics for the development of altruism and we-intentions (Riar et al., 2020), our study shows that the static teams also have a polarising effect.

### 5.3 Practical Implications

One of the primary implications to practice of our research is to LBG design. Arguably Pokémon GO, perhaps unintentionally, first caused and then fixed a group polarisation problem. Back in 2016, the static teams were fighting against each other over territory and there were few cooperation opportunities between teams (Laato et al., 2021). This was changed in 2017 with the introduction of raids where players from all teams come together to defeat a common strong foe (Bhattacharya et al., 2019; Laato et al., 2021). Raids could unite players under a common cause and help them feel empathy towards each other. Building off the intergroup contact hypothesis (Allport, 1954), as a remedy for reducing group polarisation, in-game cooperation opportunities between teams/factions should be implemented. As mentioned, Pokémon GO already made changes to reduce polarisation, but Ingress remains a game where factions cannot cooperate. While the game

mechanics of Ingress do not allow cross-team cooperation, significant cooperative benefits have been reported from playing the game (Morschheuser et al., 2017; Riar et al., 2020; Söbke et al., 2017). This would suggest that practitioners and game designers may leverage group identity and polarisation to engage players with members of their own team and even scaffold social connectivity, which is one of the reported main benefits of playing LBGs (Finco, 2019; Humphreys, 2017; Kaczmarek et al., 2017; Paasovaara et al., 2017; Vella et al., 2019).

Our study also has practical implications on strategies to curb technology induced polarisation. In our study context we could pinpoint the birth of polarisation to the static teams. As polarisation is at least partially caused by a purely artificial division, alternative artificial divisions (i.e., "recategorisation") and meetings between people where they are sorted into new social subgroups shows promise as an intervention strategy. As the human social circles are largely influenced by their socioeconomic status, a hobby where people from various backgrounds can get together and unite against a strong enemy can be effective in reducing polarisation in other areas of life (e.g., ideological, political, religious).

Finally, the COVID-19 pandemic brought light to the importance of social interaction for learning, and the learning of social skills at schools. As school buildings closed and countries adopted distance education solutions, the implicitly present social benefits of school suddenly diminished. Our findings bring a new perspective to the discussion of using LBGs for social education. Based on the results, it can be proposed to use LBGs to teach living in a globalised world and help self-identify own prejudiced attitudes. The process of forming negative attitudes towards other players, and then meeting them in raids and forming a relationship with them, delivers an empirical experience regarding the inaccuracy of the human natural tendency to view people with prejudice.

### 5.4 Limitations

The audience from whom data was collected were exclusively from South-Western Finland. The authors were themselves active participants in the analysed communities, with presence in all three Pokémon GO teams and both Ingress factions. Despite the birth of "jym" being natural, some of the authors participated in using, discussing and criticising the word among the participants. This occurred naturally before data was collected for the current study. Reportedly some players refused to answer the questionnaire concerning the "jym"-word, as they had negative feelings towards the word, possibly resulting in a positive bias in favour of the word in our results. Furthermore, the prominent presence of the authors in both gaming communities may have influenced consciously or unconsciously the participants' survey responses and interview replies. However, as all teams and factions were represented and surveys were anonymised, we expect this effect to be minimal. The participants in the survey were self-selected, and the number of interview participants was limited by their willingness and availability. One additional limitation concerns the fidelity of the collected survey data. For example, we asked participants to select a discrete age group as opposed to precise age. This may have resulted in slight reduction of statistical power in identifying age-related associations and hence, our findings involving age may have missed subtle associations that would have required an exact age. However, we expect this to have had a minimal effect, as reasonably justified discrete group representation of continuous data in many cases adequately represents the original variable in behavioural sciences (Kim and Frisby, 2019).

Our data analysis focused on observing slang word use to identify differences between player subgroups. While language can be a powerful indicator of social status and group identity, it entails more than just terminology (Ksiazek and Webster, 2008; Rumsey, 1990). As the study was limited geographically and linguistically to South-Western Finland and the Finnish language, its interpretability may exhibit characteristics specific for the Finno-Ugric language tree and the Finnish culture. While "jym" was accepted by some subgroups and rejected by others, the interviews revealed several reasons for this, one of which was its use with improper Finnish grammar. This hints that there are language specific complex nuances in communication and calls for more detailed analysis of phrasing, grammar and even tone to uncover social identities of players using the linguistic ideology approach (Rumsey, 1990). Besides written communication, "jym" was used and discussed face-to-face while playing, and these discussions were not recorded. This limited us from fully exploring the evolution of the word.

## 6. Conclusions and Future Work

We observed the effect of divisive static teams on players' social behaviour via linguistic data collected in multiple layers. With this unique empirical study design, we identified trends in game slang use specific to

teams and possibly further inner subgroups inside teams. A subsequent survey and interviews focusing on a particular word, "jym", demonstrated systematically that attitudes towards certain language and slang terms were associated with the players' chosen in-game team. These exploratory findings on technology induced polarisation in the context of LBGs open several future research directions.

With regards to language and slang in LBGs and multiplayer online games, future studies should focus on expanding outside the geographical and linguistic boundaries of individual countries and generalise language evolution in games in a broader context. In the case of using language as a vessel for identifying group polarisation, other approaches besides looking at individual words should be harnessed. For example, our interviews revealed that proper grammar use played an important role in adapting or discarding novel game related terminology. Furthermore, because LBGs simultaneously incorporate in-game communication as well as real world communication in person, future work on language acquisition, polarisation and LBGs could further explore the complex interplay between these two dimensions.

As the contact hypothesis (Allport, 1954) suggests meaningful interaction on equal standing between two opposing groups can lead to diminished prejudice, future research could complement our findings by focusing on intervention strategies for reducing polarisation with inter-team cooperative endeavours. Furthermore, social personality and self-efficacy play a role in group polarisation (Satherley et al., 2020). Thus, exploring individual traits and their relationship in online gamers and LBG players presents a venue for identifying vulnerable - or resistant - personality types. By better characterising such individualistic behaviour, future game design may be better equipped to alleviate trigger-like effects from mechanics or communication mediums that adversely affect certain player sub-populations. While our work successfully identified interesting patterns in opposing out-group social strata, further work in this field is warranted, as previous research on e.g., Ingress has mainly focused on the benefits of cooperation (Morschheuser et al., 2017; Riar et al., 2020) rather than negative outcomes.

In summary, the issues and effects presented and discussed above reach far beyond the scope of LBGs and Finno-Ugric languages. LBGs are merely a single application domain where technology induced social phenomena arise. Our current work provides a foundation for future extensions on this research topic by re-vitalising the idea to use language as an indicator of polarisation (Irvine et al., 2009; Ksiazek and Webster, 2008; Rumsey, 1990). As technology-mediated social stratification naturally arises in situations beyond LBGs, increasing our collective understanding of mechanisms driving negative conflict-prone attitudes has great potential for improving social and individual well-being.

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**Samuli Laato, Sampsa Rauti, Antti Laato, Teemu H. Laine, Erkki Sutinen & Erno Lehtinen**
**Learning History with Location-Based Applications: An Architecture for Points of Interest in Multiple Layers**

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# Learning History with Location-Based Applications: An Architecture for Points of Interest in Multiple Layers †

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**Abstract:** Location-based applications (LBAs) capture the user's physical location via satellite navigation sensors and integrate it as part of the digital application. Because of this connection, the real-world environment needs to be accounted for in LBA design. In this work, we focused on creating a database of geographically distributed points of interest (PoIs) that is optimal for learning local history. First, we conducted a requirements elicitation study at three outdoor archaeological sites and identified issues in existing solutions. Second, we designed a multi-layered prototype solution. Third, we evaluated the solution with nine experts who had prior experience with LBAs or similar systems. We incorporated their feedback to our design to iteratively improve it. As a whole, our work contributes to the LBA design literature by proposing a solution that is optimized for the learning of local history.

**Keywords:** location-based applications; pervasive games; education; history; edge computing; crowdsourcing; point of interest



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## 1. Introduction

Today, satellite navigation sensors are ubiquitously embedded in smartphones. Together with internet connectivity, this has enabled location-based applications (LBAs) to become popular and widely used [1]. These applications link the user's geographical location to the digital world. Examples of popular LBAs include navigation software (e.g., HERE drive, Google Maps, Navman) and games, such as Pokémon GO and Orna. Because LBAs provide a digital 2D representation of real world geography, they can be transformed into augmented reality (AR) applications by including fictional things to the map interface [2,3]. For example, the location-based game Pokémon GO, interprets real buildings as part of the game world but additionally superimposes fictional creatures in the map interface [4].

Some LBAs, particularly games, have the benefit of naturally motivating mild exercise in the form of walking, cycling, or otherwise moving around [5]. This characteristic makes them interesting from an educational standpoint, as they are a welcome change to the often necessary and currently widely used forms of learning where learners need to sit still. Recent work has highlighted LBAs' potential to teach about the environment the users are in, for example, in the form of showing information about the surrounding buildings or by directing LBA users to local points of interest (PoIs) [6]. A study by Huizenga et al.

demonstrated that LBAs can be harnessed to teach history, which increased students' motivation to learn [7]. In this type of design, where players learn about their surroundings by walking in historical locations, it is important that the virtual PoIs are of high fidelity, contain reliable information, and are correctly placed [8]. While such sets of PoIs can be created for individual places or cities [7], the global maintenance of such a PoI database requires thousands of hours worth of human resources [9].

While scholarly work has demonstrated LBAs, and, more specifically, location-based AR games, to be useful in history education (e.g., Reference [7,10]), the main issue with these solutions is that they only work at specific locations, not globally, and a large amount of work would be required to extend them to world wide coverage. To solve this problem of labor, the successful existing solutions have relied on crowdsourcing [9], that is, sourcing the manual labor to volunteers around the world. OpenStreetMap (OSM) is an example of a crowdsourced [11] global map [12], whereas some other maps (e.g., Google Maps) are a mixture of manual work from a company and input of its users and business owners. With regard to location-based games, the current market leader in global PoI creation and management is the location-based technology focused company Niantic. Their crowdsourced PoI database is primarily created for the purpose of being a platform for games [13,14] and is almost entirely user-generated, with some part of the review process and the entirety of the technical solution being taken care of by Niantic [9]. Niantic provides players with interfaces for both submitting and reviewing PoIs, and also enables players to vote for suggested edits to the PoIs. From the above listed four challenges for creating a global PoI database for LBA-based education, Niantic's solution resolves fairly well the first two issues. However, the database and its criteria have been shown to discriminate against minority inhabited areas [15] and to lack quality PoIs in some areas, such as archaeological sites [8]. Furthermore, the database contains PoIs only in a single layer, lacking historical depth, and it struggles to motivate players to meaningfully contribute to the solution. Based on extant literature on the topic, these challenges may be summarized as follows:

1. Thousands of hours of manual labor is needed to provide PoIs and related metadata without automation [14]. Crowdsourcing and gamification are promising [9,16], but they can also escalate into cartographic vandalism [17].
2. Technical support and solutions for creation, as well as maintenance, are needed [9].
3. Criteria need to be decided. What are the optimal criteria for accepting PoI candidates? Will this create an uneven divide of PoIs between areas? How to solve the problems arising from an uneven distribution [13–15]?
4. How to differentiate between labor force expertise? How to best utilize the expertise of, for example, archaeologists for outdoor archaeological site PoIs [8,18]?

Accordingly, technical problem solving and innovation are needed to create a global PoI database that is historically relevant and which LBAs can use to support the learning of local history. Research on the topic is still at its infancy, and work is needed to establish the design requirements of such a database. Work is also needed in optimizing existing solutions. To address these research problems, we first conducted a design elicitation study [19] in the context of three archaeological sites in the Levant: *Gezer*, *Hazor*, and *Megiddo*. Next, we designed a PoI database creation and maintenance scheme that can be used to fulfil the identified design requirements. We evaluated the proposed solution by comparing it to currently available solutions using the use case view [20]. Third, we contacted experts (N = 9) who had prior experience with LBAs and PoI solutions to evaluate our proposal. With these three approaches, this work makes the following contributions:

1. Establishes the design requirements for a virtual geographical PoI database that has the primary aim of scaffolding the implicit learning of local history.
2. Proposes a technical solution for the creation and maintenance of such database.
3. Provides a formative evaluation of the system through collected expert feedback.

## 2. Research Design and Methodology

In the design requirements elicitation part of this work, we focus on three archaeological sites located in the country of Israel: *Tel Hazor*, *Tel Megiddo*, and *Tel Gezer*. All three places appear in the First Book of Kings, Chapter 9, verse 15 and have been of interest to archaeologists with several excavations taken place [21,22]. These sites have ruins of ancient structures which have been discovered in multiple strata, such as those dated to Late Bronze Age and Iron Age [23]. All three sites are outdoor locations and are currently open for visitors. *Tel Hazor* and *Tel Megiddo* have been declared World Heritage Sites, meaning their conservation has been recognized internationally to be of great importance. We focus on how these locations appear in OSM and the Niantic PoI database. As a consequence of this analysis, we derive a set of design requirements for a LBA database focused on implicit teaching of local history.

The PoI database used in Niantic's *Ingress* game was chosen for analysis as the database is global [14], the virtual PoIs match real-world locations [13], and PoIs are visible for all in the Ingress Intel Map [24]. Besides *Ingress*, the same PoIs are largely used also in other games, such as *Pokémon GO* and *Harry Potter: Wizards Unite* [13]. Furthermore, applications based on this database have been found to increase players place attachment [6], thus providing preliminary evidence towards LBA's potential for enhancing visitors experience at cultural sites. The three archaeological sites were looked up in the *Ingress Intel Map* in October 2019 and later again in October 2020 together with OSM data. All found PoIs, their title, and location were recorded, and, based on these characteristics, they were mapped to corresponding real-world objects. If the PoI title was in another language than English, such as Arabic or Hebrew, it was translated to English. As a comparison and tool for analysis, information of the sites was obtained from the *Israel Nature and Parks Authority* [21] website, as well as major publications on the archaeological findings and their scholarly interpretations. The virtual PoIs found in *Ingress* were analyzed by looking at (1) what kind of a PoI is it? (ruin, sign, model), (2) from which time period or stratum is it from?, and (3) which archaeological interpretation does it represent? The virtual PoIs were then compared to the actual visible structures.

In the second part, following the design elicitation, an iterative design science approach [25] was used to design a multi-layered PoI database that has temporal layers of geographically distributed PoIs. Then, using knowledge from previous research, the requirements elicitation and expert feedback, we improved the solution. This is also connected to our third part, where we harness expert feedback to evaluate the system. To this end, we created a video presentation (8 min 27 s) to explain our solution and uploaded it to YouTube as an unlisted video. We embedded the video into a survey created with Webropol (Helsinki, Finland). We included the following questions:

1. Can this kind of a solution be used to teach local history? Why/why not?
2. Do you believe the solution can be an improvement upon existing solutions? Why/why not?
3. What challenges do you see in implementing this kind of a system in practice?
4. For what purposes can this solution be used in addition to location-based games?
5. Do you have any improvement suggestions to the proposed solution?

The participants were recruited among active contributors to the Niantic crowdsourced PoI system, as well as University personnel who have worked with LBA research and development in South Western Finland. All participants were asked for a permission to participate in the research and promised that their responses would only be used anonymously in the reporting. In addition to the expert feedback, we evaluated our system through using the case view of Kruchten [20,26] and analyzing how the system could be optimized via the use of edge computing.

## 3. Design Requirements Elicitation

### *3.1. Case Study: Archaeological Locations*

Annually millions travel to see archaeological sites of cultural, historical or religious significance. These sites are typically outdoors and are prepared for visitors after archaeological excavations are completed [27]. Pottery and other smaller artifacts found on the excavation site or nearby may also be put on display, as well as models or reconstructions of predicted historical structures. To supplement the artifacts visible on site, signs, guidebooks, audio-guides may be offered to visitors. AR applications and games can also be added including gamification, scientific interpretations and additional info about the location [28,29].

#### 3.1.1. Tel Hazor

Lead by Yigal Yadin, major archaeological excavations took place at Tel Hazor in the 1950s, which revealed bronze and iron age structures and evidence of both Canaanite and, then later, Israelite settlement [30–33]. The site has been of interest to biblical scholars, archaeologists, and historians [31] and has been studied together with several other similar ancient ruins in the region [33,34]. The largest individual remaining structure in Tel Hazor is an underground water system, which was discovered by Yadin's later 1968–1969 expeditions and has been dated to the Iron-age [35]. Similar water systems have been found in several cities on top of mountains from the same time period [35]. Another major structure is a *"Salomonic city gate"*, dating of which has been discussed by scholars to be either from the time of Salomon (10th century BCE) or the Omrid dynasty (9th Century BCE) [34]. In addition, other structures, mostly interpreted as housing, remain on site [36], including a typical 8th century BC Israelite four-room house [37,38].

Figure 1 shows the locations and names of all virtual PoIs (4) of Tel Hazor currently in the Niantic PoI database. Two of the PoIs, *10 Century BC Salomonic Gate* and *The Water System- Tel Hazor*, point to ancient historical artifacts. *Yaco 'Bob'The Watchman* shows a modern art piece depicting an ancient Israelite Guard, and the final PoI *Tel Hazor-National Park* is a reference to the entire site. It is evident these PoIs only lightly touch the historical depths of this location, as multiple structures, such as the Israel four-room house, are not included as virtual PoIs, and the information of the existing PoIs is limited. For example, with regard to the *10 Century BC Salomonic Gate*, only the interpretation of Yadin and Ben-Tor is shown, even though Finkelstein dates the structures to the period of the Omrides dynasty, as seen in Table 1. With regard to OSM, it displays 10 PoIs in Tel Hazor, a more detailed view compared to the Niantic solution.

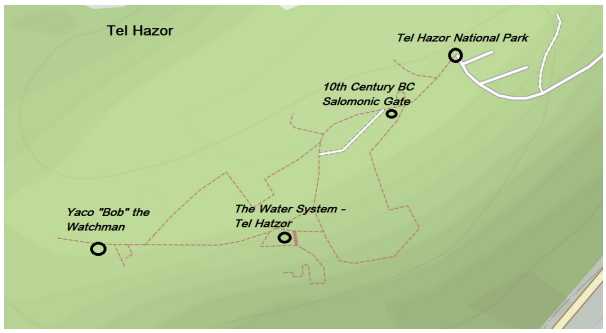


**Figure 1.** A view of Niantic points of interest (PoIs) in Tel Hazor. PoIs are observed in the Ingress Intel Map and depicted on top of OpenStreetMap (OSM). Image constructed by the authors on 30 October 2020.

**Table 1.** Comparison of chronological and historical explanations of ruins and artifacts discovered in strata X and IX in Tel Hazor.

| **Yadin and Ben-Tor** | | |
|---|---|---|
| **Stratum** | **Dating** | **Historical Setting** |
| X | 10th Century BCE | Salomon |
| IX | Late 10th, Early 9th | Israelite |
| **Finkelstein** | | |
| **Stratum** | **Dating** | **Historical Setting** |
| X | Early 9th Century BCE | Israel: Omrides |
| IX | First half of 9th Century BCE | Israel: Omrides |

3.1.2. Tel Megiddo

Megiddo is a world heritage site located on a mountain in the middle of the Jezreel plains and has been featured in pop culture due to its association to the Armageddon, apocalypse, and the end of the world [39]. Among the most massive constructs, Tel Megiddo site contains a deep water system [40] from the Iron Age period, similar to those found in *Hazor* and *Gezer* [35], as well as the ruins of a great temple dated to the early Bronze Age (3000 BCE) [41]. Tel Megiddo has arguably the most detailed data in all of Levant for the period from Late Bronze (3000 BCE) to Iron Ages (750BCE), thus having unparalleled historical value [23].

Figure 2 shows a side-by-side comparison of PoIs in OSM (screenshot taken by the authors) and Niantic virtual PoIs (7) displayed on top of the same OSM background. From the comparison, we see that the PoIs in OSM are much more detailed but still do not depict he entire archaeological richness of the location. The Niantic PoIs are much more generic and contain only a single historical location: the city gate. Three of the Niantic PoIs are signs: *Tel Megiddo*, *Tel Megiddo World Heritage Site*, and *Tel Megiddo National Park*. Then, there are three scultupres: *Battle Ready Chariot Sculpture*, *Chariot Sculpture*, and *Salomon's Stabled Horse*. Unlike in *Hazor*, the PoIs in *Megiddo* do not offer direct references to ancient structures, except for the city gate. For example, the water system is not a PoI, and neither is the ruin of the Bronze Age (3000 BCE) Canaanite temple [41]. Furthermore, the naming of the PoIs and their descriptions do not depict that there is an ongoing scholarly debate on the dating of the strata VB and VA-IVB (see Table 2).

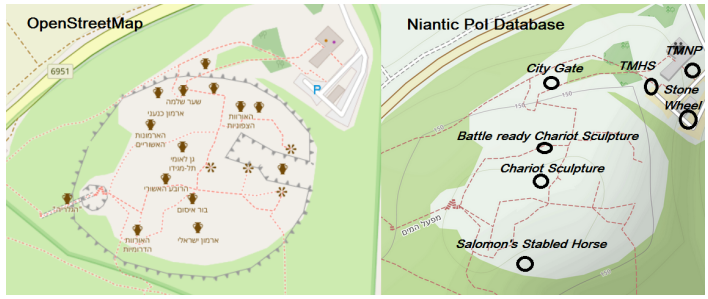


**Figure 2.** Depicting the PoIs in Tel Megiddo by OSM, as well as the Niantic PoI database. Image constructed by the authors on 30 October 2020.

**Table 2.** Comparison of chronological and historical explanations of ruins and artifacts discovered in strata VB and VA-IVB in Tel Megiddo.

| **Yadin and Mazar** | | |
|---|---|---|
| **Stratum** | **Dating** | **Historical Setting** |
| VB | 10th Century BCE | United Monarchy |
| VA-IVB | Late 10th Century | Salomon |
| **Finkelstein** | | |
| **Stratum** | **Dating** | **Historical Setting** |
| VB | About 900 BCE | Early Israelite Monarchy |
| VA-IVB | First half of 9th Century BCE | Israel: Omrides |

#### 3.1.3. Tel Gezer

Ancient Gezer was an important strategic area due to its geographical location guarding Via Maris, Valley of Aijalon and the trunk road leading to Jerusalem [42]. Excavations began at the site in 1902, lead by Robert Alexander Stewart Macalister, and lasted seven years [43]. More excavations have since taken place, such as Alan Rowe's six-week campaign in 1934 and The Hebrew Union College Excavations in 1964–1966 [43]. Structures from multiple strata dating to Late Bronze Age and Iron Age have been discovered from the location [33,42,44], including a Salomonic four-entryway city gate, similar to which is also found in Tel Hazor and Tel Megiddo [42]. However, the Gezer gate is a bit different in it being based on a square plan instead of a rectangular one [34]. A Canaanite water tunnel has also been found in the ruins, along with Masseba stone structure and many other smaller structures.

Seven PoIs were discovered at Tel Gezer in the Niantic PoI database. These PoIs were named in Hebrew and are roughly translated by the authors as (1) Sheikh Aljazarli's Tomb, (2) Area of Worship: Masseba Site, (3) Salomon Gate, (4) Canaanite Gate, (5) Water System, (6) Map of the vicinity of Tel Gezer, and (7) Gezer Calendar. Compared to the other two observed locations, *Tel Gezer* has the largest quantity of virtual PoIs representing ancient structures in the Niantic database, exceeding the four PoIs shown in OSM. Yet, for example, the debate regarding the chronology of the structures is not visible. Similarly to virtual PoIs in *Tel Hazor*, Finkelstein's Iron Age low chronology [45,46] is dismissed (see Table 3). In OSM, Tel Gezer shows four PoIs. Thus, here, it shows less PoIs than the Niantic solution, differentiating the location from Tel Hazor and Tel Megiddo.

**Table 3.** Comparison of chronological and historical explanations of ruins and artifacts discovered in strata IX and VIII in Tel Gezer.

| **Dever** | | |
|---|---|---|
| **Stratum** | **Dating** | **Historical Setting** |
| IX | 10th Century BCE | Salomon |
| VIII | Late 10th, early 9th | Israelite |
| **Finkelstein** | | |
| **Stratum** | **Dating** | **Historical Setting** |
| IX | 10th Century BCE | No evidence for united monarchy |
| VIII | First half of 9th Century BCE | Israel: Omrides |

### *3.2. Design Requirements*

Based on the analysis of the three archaeological sites, we propose four design considerations, as follows.

#### 3.2.1. Ensuring the Quality and Fidelity of the Virtual PoIs

Virtual PoIs should cover the key real-life PoIs on the site to support learning of local history. *Ingress* currently allows PoIs to have a short description and photos, in addition to

their name and location, while OSM displays no additional information. When aiming for historical accuracy, creating high fidelity historical PoIs requires expert knowledge. In the same way, contributions to the description of PoIs and the relations between them would require further elaboration by experts of history education. Here, automatic solutions can fall short unless they make use of already existing information [14]. The alternative is to use crowdsourcing, or a mixture of automatic procedures and crowdsourcing.

#### 3.2.2. Support for Visualizing Multiple Layers of PoIs

When looking at the three case archaeological sites of *Hazor*, *Megiddo*, and *Gezer*, a common challenge is that there exists competing views among scholars with regard to interpretations of the excavated structures' dating and original purpose. One of the questions with regard to the observed three locations has been whether or not the great fortification systems with gates mentioned in *The First Book of Kings 9:15* can really be dated to the reign of Solomon (i.e., to time of united monarchy) or whether they should be dated a little bit later to the Omride dynasty in the kingdom of Israel (e.g., Reference [47,48]). This discussion highlights how scholars have dated stratigraphic layers differently at archaeological sites and, consequently, interpreted the origin and purpose of discovered structures in various ways.

Because scholars may disagree on interpretations of archaeological evidence, it is important to accurately present evidence of all cases for visitors. However, the existing solutions enable only the visualization of a single layer of PoIs [2,13]. This is also problematic from the perspective of visualizing various historical era. In the paramount reality, only one reconstruction can be presented at a time [3], but AR technology and LBAs can solve this issue as the reconstructions are digital and can be switched at will. For example, a broken ancient wall, which depending on interpretation was either an arc or just a wall, can be displayed as both.

#### 3.2.3. Information on Lost Objects and Structures

Several excavations, such as those that have taken place in Tel Hazor [27,31,49–51], have revealed structures from multiple time periods across many strata. Furthermore, when archaeologists dig deeper to reveal older structures, they are forced to remove strata on top. As a result of this process, many excavation sites are left with structures from multiple strata to display. AR gives the possibility of viewing the same place through various lenses, each depicting information from a certain era [52]. This also connects to the previous theme in that the PoI database should provide support for multiple layers of PoIs. It is equally important that the PoI database contains information that no longer exists in the paramount reality. For example, at archaeological sites, when strata are removed to dig to older layers, the lost information could be captured and displayed in AR instead as one form of conservation of knowledge. Furthermore, the system could enable showing two related objects from different eras in AR, enabling side-by-side comparison of how the place has evolved during the years.

#### 3.2.4. Design of Crowdsourcing to Expand the Solution into Global Scale

Based on observing the Niantic Wayferer system that is used to peer-review PoI submissions for their database, we notice a few key issues. The challenges of the system lie in that (1) editing of PoI locations is a long and unpredictable process; (2) portal candidates submitted too close to existing ones are not included in the visible PoI database; (3) players are motivated to create PoIs close to them and demotivated for accepting PoIs close to their opponents; (4) the peer-reviewers of PoI candidates are selected among players and, in most cases, are not experts in evaluating the descriptions; and (5) the PoI criteria are designed and communicated to players in such a way that historically valuable locations can easily be rejected. These are but examples of potential issues that may arise in expanding a PoI database to become global via using crowdsourcing [16]. However, open source software projects, Wikipedia, OSM, and other crowdsourcing success stories have proven that it is a

viable strategy if implemented correctly [11]. Yet, even Wikipedia and others can encounter problems, such as a few individuals coming to dominate a vast amount of content [53] and vandalism [17].

## 4. Preliminary Solution: A Multi-Layered PoI Database Creation Scheme

### *4.1. Visualizing Historical Layers, Information, and Interpretations*

The first thing to address, that is particularly relevant at archaeological sites, is the problem of visualizing structures that no longer exist. For example, several historical buildings have been destroyed and at archaeological sites excavations to deeper strata require the destruction of what is on top. However, having currently visible and destroyed structures displayed on a map interface for LBA users can be confusing. Furthermore, this would make it more difficult for users to visualize what their environment looked like at a given era. For this reason, we propose that a PoI database for teaching local history should be divided into layers. The topmost layer would represent structures that are currently visible in the world. In addition to this layer, historical layers would be included. LBA users could choose whether they want to see PoIs of the current era, or a from previous era. This is displayed in Figure 3.

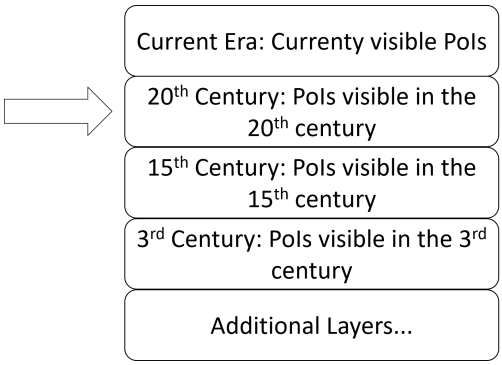


**Figure 3.** With a multi-layered PoI database that has information of historical PoIs, location-based application (LBA) users can re-imagine what their surroundings looked like centuries ago.

In these layers, PoIs could be placed on the locations where structures historically resided in that time period, similarly to how they are displayed in Figure 1. Thus, switching between the historical layers would display different PoIs, although it is perfectly possible that some buildings existed in multiple eras and are thus displayed on multiple layers. The layers that are accessible would be determined based on the location. For example, a rich historical city could have way more layers than a newly founded town. LBAs using the PoI database could use it in various ways; for example, games could require players to reach certain goals in order to unlock further layers.

Having multiple layers of PoIs enables visitors to view what the place would look like in the eyes of Finkelstein [45] and in the eyes of Mazar [54]. But, it also enables visitors to see how it looked like in the middle Bronze Age and in the late Iron age. An additional advantage of this multi-layer approach is that it is future proof in that new layers and interpretations can be added, and PoIs never become obsolete once correctly added. A possible disadvantage is that, when there are more layers, managing and presenting them in a clear way becomes increasingly complex.

### *4.2. PoI Criteria*

One of the most important aspects of these types of solutions is the criteria based on which the PoI are submitted and accepted in the database. Several sets of criteria have been

proposed by previous works (e.g., Reference [13,14]) which rank objects based on their importance, so that a large cathedral is a preferred PoI over a tree. For example, Niantic uses man-made-structure as a prerequisite for PoIs to be accepted to their database. For a PoI database aiming for both temporal and geographical depths, we see such limitations to be unnecessary. The fields where historical battles took place, as well as mountain tops where ancient settlements resided, should be valid PoIs as they have historical value. Another aspect regarding the PoI criteria is the distance between PoIs. Depending on the LBA that uses the PoI database, too short a distance between PoIs can be limiting. To this end, LBAs could have the opportunity to only display a set of PoIs from the database, but, for the database itself, no limit to the distance between PoIs is needed. In order to teach history to LBA users, we propose the following acceptance criteria for PoIs.

1. The PoI needs to have historical significance.
2. It needs to represent a historical structure or event that took place in the geographical location that it is placed in.
3. The PoI needs to have a descriptive name and should not contain fabricated information, and, when possible, the information should be verified by experts.
4. The rough dates of the event or structure the PoI represents can be included.

### *4.3. Populating the PoI Database: Automation, Crowdsourcing, and Expert Knowledge*

For a global database that not only has the current layer but several historical layers, the amount of labor required to accurately map the entire world and its history is immense. However, the task is particularly suitable for crowdsourcing [11,16]. Using an existing crowdsourced map, such as OSM, as a backbone is useful for supporting crowdsourcers in placing the PoIs to correct geographical locations [14]. LBA users can also be harnessed as an edge computing resource for crowdsourcing, which we name here as *"edge sourcing"*. End users are harnessed as on site experts to document and compute new additions to the PoI database.

Among tactics for motivating people to participate in crowdsourcing of the solution, gamification [9,13] has been widely used in previous work. Harari explains that blank spots on world maps hugely motivate people to travel and fill in those spots [55]. Giving credit to those who contribute and having a blank map are, therefore, promising solutions for participant motivation. In order for the review process to work, all participants need to be motivated to be on the same side [16]. A cross-team conflict, such as that in the Niantic's games Ingress and Pokémon GO, can cause players of opposing teams to develop negative feelings towards each other [56], which can increase sabotage of the PoI database or underlying map systems [17]. Furthermore, religious and ideological conflicts of the real world can interfere in objective analysis of locations [57]. As a remedy and to assure the quality of the PoI database, universities and other accredited institutions can be provided with a fast track for submitting and removing PoIs, enabling the institutions which have the purpose or harboring knowledge to more efficiently contribute to the database.

## 5. Expert Evaluation

Altogether, nine participants replied to the survey. All participants agreed to give permission to use their responses anonymously in this work. The participants were all experienced LBA users, with experience about the Niantic PoI database solution and OSM. Participants were aged between 25–60 and both male and female.

### *5.1. Advantages*

Participants saw potential in this solution for teaching local history. The most prominent given reason was that, as the system would be tied to historical locations, learning history in some way while using our solution would be inevitable. For example, one participant commented as follows: *"In a game [using this database] many crucial locations would be a part of local history: famous places, birthplaces, meaningful infrastructure locations, artworks*

*etc.*". Another expert commented: *"This solution is better [than the Niantic's solution or OSM], because here the PoIs are specifically tied to the theme of learning history."*

### *5.2. Potential Issues*

The experts highlighted the complexity and difficulty of maintenance as the potential key issues in our proposed system. One participant explained: *"The biggest challenge lies in how to create the simplest working basic structure for the system. Another challenge relates to recruiting experts for the proposed expert verification and maintenance within the system."* Another participant raised an issue regarding the PoI criteria and the need to be more specific there: "*Where do you draw the line what is culturally or historically significant and deserves to be a PoI?*". Finally, issues related to the maintenance of the system were proposed, i.e.,: *"Perhaps the biggest challenge would be how to control, display and use the collected PoIs in applications."*

### *5.3. Improvement Suggestions*

All participants responded with some improvement suggestions. The following four were estimated by the authors as welcome additions to the system: (1) *"There should be a color coding to the PoIs in such a database. Not all PoIs are the same, and there should be tags defining what kind of PoI it is."*; (2) *"Just create the database based on openly available information (e.g., Wikipedia), get coordinates from there and place them in the database. Half of the job done."*; (3) *"Gamification can help motivate people to contribute (see the Niantic solution). So as an improvement suggestion, you could think whether such a database is created first and then used, or created as it is used via crowdsourcing."*; and (4) *"Clarification is needed on who can input data to the database. What kind of a registration is required? Who controls it?"*.

## 6. Use Case View of the Final Proposed Solution

Based on the expert evaluation, we made final adjustments to the proposed solution. There are three use cases [26] of our PoI database scheme that we discuss in this section. First is the basic suggestion and review loop in PoI creation and maintenance. This is displayed in Figure 4. LBA users can submit either individual PoIs or multiple PoIs for review. The reviews can be provided either by experts or crowdsourced to other LBA users. In case the reviews are favorable, the PoI suggestion will be moved to the global backend systems for further processing. The local review node operates as an edge computing resource that is able to significantly reduce the computational load and traffic to the main backend systems. In addition, data transmission is faster between users and the local node in comparison to if users communicated directly with the global backend systems.

The second use case relates to adding supplementary information to existing PoIs. Once the temporal and geographical dimensions of a PoI are established, LBA users can see them on a map. Upon traveling to these PoIs, users have the option to add data about the PoI and submit it onward for processing and validation. In Figure 5, we visualize two users' devices, one sending video data and the other sending audio or text files. Audio and video files can be processed locally by first converting them to file formats that take little space and then by extracting metadata from them using machine learning or other types of techniques. This pre-processed data can then be sent over to the local node for further processing before finally being added to the global database. By utilizing edge computing in this manner, the system load can be split among crowdsourcers, which also saves bandwidth as less data needs to be sent over the internet.

The third use case is the use of the PoI database. When a LBA requests information related to a PoI, a local edge node can return this information directly from a cache or local database without a need to make a request to a backend database. This decreases latency and reduces global traffic. Updating PoIs to global database does not need to be fast because reviewing the PoIs manually will take time anyway and propagating PoI changes quickly is not important in history-themed LBAs. Therefore, delivering PoI data to the backend from the edge and syncing the backend database with the local edge nodes can be done when the system is not under heavy load.

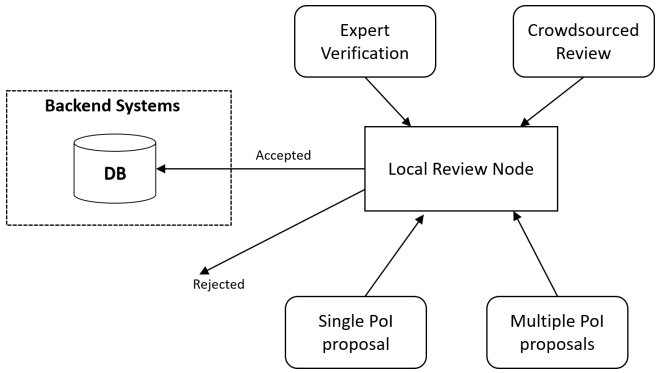


**Figure 4.** A visualization of the PoI submission process in our system that is optimized with the use of edge computing.

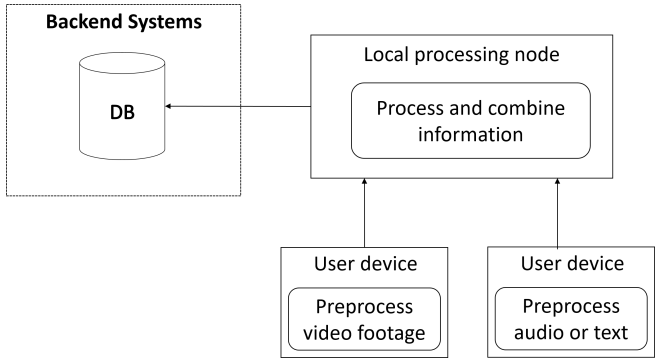


**Figure 5.** An outline of how edge computing is used in two stages when submitting metadata and supplementary information to the PoI database.

## 7. Discussion

### *7.1. Comparison with Previous Solutions*

There are two main types of implementations to which our system can be compared to. The first is previous LBAs that have been designed for history education. Viinikkala et al. created a location-aware AR adventure game taking place in a cathedral, where users could relive stories from the past [10]. The solution contains high fidelity AR but is local and can only be played in a specific location. Huizenga et al. [7], likewise, created a game for learning history; however, their solution Frequency 1550 was city-wide. These solutions were limited in both the temporal and geographical dimensions. Neither was global nor provided a platform for spontaneous learning of local history across eras. Our solution is superior in this regard, but it loses in ability to utilize more context specific technologies, such as physical sensors placed on specific locations or game design that relies on total control of a physical space.

The other solution type that our system needs to be compared to are existing map services, such as OSM [17] and, in particular, the crowdsourced PoI database created by Niantic [9]. Our solution has the important advantage of this work in that it has multiple layers of PoIs, enabling experiencing complete historical eras at once. One important

criticism towards this proposition is that getting historically relevant high fidelity PoIs with crowdsourcing would be increasingly difficult in this case as populating layers of history with accurate PoIs requires expert input. As a remedy, we included a fast track for experts, such as accredited universities, to contribute to the system as displayed in Figure 4.

### *7.2. Challenges in the Real World Implementation*

Additional discussion is needed on the technical implementation. This relates to ethical, legal and privacy issues that are connected to the crowdsourcing solution and data collection [58]. For example, as people are invited to contribute images to the PoI database, verification is needed to make sure the images are not copyrighted and are in fact unique. Some images taken by players may contain other people, so blurring their faces would be needed to avoid privacy infringement. As people are possibly taking video footage from real world objects and edge computing is used to process this data, questions regarding the consumption of network bandwidth, the mobile device memory, and computing power arise. Here, we need to balance the technical implementation with what is convenient to the user and to the system in a way that is ethical.

In this work, we discussed mainly outdoor locations, but it is worth considering that valuable historical information and content exist also within buildings, such as old cathedrals, churches, museums, castles, and caves. To this end, techniques involving indoor localization (e.g., Reference [59,60]) need to be utilized. To expand this solution to cover indoor historical locations, further engineering work is needed. Here, in addition to standard global positioning system (GPS) sensors, more precise sensors (e.g. bluetooth, li-fi, lidar, gyroscope, and other sensors) could be used to determine the mobile device orientation and location accurately within indoors. One additional technical problem that needs to be addressed is the synchronization of the local data node to the global database.

It also needs to be discussed how to enable experts to contribute to the solution. Without additional funding, experts at universities may not have the resources or interest to contribute effort to such a database. Here, one resource that could be utilized are university students. Bergström [61] describes how the LBA Pokémon GO could be integrated as an observational study activity at universities. Along the same lines, students of history could be tasked to contribute to such a PoI database as part of their studies as field work. This could benefit students as they learn, as well as teachers and the University as their reputation increases, and, of course, LBA users as they receive higher quality PoIs.

### *7.3. Pedagogical and Practical Considerations*

The way our solution teaches local history is partly based on implicit learning, i.e., automatic learning while using LBAs. As users travel to PoIs while using LBAs, they absorb information and can get prompted to learn more [62]. As such, this PoI database is an optimal backbone for LBAs as it introduces implicit learning benefits with little to no cost on usability. However, there is very little evidence of the effects of implicit learning on deeper conceptual learning in history [63]. Accordingly, the hypothesized learning benefits need to be rigorously evaluated in future studies. A second benefit is that users get to learn local history while walking around, introducing physical exertion to history education. A third benefit from the educational standpoint is that potential for gamifying learning, which can boost students' motivation. Students' can even use LBAs while socially interacting, enabling them to communicate with one another while travelling to historical PoIs.

This kind of a system for LBAs could also have negative consequences. Having PoIs at world cultural heritage sites might attract unwanted attention. For example, the database could be used as a backbone for applications whose users have no regard for the site they are walking at. This could, in worst cases, cause damage to the place. Furthermore, not all places are suitable for LBAs at all. As an example, the Auschwitz concentration camp, a museum for the Jewish holocaust, has completely forbidden the playing of location-based games on their grounds [64].

### *7.4. Limitations and Future Work*

In this work, we presented a design elicitation, as well as a design of a multi-layered geographical and historical PoI database and its evaluation. In the design elicitation, we chose a particular geographical and historical context, archaeological places in the Levant, for analysis. We focused on the Niantic PoI database and OSM at these sites and compared how well they manage to take into account the historical structures in these locations. As such, the design elicitation was operationalized in a quite specific context. To counter this limitation, the design elicitation could be carried out in other context and also methods invoking knowledge from LBA users could be used. There are also limitations in the system design. At this stage, the design is preliminary and needs to be implemented for rigorous testing. This is an obvious limitation. With regards to the expert evaluation, we were limited by the number of participants and our ability to describe the solution to participants.

One of the most important topics for future work remains the empirical validation and testing of the proposed solution. Because it heavily relies on crowdsourcing, a simple small-scale proof of concept would be insufficient to adequately test its feasibility. In addition, several ethical considerations arise from this work. First, crowdsourcing harnesses the crowds to do work but without employee benefits or protection. Second, using individuals' phones as edge computing resources imposes strain on their hardware. Users might not expect or realize that their phones are being used for pre-processing of data. Thus, users should be able to choose to opt out of pre-processing data, in which case raw data would need to be sent over the internet, which, then again, could increase network bandwidth consumption.

### *7.5. Conclusions*

The proposed PoI database solution has potential in teaching local history, but, as such, it cannot replace traditional history education where global history is taught. Still, it can transform the teaching of local history to be more engaging and interactive and also enhance visitors' experience at cultural outdoor sites with rich history, such as the archaeological sites which we observed in the design elicitation. The multi-layered geographical database gives more depth to the currently used temporally uni-layered solutions in popular LBAs, such as Pokémon GO. As pervasive computing, smart cities, smart environments, and digitization of our daily lives moves onward, scientists and technology designers need to constantly not only create new solutions, but to seek ways to make use of the available infrastructure as well. Here while our solution was designed with the purpose of implicit local history learning, it can have other benefits as well such as bringing LBA users together to specific PoIs facilitating social interaction and motivating people to walk to PoIs scaffolding physical activity.

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## Abbreviations

The following abbreviations are used in this manuscript:

| | |
|---|---|
| PoI | Point of Interest |
| LBA | Location-based application |
| AR | Augmented reality |
| OSM | OpenStreetMaps |
| GPS | Global positioning system |

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**Samuli Laato, Tarja Pietarinen, Sampsa Rauti, & Erkki Sutinen**
**Potential Benefits of Playing Location-Based Games: An Analysis of Game Mechanics**

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IV

# 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.


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### 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 [11,66,71], (2) exercise [6,25,26,43,45,46,74], (3) story or narrative-based learning [2,36,67] and (4) cartography/navigation [12,15,49].

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 [38,73].

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 (i.e. [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 [31,61] 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 subgenres 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.

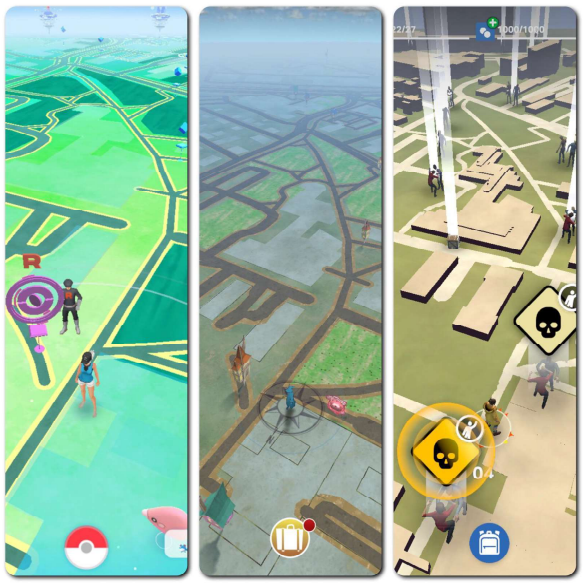

**Fig. 1.** Screenshots of the three analyzed games.

## 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
- 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 Sect. 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.** Figure 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

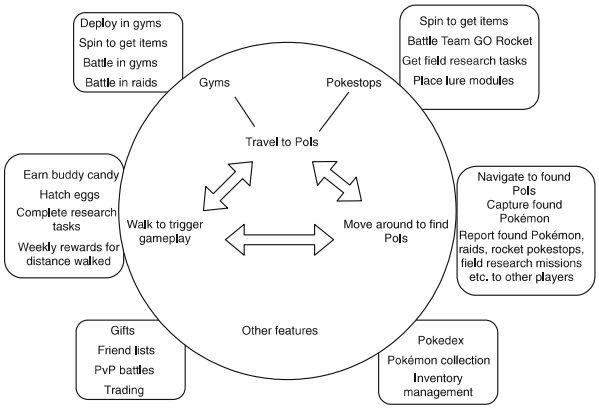


**Fig. 2.** Gameplay Diagram of Pokémon GO.

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

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

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].

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.

**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 | - Battle in Wizarding challenges | - Travel to PoIs |
| | - Walk to open portmonteaus | - Report foundables to other players | - Report foundables to other players |
| | - Move around to find PoIs | - Friend list | - Move around to find PoIs |
| | - Daily reward for walking 250 m | - Place dark detectors | |

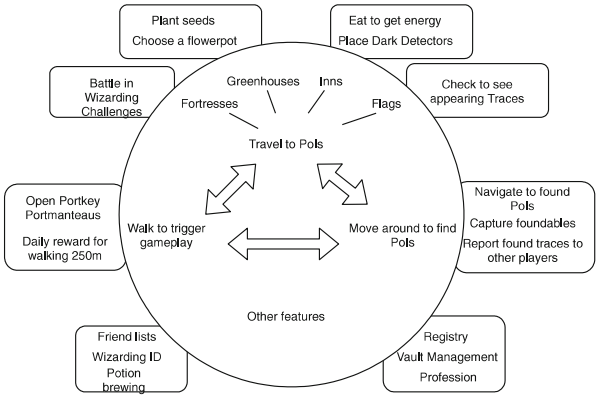


**Fig. 3.** Gameplay diagram of Harry Potter: Wizards Unite.

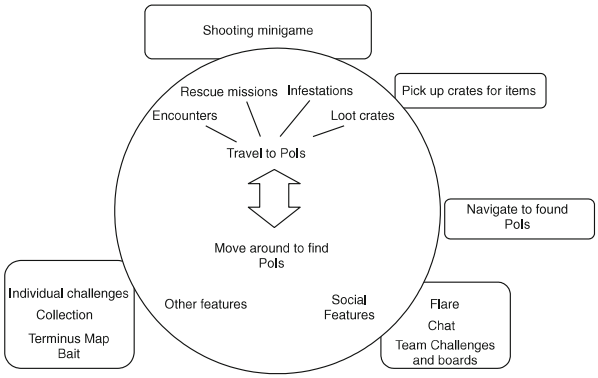


**Fig. 4.** Gameplay diagram of The Walking Dead: Our World.

**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 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.

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 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

**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<br>- Move around to find PoIs | - Flare<br>- Bait<br>- Team Chat<br>- Boards (team challenges) | - Travel to PoIs |

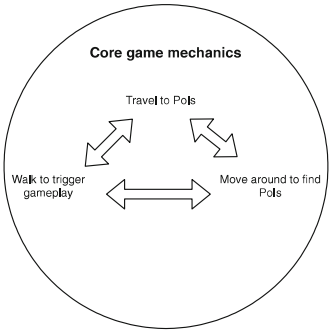


**Fig. 5.** The core movement based gameplay mechanics of Pokémon GO and HPWU.

physically meet each other. This design choice is undoubtedly intentional, and might be preferred by certain groups of players wishing for more privacy.

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 [33,65]. 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 [15,30,65].

**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 [33,65]. 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 [54,56] 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.

## A Appendix

(See Appendix Tables 4 and 5)

**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 |

(*continued*)

**Table 4.** (*continued*)

| Game name | Genre |
|---|---|
| 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 |

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# Playing location-based games is associated with psychological well-being: an empirical study of Pokémon GO players

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**ABSTRACT**

Location-based games (LBGs) augment urban environments with virtual content turning them into a playground. The importance of understanding how different modes of play impact LBG players' psychological well-being is emphasized by the enormous and constantly rising popularity of the genre. In this work, we use the two-factor theory of psychological well-being to investigate the associations between five constructs related to game mechanics and personality traits, and psychological well-being and fatigue. We test our proposed structural model with Finnish Pokémon GO players ($N = 855$). The results show deficient self-regulation and fear of missing out to be positively associated with gaming fatigue. Engagement with cooperative and individual game mechanics had a positive relationship with well-being. Competitive game mechanics were found to have a positive relationship with both well-being and fatigue. Finally, the overall playing intensity had a strong relationship with well-being, but no association with fatigue.

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Location-based games; pervasive games; Pokémon GO; well-being; fatigue; fear of missing out

## 1. Introduction

Satellite navigation and the ubiquitous access to smartphones have given birth to location-based games (LBGs) which make use of the players' real-world location as a way to interact with the gameworld (Papangelis et al. 2020). As such, LBGs turn the real world into a playing field. The games have recently become massively popular, being downloaded cumulatively to over a billion devices and the most popular game Pokémon GO alone generating over four billion USD in lifetime revenue (Chapple 2020).

The behavioural consequences of LBGs as well as their implications on urban life are manifold. LBGs have been studied in the fields of philosophy (Liberati 2019), human–computer interaction (Papangelis et al. 2020), health (Althoff et al. 2016), psychology (Kaczmarek, Behnke, and Dżon 2019), education (Rauti, Laato, and Pietarinen 2020) and cartography (Colley et al. 2017) among others. While the extant literature on video games in general has taken into account broadly both positive and negative consequences of playing (McLean and Griffiths 2013), the negative side of LBGs deserves further attention (Kaczmarek, Behnke, and Dżon 2019). Previous work on the negative effects of LBGs has focused predominantly on analysis of the games as distractions to drivers and pedestrians (Ayers et al. 2016), players' trespassing behaviour (Papangelis et al. 2017), addiction and back pain (Kaczmarek, Behnke, and Dżon 2019) and the adoption of unwanted real world behaviour (Alomar, Alsaleh, and Alarifi 2019). The effects of playing LBGs on psychological well-being have been explored to some extent (e.g. Bonus et al. 2018; Yang and Liu 2017), but understanding how specific game mechanics and personality traits relate to psychological well-being and fatigue of players still needs to be addressed. Understanding the relationships between well-being and fatigue and LBG playing habits and player personality traits helps decision makers and game designers to make more accurate evidence-based decisions with regards to, for example, health game interventions.

The current study aims to fill this research gap by focusing on the relationship between playing LBGs and psychological well-being. The two-factor theory (TFT) and related studies (Herzberg, Mausner, and Synderman 1959; Stallings et al. 1997) suggest that well-being should be studied independently of negative affect, as the two are driven by different sets of factors, and both positive and negative affect can co-exist simultaneously (Diener et al. 1999; Yang and Liu 2017). In this study we use the TFT to study the associations of playing LBGs on psychological well-being (positive) and fatigue (negative).

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With this research approach we expand the understanding of LBG players' psychological well-being and illuminate the societal change that results from gaming moving outdoors. As empirical work we build a theoretical model by employing (1) psychological well-being; and (2) fatigue as our dependent variables and observing the relationships of game mechanics, playing intensity, fear of missing out (FoMo) and deficient self-regulation (DS-R) with the dependent variables. To test the model we collected cross-sectional data from Finnish Pokémon GO players ($N = 855$). Pokémon GO was chosen for the following reasons: (1) it is currently the most popular LBG; (2) a vast body of academic literature has focused on Pokémon GO making our findings comparable to the prior studies; and (3) previous studies have suggested that findings from Pokémon GO may be generalised to cover other LBGs (Hamari et al. 2019; Laato et al. 2020c). The findings of our structural model highlight the importance of avoiding game-related FoMo and DS-R to facilitate psychological well-being and showcase that the overall playing intensity has a significant positive relationship with psychological well-being but no relationship with fatigue.

## 2. Background

### 2.1. Games and psychological well-being

As video games are a broad category and each game is unique, it is no surprise that a multitude of both positive and negative consequences of playing them have been identified (Jones et al. 2014; McLean and Griffiths 2013). Among the positive outcomes is psychological well-being. Johnson et al. (2013) surveyed 200 studies connected to video games and well-being, and concluded that video games can facilitate emotional, social and psychological well-being of young players, including positive emotional state, self-esteem, optimism, vitality, resilience, engagement, relationships, sense of competence, self-acceptance, and social connections and functioning. A more recent literature review (Halbrook, O'Donnell, and Msetfi 2019) investigated the positive effects of video games on well-being including both psychological and physical perspectives. The findings showed engagement with social components of games to have clear positive effects on psychological well-being. The study further suggests that playing cooperative games may result in higher levels of enjoyment whilst lowering the levels of aggression among players, but this only happens when the amount of playing is moderate and is primarily motivated by social interaction. Halbrook, O'Donnell, and Msetfi (2019) further concludes that games with prosocial features correlate with players' ability to cooperate, and scaffold the ability to maintain positive relationships also outside games. The strong relationship between prosocial gameplay and prosocial behaviour was also identified by McLean and Griffiths (2013) in their systematic literature review on positive and negative effects of video games. They further found several other positive psychological effects of video games, including affective, arousal and cognitive effects; increase in perceptual, visual attention and spatial skills; and development of visuospatial cognition. McLean and Griffiths (2013) and Eichenberg and Schott (2017) both presented evidence of video games having been successfully used as tools for psychotherapy, thereby facilitating the psychological well-being of patients. Finally, Joronen, Aikasalo, and Suvitie (2017) investigated the nonphysical effects of exercise games (exergames) on child and adolescent well-being by surveying 10 intervention studies. The results suggested that some of the studies found positive effects, among others, on psychological well-being, self-efficacy enjoyment and motivation, but the effects of individual game mechanics were not observed.

In order for a game-based psychological well-being intervention to reach the desired positive effect, its game mechanics must be carefully planned and aligned with the goals of the intervention. This process implies the understanding of a variety of game motivators and design principles that contribute to intrinsically motivated engagement (Laine and Lindberg 2020), which in turn can translate to increased adherence to the intervention. Yet research has shown that many interventions fail to do this, thus raising a question on how regularly are game designers involved in intervention development processes. For example, Brown et al. (2016) analysed the results of 61 randomised controlled trials where gamification was applied to web-based mental health interventions, with the main focus on whether gamification helped increase adherence to the intervention. The authors found no statistically significant evidence that gamification elements – the most popular being story, progress, goal setting, and rewards – would increase adherence. Moreover, most of the interventions used only one or two gamification elements, thus suggesting that these interventions may not have been designed as games, but these elements were added on top of an existing health intervention. Complementing this result, Cheng et al. (2019) reviewed 70 studies that applied gamification on mental health and well-being interventions, discovering that researchers often treat gamification as a black box without considering the underlying mechanics.

The negative effects of video games have been discussed in particular related to games with violent content. This has been a vibrant topic among game researchers for decades. There has even been reported publication bias and flawed methodologies in several previous studies on the effects of violent video games (McLean and Griffiths 2013). A recent study by Kuhn et al. (2019) investigating the effects of violent video games on aggression found no evidence to support video games causing violence after a two-month control group study. Beyond the debate whether video games induce violence, previous studies have linked playing games to (1) having negative influence on academic performance when the amount of playing time is substantial (McLean and Griffiths 2013; Liu and Peng 2009); (2) fatigue (Liu and Peng 2009); and (3) problems in personal life (Liu and Peng 2009). The negative effects have been shown to be correlated to psychological dependency on the game (i.e. addiction) (Liu and Peng 2009) as well as DS-R (Lee and LaRose 2007).

In addition to the extant literature identifying both positive and negative influence of playing on well-being, there is also some evidence of games having dual outcomes. A recent study on online video games showed playing to decrease well-being (Goh, Jones, and Copello 2019) while an earlier work demonstrated playing games to increase well-being (Johnson et al. 2013). Lobel et al. (2017) found no connection between playing cooperative games and prosocial behaviour while Halbrook, O'Donnell, and Msetfi (2019) showed the exact opposite. While the argument can be made that the genre and type of the game heavily influences these outcomes, Von Der Heiden et al. (2019) found no significant correlation between players of different game genres and psychological functioning. Whether games lead to positive or negative outcomes also relates to the players themselves. Vallerand et al. (2003) demonstrate that individuals may develop either a harmonious or obsessive passion with regards to an activity, where harmonious passion is self-regulated and produces psychological well-being and obsessive passion is linked to addiction and negative affect. In summary, video games in general can have a wide range of positive and negative effects, with some evidence also pointing that they may have a dual effect simultaneously increasing well-being (Johnson et al. 2013) and fatigue (Liu and Peng 2009).

### 2.2. Location-based games and the positive and negative outcomes of playing them

Previous studies on psychological well-being have shown surprising life events to be better predictors of psychological well-being than expected events (Stallings et al. 1997). By taking playing outside, LBGs turn the chaotic unpredictability of urban life into a playing field, adding an ever-changing element to the game: real life. At no point players are completely able to predict what will happen next, as players might run into people they know or encounter a particularly beautiful sunset. In addition, several LBGs are creating in-game random events for players. For example, in Pokémon GO players might be surprised with a shiny pokémon (a very rare form of a pokémon) or hatch a pokémon that they did not have before or the hatching of a rare pokémon from an egg (Yu and Fu 2019). As an example, Koskinen et al. (2019) and Bonus et al. (2018) demonstrate that Pokémon GO can facilitate positive and memorable experiences. A recent work by Alavesa and Xu (2020) also showed that several players are eager to share their experiences online in the form of images and screenshots taken while playing.

Previous studies on LBGs have divided game mechanics into three categories: (1) individualistic; (2) cooperative; and (3) competitive (Morschheuser et al. 2017; Riar et al. 2020). Here cooperative game mechanics have been shown to lead to altruism and increased we-intentions (Riar et al. 2020), and engagement with cooperative game mechanics has been shown to be a better predictor of positive emotions than individualistic game mechanics (Morschheuser et al. 2017). Papangelis et al. (2017) note that in LBGs the real world environment impacts players' perceptions of the game, and that the playing location is therefore an important component in the outcomes of playing LBGs. This also connects to territorial expression in the LBG world, which has further been linked to social structures among players (Papangelis et al. 2020).

The behavioural consequences of LBGs have been studied by, for example, Alomar, Alsaleh, and Alarifi 2019; Colley et al. 2017; and Oleksy and Wnuk 2017. However, studies looking at the relationships between playing LBGs and psychological well-being are scarce. Among the few studies are that of Watanabe et al. (2017) who showed playing Pokémon GO to be correlated with mild improvement on psychological distress. Another related study showed relationship initiation in LBGs to have effects on both positive and negative aspects of well-being (Yang and Liu 2017). The most recent study (Williams and Slak-Valek 2019) found a correlation between playing LBGs and increased sense of happiness.

The positive and negative effects of playing LBGs identified by previous studies are summarised in Table 1. Note that some potential negative impacts such as trespassing and reckless driving (Ayers et al.

**Table 1.** The positive and negative outcomes of playing LBGs derived from previous studies.

| Positive impacts of LBGs | Negative impacts of LBGs |
|---|---|
| (1) Exercise (Althoff et al. 2016; Laato et al. 2020c; Laato, Inaba, and Paloheimo 2020b) | (1) Physical problems, pains, problems with vision (Kaczmarek, Behnke, and Dżon 2019) |
| (2) Social Connectedness (Bhattacharya et al. 2019; Vella et al. 2019) | (2) Smartphone addiction (Kaczmarek, Behnke, and Dżon 2019; Sobel et al. 2017) |
| (3) Positive life experiences (Bonus et al. 2018; Koskinen et al. 2019; Oleksy and Wnuk 2017) | (3) Problems with self-regulation, internet addiction (Yu and Fu 2019) |
| (4) Improvement on psychological distress or well-being (Watanabe et al. 2017: Williams and Slak-Valek 2019; Yang and Liu 2017) | (4) Reckless behaviour in traffic (Ayers et al. 2016; Faccio and McConnell 2020; Wagner-Greene et al. 2017) |
| (5) Navigation and cartographic skills (Carbonell Carrera, Saorín, and Hess Medler 2018; Colley et al. 2017) | |

2016; Wagner-Greene et al. 2017) were excluded from this list. Even though these might be issues for a small proportion of players, a recent study found the claims that LBGs cause adoption of such behaviour to be unjustified (Alomar, Alsaleh, and Alarifi 2019).

Comparing this summary to our review of the effects of video games in general, it is evident that several major research gaps exist. First, the possible negative aspects of LBGs are only touched by a few studies (e.g. Kaczmarek, Behnke, and Dżon 2019; Yang and Liu 2017). Second, the studies seem to focus on aspects that are specific to LBGs, while likely some of the findings on video games in general (e.g. Johnson et al. 2013) also apply to LBGs. To address these gaps, we explore the associations between fatigue (negative) and psychological well-being (positive) and playing Pokémon GO. In doing so we not only include the impact of engagement with game mechanics, but also the impact of DS-R and FoMo which are related to the marketing strategies (e.g. Niantic 2020) that LBG developers may use to motivate players to make in-app purchases, nudge players to advertise the game on social media (Alavesa and Xu 2020) and engage players to play more (Laato, Laine, and Islam 2020).

### 2.3. Theoretical foundation

#### 2.3.1. The two factor theory and Kano's satisfaction model

The two-factor theory (TFT) was originally developed to understand job satisfaction, but has since been also used in other research areas. At its core, the theory divides job satisfaction to be the outcome of two types of factors: (1) Motivators; and (2) Hygiene factors (Herzberg, Mausner, and Synderman 1959). In the context of a workplace, motivators are factors related to the work itself such as how challenging and rewarding the work is and does it facilitate a sense of importance. Motivators are predictors of job satisfaction, but according to TFT, their absence does not cause dissatisfaction. In fact, dissatisfaction is predicted only by hygiene factors, which are conceptualised to be things such as salary, relationships with co-workers and working conditions. The hygiene factors do not increase job satisfaction, but their absence will increase job dissatisfaction. In summary, TFT postulates that satisfaction and dissatisfaction should be separated instead of seeing them as the polar ends of the same phenomenon. Furthermore, TFT states that factors influencing satisfaction are called motivators, which are distinct from the hygiene factors that predict dissatisfaction. (Herzberg, Mausner, and Synderman 1959)

Previous studies have found this theory to be problematic because while satisfaction and dissatisfaction can be regarded to be separate phenomena, it does not mean one factor could not have an impact on both (Islam 2014). An alternative view on satisfaction and dissatisfaction is the Kano's satisfaction model (Kano 1984) which conceptualises satisfaction and dissatisfaction to be the result of (1) basic factors; (2) excitement factors; and (3) performance factors. The theory shares similarities with TFT by postulating that basic factors do not cause satisfaction, but their absence can increase dissatisfaction. Excitement factors are the opposite, also aligning with TFT by saying their presence can cause satisfaction but their absence does not cause dissatisfaction. Kano's satisfaction model departs from TFT in the third group of factors, the performance factors, by stating these are factors that can impact both, satisfaction and dissatisfaction (Islam 2014; Kano 1984).

Adopting TFT to the context of human psychological well-being, Bradburn (1969) proposed that in fact well-being should not be viewed as a spectrum either with sadness and depression on the other end. Instead, the two should be considered independently of one another (Bradburn 1969). Since then, this conception has been empirically verified by several studies (Stallings et al. 1997; Watson and Tellegen 1985; Diener et al. 1999). When probing into what factors increase well-being or positive affect, studies have found (1) sociability, (2) extraversion; and (3) the frequency of pleasant events to be one of the strongest predictors (Stallings et al. 1997). On the other hand, sadness or negative affect seems to be predicted by a different set of factors, in

particular, neuroticism, health complaints, frequency of unpleasant events and stress levels (Stallings et al. 1997).

An important implication of Kano's model compared to TFT is that the same factor can have a positive impact on both satisfaction and dissatisfaction (Kano 1984) or well-being and sadness (Stallings et al. 1997). This apparent causal asymmetry is the result of conceptualising the existence of performance factors (Kano 1984). The dual outcomes of the same activity has been demonstrated recently, for example, in relation to self-promotion, which was found to lead to both addiction (negative) and vitality (positive) (Islam, Mäntymäki, and Benbasat 2019). Currently it remains unexplored whether similar duality can be seen in LBGs. However, recent findings regarding the multiplayer elements of LBGs suggest that cooperative mechanics may lead to increased we-intentions (Morschheuser et al. 2017) but also give birth to negative attitudes towards opposing players (Laato, Inaba, and Paloheimo 2020b).

Thus, we propose that when studying the relationship of playing LBGs and psychological well-being, the negative effects should be represented in the theorised model as another dependent variable. For the negative dependent variable we chose gaming fatigue, which has been shown to be linked with psychological and health problems especially with regards to gaming addiction (Männikkö, Billieux, and Kääriäinen 2015). To summarise, using TFT conceptualisation of well-being (Diener et al. 1999), we employ two dependent variables: (1) psychological well-being; and (2) gaming fatigue.

#### *2.3.2. The self-determination theory*

In addition to game mechanics, a major part of LBGs' influence on players is connected to the marketing strategies by which the games advertise themselves to the players, trying to engage them to play and get them to make in-app purchases (Laato et al. 2020c). From the wide variety of psychological tricks that LBGs can utilise, two seem particularly relevant: (1) fear of missing out (FoMo); and (2) deficient self-regulation (DS-R). In order to understand DS-R and FoMo we refer to the self-determination theory (SDT) which especially concerns humans' intrinsic motivation (Deci and Ryan 1985). The theory decomposes intrinsic motivation into three components: (1) competence; (2) autonomy; and (3) relatedness. Competence describes the human willingness to be useful and have the ability to impact their surroundings in a meaningful way; autonomy describes the human need to seek to control their immediate surroundings and be an autonomous actor, not having to rely on external actors for survival; and relatedness describes the need to interact with other humans, building social connections and self-evaluating through comparison to others. (Deci and Ryan 1985)

Self-regulation is an integral part of human thought processes and refers to the individual's ability to regulate their behaviour (Deci et al. 1994). SDT posits that self-regulation is the result of being able to act autonomously, that is, acting based on one's interests and values (Reeve et al. 2008). If the autonomous acting is disrupted, this can lead to DS-R. Other reasons for DS-R or self-regulation failures have been found to be cognitive dissonances, false assumptions and impulsive action (Baumeister and Heatherton 1996). In the context of video games, DS-R is linked to video game addiction (Lee and LaRose 2007), and in addition to autonomy, also competence and relatedness have been shown to negatively associate with video game addiction (Wu, Lei, and Ku 2013). Related to DS-R is dysfunctional impulsivity, which refers to making quick decisions based on affect and intuition in cases where such decisions are non-optimal (Puerta-Cortés et al. 2017). This has been shown to be a predictor of playing massive multiplayer open online games (Puerta-Cortés et al. 2017), and, for example, the most popular LBG Pokémon GO can be seen to be such a game. The mechanism via which games increase DS-R is typically attributed to game mechanics offering instant gratification (Svelch 2017).

FoMo describes the feeling of being left out on something and is typically discussed especially with regards to social relationships (Przybylski et al. 2013). Building off SDT, FoMo has been suggested to occur when the relatedness need is not fulfilled, and is characterised by constantly seeking to know what people and groups socially connected to the individual are doing (Al-Menayes 2016; Przybylski et al. 2013). FoMo has been shown to increase social media use and engage people (Beyens, Frison, and Eggermont 2016), and LBG companies trying to engage players are therefore trying to invoke the feeling in people. As an example, Pokémon GO constantly features events that are only available for a limited time, and in the developer's communication of these events, they encourage players to play now and share photos of them catching rare pokémon and having fun on social media (Niantic 2020).

## 3. Research model and hypotheses

In this section we theorise the relationships of DS-R, FoMo and engagement with game mechanics with two dependent variables: (1) psychological well-being; and (2) gaming fatigue. Building off SDT, we adopted the concept of subjective vitality to represent psychological well-being and define it as the feeling of being alive, alert

and full of energy (Bostic, Rubio, and Hood 2000; Islam, Mäntymäki, and Benbasat 2019). There are two types of subjective vitality measurements. One measures the ongoing characteristics of individuals while the other is temporal and measures the state of well-being at a particular moment (Ryan and Frederick 1997). We adopted the latter, as it allows us to measure well-being while playing LBGs and link it to the game mechanics and personal attributes. Lewis and Wessely (1992) define fatigue as an exhaustion of mental and physical strength resulting from bodily labour or mental exertion. As we focus on gaming in our study, we focus only on the mental exhaustion aspect (Lewis and Wessely 1992). Therefore, we define fatigue as the exhaustion of mental strength resulting from playing. Next, we hypothesise key relationships to these dependent variables based on the selected theories.

### 3.1. Deficient self-regulation

As DS-R is associated with the loss of control (Tokunaga 2015), it has been connected to increased playing intensity and even video game addiction in previous studies (Lee and LaRose 2007). Players with DS-R are particularly susceptible to incentives that games provide to spend real money and make microtransactions (Soroush, Hancock, and Bonns 2014). For this reason, video game developers are interested in coming up with ways to boost DS-R to increase in-game sales. Controversially, this also applies to games that are advertised as health games, such as several LBGs. A hedonistic lifestyle filled with continuous seeking of instant gratification, which certain gameplay promotes, gives heightened temporary enjoyment, and therefore can develop addiction, which reduces self-regulation (Eisingerich et al. 2019; Svelch 2017; Turel and Serenko 2012).

The problematic nature of DS-R materialises in that players lose control of their playing which can backfire by taking time away from other more meaningful or necessary activities. The dismissal of important activities in favor of playing can cause cognitive load (Sweller 2011) which will cause additional strain on players. Via this mechanism, DS-R can increase players' negative affect and consequently gaming fatigue. Seeing that DS-R has been connected to increased playing, more impulsive behaviour (Lee and LaRose 2007; Tokunaga 2015) and lack of fulfillment on the needs depicted by SDT (Wu, Lei, and Ku 2013), it seems feasible that it could also negatively associate with well-being. Low self-regulation abilities can relate to long term negative affect, such as fatigue (Reeve et al. 2008). For these reasons, we propose the following two hypotheses.

**H1:** Deficient self-regulation is positively associated with gaming fatigue.

**H2:** Deficient self-regulation is negatively associated with well-being.

### 3.2. Fear of missing out

LBGs can invoke FoMo in two ways. First, the games are often highly social including both cooperative and competitive game mechanics. Players are offered rewards from interacting with one another and are provided challenges which require the help of others to conquer. Social gatherings not only happen in the online world, as LBGs can bring players together in the real world (Bhattacharya et al. 2019). Subsequently, LBGs can incentivise players to play via FoMo, by communicating to players that unless they play they could miss out on some of the social events and related social gratification. The second way LBGs draw out FoMo is by constantly introducing events and limited time opportunities for obtaining unique rewards. Players share these rewards and their in-game achievements to others on social media and chat channels which can further escalate the sense of FoMo on players seeing these posts. As gaming companies can be relentless in the frequency of events and calls to play now, this can cause a strain on players who are experiencing FoMo. Furthermore, previous studies on social media users have found FoMo to be linked with fatigue (Bright and Logan 2018; Dhir et al. 2018). Accordingly, we hypothesise the following:

**H3:** FoMo is positively associated with gaming fatigue.

FoMo has been found to also strongly correlate with smartphone addiction (Elhai et al. 2016; Wolniewicz et al. 2018). Addiction on the other hand, decreases well-being (Cardak 2013). In addition, it is associated with lower mood and life satisfaction (Przybylski et al. 2013). While studies have shown that a different set of factors influence well-being and negative affect (Stallings et al. 1997), Kano's model of satisfaction suggests the existence of factors that can have an impact on both (Kano 1984). FoMo may be such a factor because it has been conceptualised to be the consequence of deeper deficiency at the level of core intrinsic motivation (Wu, Lei, and Ku 2013). According to SDT, FoMo occurs when the relatedness need is unfulfilled (Al-Menayes 2016), suggesting a negative relationship between FoMo and well-being. For these reasons, we hypothesise the following.

**H4:** FoMo is negatively associated with psychological well-being.

### 3.3. Engaging with LBG game mechanics

While LBGs at their core consists of gameplay that is tied to the player's real world location, the games can in theory be as complex as any game. In fact, recently released LBGs such as Minecraft Earth and Orna are differentiating themselves from other games from the genre by adding all kinds of unique new features. While the games motivate players to go out and walk, the increasing complexity of the games can actually do more harm than good. Complex games and multiple game mechanics force players to look more of the smartphone screen and less at the environment they are walking in. Referring to the cognitive load theory (Sweller 2011), the more game mechanics players need to engage with, the more likely they are to get overloaded. Following previous studies on LBG game mechanics (Riar et al. 2020), we decompose the game mechanics into three groups: (1) individual; (2) cooperative; and (3) competitive; game mechanics. Next, we hypothesise their relationships to well-being and fatigue.

#### 3.3.1. Individual mechanics

While characterised as outdoor social games (Laato et al. 2020c), a major proportion of the standard gameplay in almost all LBGs is individualistic. Still, the individualistic mechanics can offer incentives to exercise (Althoff et al. 2016; Laato et al. 2020a), visit new places (Oleksy and Wnuk 2017), facilitate memorable life experiences (Bonus et al. 2018; Koskinen et al. 2019) and give gratifications from progression (Alha et al. 2019). On the other hand, individual playing can have negative effects as well (Yang and Liu 2017), because too intense playing may lead to neglecting more meaningful and important activities (Beach et al. 2019). Neglect of real life activities can increase cognitive load (Sweller 2011) which can in turn lead to fatigue. In addition to cognitive overload, eventually the game mechanics might become stale and uninspiring, leading to a lack of enthusiasm and consequently, fatigue. Accordingly, we propose the following two hypotheses.

**H5:** Engagement with individualistic game mechanics has a positive association with gaming fatigue.

**H6:** Engagement with individualistic game mechanics has a positive association with psychological well-being.

#### 3.3.2. Cooperative mechanics

Introverted people experience greater cognitive load from social encounters. Too many social encounters, especially with unfamiliar people, can lead to cognitive overload, which in turn births anxiety and wishes to retrieve away from the social situation (Kirschner et al. 2018). A recent study characterised engaged LBG players as introverted (Caci et al. 2019), meaning the players are at greater risk to get overloaded by social encounters and get fatigued. Yang and Liu (2017) found relationship initiation to have dual outcomes, both increasing and decreasing psychological well-being. These findings would suggest that LBG players engaging in social encounters could indeed experience fatigue. Accordingly we hypothesise the following.

**H7:** Engagement with cooperative game mechanics has a positive association with gaming fatigue.

On the other side of the study by Yang and Liu (2017) was that relationship initiation increases well-being. Psychological well-being has been further decomposed into joviality, self-assurance and serenity, of which especially self-assurance has been shown to be linked with positive social outcomes in face-to-face computer-assisted environments (Pietarinen et al. 2019). Moreover, social activities in video games, particularly those of cooperative nature, have been found to positively affect psychological well-being and player enjoyment (Halbrook, O'Donnell, and Msetfi 2019). LBGs can facilitate face-to-face group interaction with several game mechanics, of which an example is raids in Pokémon GO, whereby a group of players come physically to the same place to join their forces to beat a powerful boss (Bhattacharya et al. 2019). The collaboration in raids can be characterised as a group work where participants work together towards a common goal. Building off the work of Pietarinen et al. (2019), Halbrook, O'Donnell, and Msetfi (2019), and previous studies on the outcomes of cooperation in LBGs (Morschheuser et al. 2017; Riar et al. 2020; Yang and Liu 2017), we theorise that the face-to-face cooperation that LBGs facilitate can have a positive relationship with psychological well-being. Accordingly we formulate the following hypothesis.

**H8:** Engagement with cooperative game mechanics has a positive association with psychological well-being.

#### 3.3.3. Competitive mechanics

Competition and exploration of self through playing has an important role in the psychological development of humans (Pellegrini and Smith 2005). Climbing trees and playful fighting can be seen as re-enactment of our evolutionary past, something programmed into our being to prepare us for skills that would have been useful in the hunter-gatherer way of living (Pellegrini and Smith 2005). In a similar way, humans are seen to have a tendency to engage in competitive playing

and sports. Competition has been shown to play a crucial role in the enjoyment of video games, with it bringing perceived meaning to the activity via human opponents, and also providing gratifications when overcoming human opponents (Vorderer, Hartmann, and Klimmt 2003). While competition can certainly have positive impacts on well-being through gratifying primal needs and even increasing serotonin and dopamine levels in the case of winning (Boureau and Dayan 2011), it can also lead to several negative things such as taking away time to such an extent, that it hurts with other life activities. Furthermore, competition can increase stress levels, technology overload and consequently lead to fatigue (Karr-Wisniewski and Lu 2010). Accordingly, engaging with competitive mechanics may positively be associated with both well-being and fatigue. Thus, we propose the two hypotheses.

**H9:** Engagement with competitive game mechanics has a positive relationship with gaming fatigue.

**H10:** Engagement with competitive game mechanics has a positive relationship with psychological well-being.

### 3.4. Playing intensity

Playing intensity is understood to be the combination of the daily number of hours spent playing and the habit of playing (Puerta-Cortés et al. 2017; Whelan, Islam, and Brooks 2020). As such, high playing intensity can cause fatigue (Liu and Peng 2009; Whelan, Islam, and Brooks 2020), but it can also predict psychological well-being due to the various positive outcomes of playing (e.g. Bonus et al. 2018; Koskinen et al. 2019; Riar et al. 2020; Vella et al. 2019; Yang and Liu 2017). There could furthermore be diminishing returns in the effects of playing intensity; in other words, once playing intensity is above a certain threshold, which might vary from player to another, more time spent playing no longer increases psychological well-being. Furthermore, if the playing starts to hurt other more important life activities, then that should be seen in DS-R, which was in turn predicted to have a strong negative influence on well-being. Accordingly, we use playing intensity as a control variable, proposing that it is associated with both fatigue and psychological well-being.

Our final research model connecting the proposed hypotheses is shown in Figure 1. On the right side of the model we have the three types of game mechanics: (1) cooperative; (2) competitive; and (3) individual, which were hypothesised to have significant relationships with both gaming fatigue and well-being. On the right side we have DS-R and FoMo which were predicted to have a negative association with well-being and a positive association with gaming fatigue.

## 4. Methodology

### 4.1. Survey design

We searched the prior literature for validated scales for the eight constructs in our structural model: (1) DS-R; (2) FoMo; (3) psychological well-being; (4) Fatigue; (5) Playing intensity; and (6) Engagement with individual, (7) cooperative, and (8) competitive game mechanics. We found validated scales for the first five from prior literature, and adopted them to the context of the case LBG, Pokémon GO. For looking at the engagement with game mechanics, we adopted the approach used by Morschheuser et al. (2017) and Riar et al. (2020) where the game mechanics are measured as formative constructs. To this end, we played and studied the case game Pokémon GO to identify relevant game mechanics, and based on this analysis, we created a multiple choice question where players were asked to select all game mechanics which were important to them. These items were classified into (1) cooperative; (2) competitive; and (3) individualistic; game mechanics. Some of the survey items taken from prior literature had to be adopted and changed to fit the current study context of LBGs, but the changes were kept as minor as possible and reviewed by two authors before being included in the final survey. The full list of used constructs, related survey items and the sources for the scales can be found in Appendix.

As the survey was going to be deployed for Finnish speaking players, we translated and validated the survey in the Finnish context. To this end, an author who was also a native Finn first translated the items into Finnish. Another native Finn then translated the items back to English. The original English items and the re-translated items were then compared. At this point some issues were identified, mainly grammatical, however a few inaccurate translations were also detected. The two translators discussed the items, the translations and their meaning, making sure that for those items where the translation was different, a common understanding was found on what was the best wording.

To ensure the understandability of the survey, it was sent to 12 Pokémon GO players in a closed WhatsApp chat for proofreading and review. The participants gave a few suggestions on the grammar, which were then fixed by the authors. In addition to the survey items (available in Appendix), a title page was included in the survey where the goal of the study and handling of

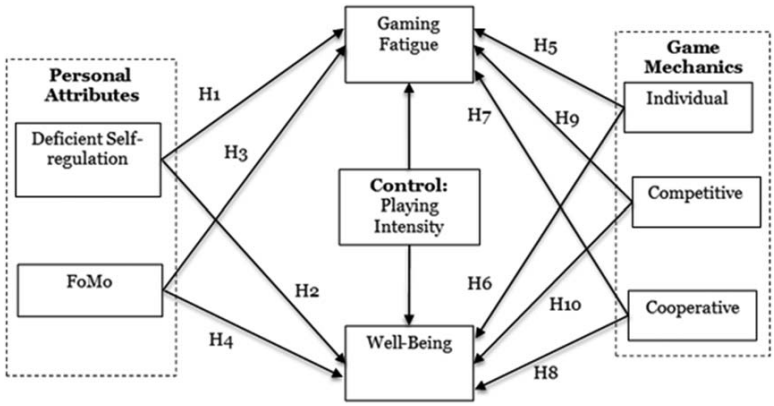


**Figure 1.** Proposed structural model to explore the two-factor relationships of well-being and fatigue in playing LBGs.

the data were explained. The authors also included their contact information to this page as well as a notification that by proceeding to fill the voluntary survey, the respondents would give their permission to use the data anonymously for research.

### 4.2. Data collection

The survey was implemented using the Webropol survey tool and all questions were marked mandatory to avoid the situation where some answers would be incomplete. The Webropol tool takes technical measures preventing the same IP-addresses from answering the survey twice. The survey was distributed on April 8th, 2020 to Finnish Pokémon GO players via two Facebook groups and eight local chat groups. One of the Facebook groups was nation-wide. The survey was available for one week, and was closed on April 14th. The final number of responses was 855 and there were no cases of missing data. The participants' demographic data can be seen in Table 2. We look at gender, age and the participants' level in Pokémon GO. For reference, reaching level 30 takes approximately 40 hours of playing and reaching level 40 ten times that, which equals to 400 hours of playing.

**Table 2.** Demographic information of the participants.

| Gender | | Age | | Level in Pokémon GO | |
|---|---|---|---|---|---|
| Female | 70.7% | Under 25 | 21.6% | 1–20 | 0.1% |
| Male | 27.3% | 26–40 | 52.0% | 21–30 | 4.0% |
| Other/undisclosed | 2% | 41–60 | 25.7% | 31–35 | 14.1% |
| | | Over 60 | 0.7% | 36–39 | 25.6% |
| | | | | 40 | 56.2% |

However, this is highly dependent on the playstyle and even playing location and therefore this is just an estimation. Still, the majority of respondents seemed to be highly active high performing players with over half of them having reached level 40. Please note that in late 2020 new levels were added to the game, increasing the level gap to 50. However, at the time of the empirical study, the max level was 40. Also a surprisingly large proportion of respondents were women, which is unusual for a video game survey but not unusual for Pokémon GO (see e.g. Alha et al. 2019; Laato et al. 2020c).

### 4.3. Validity and reliability

We verified the validity and reliability of the collected data. In particular, we looked at convergent and discriminant validity. To this end, we used the SmartPLS software version 3.3.2. All constructs were modeled as reflective constructs, except the game mechanics constructs, which were modeled as formative constructs.

For the reflective constructs, we tested the convergent validity, which concerns that all items in a scale need to measure the same construct. Originally proposed by Fornell and Larcker (1981), it is currently widely accepted that the loading values of scale items need to be at least at 0.7 and the composite reliabilities at 0.8. Furthermore, the average extracted variance needs to be 0.5 at minimum (Fornell and Larcker 1981). We carried out this analysis using SmartPLS and the results can be seen in Appendix. A few survey items were removed during the analysis for not filling these criteria, and they are also marked in Appendix. We also found the weights

**Table 3.** The correlation matrix with square roots of the average variance extracted values presented diagonally.

| | Conflict | Cooperative | DS-R | Fatigue | FoMo | Playing intensity | Individual | Well-being |
|---|---|---|---|---|---|---|---|---|
| Conflict | 1.00 | | | | | | | |
| Cooperative | 0.32 | 1.00 | | | | | | |
| DS-R | 0.21 | 0.15 | 0.82 | | | | | |
| Fatigue | 0.25 | 0.18 | 0.63 | 0.78 | | | | |
| FoMo | 0.23 | 0.21 | 0.55 | 0.66 | 0.79 | | | |
| Playing Intensity | 0.26 | 0.28 | 0.53 | 0.41 | 0.43 | 0.75 | | |
| Individual | 0.16 | 0.23 | 0.10 | 0.13 | 0.15 | 0.19 | 1.00 | |
| Well-being | 0.26 | 0.28 | 0.17 | 0.13 | 0.19 | 0.44 | 0.25 | 0.79 |

of the items in formative constructs, ranging from 0.10 to 0.72 (see Appendix).

Next, we measured the discriminant validity of the data. This means ensuring that the survey items of a particular construct do not measure other constructs. The correlation matrix with square roots of the average variance extracted values are displayed in Table 3. As can be seen from the table, the square root of the average variance extracted values displayed diagonally are in all cases greater than the correlation values. As also the discriminant validity of the data could be verified, we conclude that the data set has sufficient validity and reliability to provide results for the proposed structural model.

Next for our data, we wanted to check the model fit. Following the guidelines of Henseler et al. (2014) we utilised the goodness-of-fit (GoF) and standardised root mean square residual (SRMR) statistics for evaluating our model fit. First, we used SmartPLS to calculate the SRMR, for which the outcome value should be below 0.08. For our data, the SRMR was 0.06. Next, we used the Wetzels, Odekerken-Schröder, and Van Oppen (2009) equation for GoF. According to Wetzels, thresholds for this value regarding the model fit are small (0.1), medium (0.25) and large (0.36). Here our calculation yielded the value 0.50. Overall, the GoF and SRMR statistics indicate a good model fit. Hence, we could move on to obtain the structural model results.

### 4.4. Structural model results

The structural model results are displayed in Figure 2. We found DS-R to have a strong positive association with fatigue ($\beta = 0.37$, $p < 0.001$) and a negative association with well-being ($\beta = -0.10$, $p < 0.05$), thus confirming H1 and H2. This finding highlights the importance of self-regulation ability in maintaining psychological well-being and avoiding fatigue. FoMo was positively associated with gaming fatigue ($\beta = 0.45$, $p < 0.001$), but had no relationship with psychological well-being ($p > 0.05$). Thus, H3 was confirmed but H4 rejected.

We also looked at the relationships between three types of game mechanics and well-being and fatigue. Here we found that engagement with individualistic game mechanics had no association with gaming fatigue ($p > 0.05$), but a positive association with well-being ($\beta = 0.14$, $p < 0.01$), confirming H5 but rejecting H6. Similarly, we found that engagement with cooperative game mechanics had no association with gaming fatigue ($p > 0.05$), but a positive association with well-being ($\beta = 0.11$, $p < 0.01$). Thus, H7 was rejected but H8 was confirmed. The only deviation in the types of game mechanics found in this study was with the competitive game mechanics. With regards to H9, we found engagement with competitive game mechanics to have a relationship with fatigue ($\beta = 0.07$, $p < 0.05$) and with regards to H10 found engagement with competitive game mechanics to associate with well-being ($\beta = 0.12$, $p < 0.01$), thus confirming both hypotheses. The relatively small differences between the three constructs of game mechanics may be explained by the fact that most of these mechanics are intertwined in playing.

Overall, seven of the hypothesised relationships were supported. The control variable of playing intensity shows a clear overall positive association with psychological well-being ($\beta = 0.42$, $p < 0.001$) but no relationship with fatigue. The model explained 55% of the variance of fatigue and 27% of the variance of well-being.

## 5. Discussion

### 5.1. Key findings

Confirming our hypotheses, DS-R and FoMo were associated with fatigue ($p < 0.001$). DS-R also had a negative relationship with psychological well-being, however this impact was small. By contrast, FoMo had no association with psychological well-being, implying that it could be a factor only associated with negative affect such as fatigue (Stallings et al. 1997).

With regards to the three types of game mechanics, engaging with competitive game mechanics was associated with both increased psychological well-being and

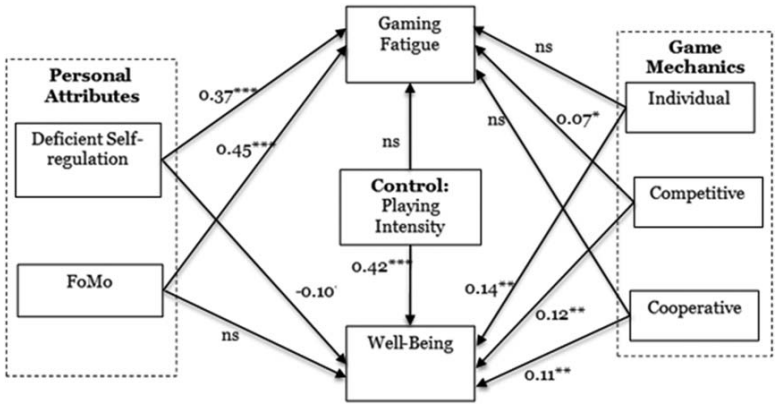


**Figure 2.** PLS analysis results (***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; ns: non-significant).

increased fatigue. This may be related to how overcoming human opponents releases the neurotransmitter serotonin and increases well-being, while losing has the opposite effect (Boureau and Dayan 2011; Vorderer, Hartmann, and Klimmt 2003). Engagement with individualistic and cooperative mechanics were associated only with psychological well-being.

Interestingly, DS-R and FoMo were much more strongly associated with fatigue than the observed game mechanics. This implies that while playing LBGs in general is a positive activity, losing control over playing (DS-R) and being compelled to play by social anxiety (FoMo) should be avoided. What makes this problematic is that several game companies are specifically leveraging FoMo to engage players. For example, the observed LBG Pokémon GO constantly pushes notifications of events with exclusive rewards (Niantic 2020). This takes control away from the player and instead of sovereign decisions on when to play, the game creator is attempting to tell players when to play. In light of our findings, this kind of marketing can be devastating to players with poor self-regulation abilities. However, further research on the topic is needed.

Finally, playing intensity had a strong positive relationship with psychological well-being, but a non-significant relationship with fatigue. This indicates that while LBGs may give birth to negative side effects such as fatigue through DS-R and FoMo, overall playing LBGs has a positive association with psychological well-being. Longitudinal studies are needed to confirm to what extent players with high psychological well-being gravitate towards playing LBGs more intensively, and to what extent a high intensity of playing leads to psychological well-being.

### 5.2. Implications to theory

Our study has three theoretical implications. First, LBG playing intensity was found to be positively associated with psychological well-being. Previous work suggests that LBGs in general may help reduce social anxiety and increase social well-being (e.g. Laato et al. 2020c; Tateno et al. 2016; Vella et al. 2019; Yang and Liu 2017). Here we contribute by showing that engagement with cooperative game mechanics is in general associated with psychological well-being. This supports other studies focusing on cooperative game mechanics in LBGs specifically (Morschheuser et al. 2017; Riar et al. 2020; Vella et al. 2019). We also identified DS-R and FoMo to be positively associated with fatigue and DS-R to also have a negative relationship with well-being. Therefore, our findings contribute to the previous studies on positive outcomes of playing LBGs, which are increased exercise and outdoor activity (Althoff et al. 2016; Laato, Inaba, and Paloheimo 2020b), positive (and surprising) life experiences (Bonus et al. 2018; Koskinen et al. 2019), learning about local surroundings (Oleksy and Wnuk 2017), practise of cartographic and navigation skills (Carbonell Carrera, Saorín, and Hess Medler 2018), increased sense of happiness (Williams and Slak-Valek 2019), improvement on psychological distress (Watanabe et al. 2017) and increased social connectedness (Vella et al. 2019).

Second, we contribute to literature on the dual outcomes of hedonic systems (Islam, Mäntymäki, and

Benbasat 2019; Yang, Wang, and Lu 2016) by showing that playing Pokémon GO was associated with both positive and negative consequences. While the overall playing intensity was significantly associated with only well-being, experiencing DS-R in the context of Pokémon GO was connected to reduced well-being and increased fatigue. FoMo in the context of playing was also linked to increased fatigue. Therefore, our findings are in line with TFT, which suggests that the drivers of positive and negative outcomes are different. These findings also relate to the perspective of obsessive and harmonious passion (e.g. Fuster et al. 2014; Vallerand et al. 2003; Wang and Chu 2007), which implies that depending on individual characteristics, players may develop either a harmonious or an obsessive passion towards the game. Here our findings highlight DS-R and FoMo as potential factors associated with obsessive passion. Thus, future work could investigate these two factors in further detail to see whether they lead to obsessive passion. Taken together, our paper contributes to the prior works that have been conducted using TFT, especially in the context of psychological well-being (Diener et al. 1999; Islam 2014; Stallings et al. 1997; Watson and Tellegen 1985)

Third, we contribute to the overall research on understanding video games as a hobby and how playing games relates to well-being (e.g. Eichenberg and Schott 2017; Halbrook, O'Donnell, and Msetfi 2019; Johnson et al. 2013; McLean and Griffiths 2013) by showing that FoMo may be linked to negative affect (fatigue) but not psychological well-being. This has implications to SDT where FoMo has been linked to the relatedness need (Al-Menayes 2016; Przybylski et al. 2013) and supplements previous studies, where FoMo has been associated with problematic smartphone use (Elhai et al. 2016; Wolniewicz et al. 2018). Overall this study contributes to the literature of the psychological impact of LBGs and helps situate the LBG genre among the rest of video games.

### 5.3. Implications to practice

One cause for the negative associations related to DS-R and FoMo may be explained by the advertisement approach adopted by the LBGs. In the case of Pokémon GO, the game not only markets in-app purchases that make personal progression in the game faster, but for example, leverages social pressure in the form of asking money to participate in social raids (Bhattacharya et al. 2019) and selling clothing and character poses for players to allow them to better express themselves (Niantic 2020). These approaches may be beneficial from the LBG developer's vantage point. However, they also need to consider the possible side effects of such measures. In fact, prior literature has pointed that fatigue may lead users to discontinue or take a temporary break from using a service (Maier et al. 2015). Therefore, the presence of FoMo and DS-R may lead to players' yielding playing altogether. Competitiveness can be engaging, but it too can lead to fatigue and consequently to the decrease in overall player retention (Song et al. 2013).

Our findings also have implications for LBG players. To increase personal psychological well-being, players need to be mindful of what aspects of the games give birth to negative affect. FoMo and DS-R seem to be invoked via constant bombardment of in-game events and news (Niantic 2020) and hence, players should not let this have an impact on their self-regulation nor reinforce FoMo. As DS-R was negatively associated with well-being and positively with fatigue, measures should be taken to counter it. There is evidence that while relationship initiation in LBGs can lead to fatigue and decreased well-being (Yang and Liu 2017), it can lead to lasting friendships that overall have a significant positive impact on the player (Bhattacharya et al. 2019; Riar et al. 2020; Vella et al. 2019). As LBGs can also be regarded as the gamification of outdoor movement (Colley et al. 2017; Hamari et al. 2019), this study has implications on how game mechanics could be used to facilitate human well-being during commuting and other necessary travel.

## 6. Limitations and future research

Research conducted on LBGs and Pokémon GO specifically have already quite exhaustively looked at reasons why people play these games (Alha et al. 2019; Hamari et al. 2019; Rasche, Schlomann, and Mertens 2017; Vaterlaus, Frantz, and Robecker 2019) as well as peeked into the behavioural consequences of playing (Alomar, Alsaleh, and Alarifi 2019; Colley et al. 2017; Kaczmarek, Behnke, and Dżon 2019; Vella et al. 2019). Our study departs from the extant work by using TFT to conceptualise a model with psychological well-being and fatigue as dependent variables. While our approach gave new insight and suggestions into how LBGs could facilitate well-being, the complexity of the research problem forced us to simplify our model and not include the many aspects which have already been addressed by previous work. Therefore, future research may build a more comprehensive research model to investigate the phenomena.

The participants ($N = 855$) of the current study were from a geographically and culturally limited area, Finland. Furthermore, data were collected in the beginning

of April 2020, when people were advised to avoid social meetings during the COVID-19 pandemic (Hellewell et al. 2020; Farooq, Laato, and Islam 2020). These two factors may have introduced some biases to the data. As a cross-sectional study, our work did not account for any possible changes in the model constructs and their relationships that may have occurred over time, for example, because of the COVID-19 pandemic. We measured psychological well-being and fatigue in the context of Pokémon GO, however, future work may measure psychological well-being more broadly. For this end, comparison studies or longitudinal studies are needed.

One of the theoretical limitations of our work is choosing fatigue as an example of the negative outcomes of playing LBGs. While fatigue certainly is a negative outcome, there are other negative outcomes such as sadness and depression (Stallings et al. 1997). Fatigue was chosen for this study because of its connection with gaming addiction (Männikkö, Billieux, and Kääriäinen 2015) and its established relationship with DS-R and FoMo (Dhir et al. 2018). However, future research may include sadness and depression as negative outcomes. DS-R and FoMo, on the other hand, were chosen as they were identified to be potential consequences of the aggressive marketing strategies identified in the case LBG. Future research could also look into how our findings may differ with regards to the big five personality factors (extroversion, agreeableness, openness, conscientiousness, and neuroticism) (Caci et al. 2019; Tabacchi et al. 2017). Finally, while we primarily looked at how playing increases well-being, it is also possible that people are playing more intensively as a result of the game increasing their well-being.

One of the important future research agendas is the confirmation of the causality of the observed relationship via longitudinal analysis. Future studies could also investigate whether similar phenomena can be seen in other video game genres besides LBGs. It is also worth considering the tradeoff between playing LBGs and doing something else. For example, with regard to exercise, LBGs have been found to be an ineffective choice (Beach et al. 2019). Finally, as LBGs are dependent on the playing location, time of day and time of year, future work could explore whether the real world environmental occurrences have impact on the findings.

## 7. Conclusions

Our results revealed a strong relationship between playing intensity and psychological well-being. This is an important finding as it suggests that those playing LBGs are generally happier. By contrast, the aggressive marketing of in-app purchases and events in LBGs may mitigate the positive effects it can increase DS-R and FoMo which were associated with the negative outcome, fatigue. Overall our findings encourage future research into the outcomes of playing LBGs and how they differ from other genres of video game. As LBG developers are constantly improving existing technology and coming up with increasingly innovative ways to tie gameplay to the real world, scholars need to work towards understanding the impact of these technologies on players and related phenomena.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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**Samuli Laato, A.K.M. Najmul Islam & Teemu H. Laine**
**Why playing augmented reality games feels meaningful to players? The roles of imagination and social experience**

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# Why playing augmented reality games feels meaningful to players? The roles of imagination and social experience

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ABSTRACT

Augmented reality (AR) games such as location-based games add virtual content on top of the real world. We investigate why playing these games feels meaningful to players by focusing on the dimensions of imagination and sociality. We theorise a structural model that we test with data collected from a global sample of players of the popular AR game Pokémon GO (N = 515). Our findings show that nostalgic feelings about Pokémon increased imagining AR content in the real world. Surprisingly, using imagination in this way was a much stronger predictor of affection towards the fictional pokémon creatures than nostalgia. The affection towards the fictional creatures, in turn, increased the meaningfulness of playing. Regarding the social factors, community identification and social self-efficacy increased players' sense of meaningfulness of playing. As our study's main design implications, we highlight the importance of socially shared narratives and harnessing the players' imagination to support a sense of meaningfulness of playing.

## 1. Introduction

Society is increasingly digitised with various cyber-physical systems, augmented reality (AR), sensors gathering data and online connectivity. AR technologies have been projected to have an increasingly significant, even disruptive, impact on our lives (Rauschnabel, 2021). Location-based AR games (LARGs) are examples of AR applications where digital content is tied to the player's geographical location. Since Pokémon GO's release in 2016, they have remained popular with new games and other AR products being released constantly. LARGs enable players to reimagine the world, adding digital content to everyday places. As LARGs mix fiction and reality to create the game world, they differ from movies and self-contained games (Liberati, 2018). Accordingly, LARGs can be conceptualised as AR layers that can be accessed with mobile devices (Jensen et al., 2019). Because technology is still limited and a believable fusion between the augmented world and our world is impossible, scholars have argued that for AR games to feel meaningful, players need to imagine and act as if the fictional game world was real (Waern et al., 2009). Surprisingly, the role of imagination has been unaddressed in several recent empirical studies on why players play LARGs (e.g. Alha et al., 2019; Ghazali et al., 2019; Hamari et al., 2019; Rauschnabel et al., 2017; Vaterlaus et al., 2019).

Using imagination while playing implies cognitive involvement, as players are actively thinking about the game world. They imagine fictional stories, and engaging with them while playing can also boost an emotional attachment to the game and its fictional world. Imagination can help ponder meaning-of-life questions by enabling exploration of the purpose of living through the playing experience, resulting in eudaimonic gratification (Oliver et al., 2016; Weise, 2004). Imagination is also connected to social processes and allows individuals to effortlessly cooperate with even those unfamiliar to them through shared fiction (Harari, 2014). To capture these aspects in AR games, in this study, we investigate how the games can create meaning for players. Individuals can find meaningfulness in utilitarian (Spreitzer, 1995) and hedonic (Oliver et al., 2016) activities. For understanding how social gameplay and players' imagination influence the meaningfulness of playing, we propose the following research question:

How can location-based AR games use imagination and social experience to increase the meaningfulness of playing them?

This study aims to fill the research gap of understanding the role of imagination and sociality in AR games by proposing a model for predicting meaningfulness in the context of the most popular LARG, Pokémon GO. The rest of this paper is structured as follows. First, we review the extant literature on meaningfulness in AR games and

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engagement with our case game Pokémon GO in particular. We present the theoretical perspective of the current study: how (1) imagination; and (2) sociality; are connected to the meaningfulness of playing. We then formalise our structural model and hypotheses, followed by the empirical study section that contains subsections on construct development, data collection and data validity and reliability. We present the results followed by a discussion section where we go through the theoretical, practical, and design implications of our findings, limitations, and future work.

## 2. Background

### 2.1. Meaningfulness in location-based AR games

Spreitzer (1995) defined meaning as a component of empowerment that describes a subjective sense of meaningfulness of an activity about the individual's pre-existing values and ideals. To understand an activity's meaningfulness, it needs to be observed in social, cultural and personal contexts (Weise, 2004). Oliver and Raney (2011) argue that meaning also has a eudaimonic dimension, connecting it to activities where life's purpose can be explored. Accordingly, meaningfulness is a broad concept. It is a subjective sense of activity being worthwhile and connects to hedonic, utilitarian and eudaimonic values. Out of these three values, hedonic and utilitarian values are most commonly present in predicting players' engagement in video games (Sharma et al., 2020). As an example, Shin (2019) used hedonic and utilitarian values to measure how AR-game players derive satisfaction, finding both to be significant predictors of satisfaction and playing intention. Some work has looked at eudaimonia in games as well (e.g. Daneels et al., 2020), but this component of meaningfulness (Oliver & Raney, 2011) has received less attention in the extant academic literature. Meaningfulness has been considered a feeling that predicts involvement (Montani et al., 2020) and engagement (Soane et al., 2013). Due to the broad definition of meaning (Spreitzer, 1995), multiple approaches for studying how games can scaffold it are needed.

One way AR games can create meaningful experiences for players is allowing them to immerse themselves in fictional worlds and impact events within that world (Oliver et al., 2016). A sense of meaning in games can also be connected to, for example, players' ability to identify with characters (Klimmt et al., 2007) and experience positive and negative emotions from their decisions within the game world (Grizzard et al., 2014; Oliver et al., 2016). According to the findings of Daneels et al. (2020), story is one of the key game elements that provides meaningful, eudaimonic experiences for players. Identification with characters in the game and story can be enhanced by imagination-supported experiencing of the consequences of the players' actions in the game world (Klimmt et al., 2007). In addition to the games' story, other real players and audiovisual experiences are important in scaffolding meaningful playing experiences (Daneels et al., 2020).

A few studies have looked into the meaningfulness of playing in the context of LARGs specifically. Arango-López et al. (2017) linked meaning in LARGs to players' experiences with the game Pokémon GO, and Wulf and Baldwin (2020) argued that a nostalgic predisposition to the Pokémon franchise (e.g. past experiences) were important in motivating players to play the game. These studies suggest that meaningfulness is connected to past experiences, way of playing, memories, and knowledge. When people are bored, nostalgia can act as an antidote to the lack of meaning (Van Tilburg et al., 2013). As nostalgia is, at its core, replaying memories and reminiscing, it has an intrinsic link to the use of imagination. This implies nostalgia can positively correlate with the meaningfulness of playing through imagination (Van Tilburg et al., 2013; Wulf & Baldwin, 2020). Contrary to video games that are contained entirely within a virtual world, the meaningfulness of playing LARGs does not limit to the LARG application itself. It is also shaped by real-world playing locations, social interactions, and playing time (Arango-López et al., 2017). Therefore, both in-game factors (gameplay, achievements, progression) and real-world factors (playing location, sociality) need to be accounted for to understand the meaningfulness of playing LARGs.

### 2.2. Engagement with pokémon GO

A concept closely related to meaningfulness and its predicted direct consequence is engagement (Spreitzer, 1995). Several studies have been conducted on user engagement with LARGs, in particular with the game Pokémon GO. These studies are displayed in Table 1. The most popularly used theory for understanding engagement with the game was the uses and gratifications theory used in quantitative (e.g. Bueno et al., 2020; Hamari et al., 2019) and qualitative (Vaterlaus et al., 2019) studies. Most of the studies in Table 1 utilised cross-sectional data. Surprisingly, only a single study (Bueno et al., 2020) measured the role of imagination, operationalised as fantasy, despite earlier work suggesting it is a crucial component in engagement with LARGs (Waern et al., 2009). However, Bueno et al. (2020) found fantasy in playing was not linked with use continuance. Yet, in one study game knowledge was identified as the most significant predictor of Pokémon GO use continuance (Jang & Liu, 2019). This finding would suggest that immersing oneself in the game story is linked to continued play. In the current study, we can explore this finding in further detail.

Despite not appearing as a predictor of engagement or use continuance in more than one study (Bueno et al., 2020), meaningfulness has been discussed in several conceptual studies, in particular on Pokémon GO. Liberati (2018) argues that while the content Pokémon GO augments on top of our reality is not part of it; it still influences it. While the AR remains in the digital realm, it can still be perceived as meaningful by players and direct their actions (Liberati, 2018). Woods (2020) gives an example of a player named Victor, who says Pokémon has been a part of his life since childhood, and he perceives them to be more than just digital objects. Pokémon GO also enables the reimagination of familiar places, transforming them into a part of the fictional world of Pokémon (Woods, 2020). Together, these two findings suggest that imagination in Pokémon GO works via supporting a connection to the Pokémon fictional narrative and the re-imagination of the players' physical environment. In summary, despite imagination and meaningfulness having received little attention in the extant literature on engagement with Pokémon GO, conceptual work (e.g., Liberati, 2018; Woods, 2020) suggests they are connected to engagement. A strong relationship between meaningfulness and engagement has also been established in the field of occupation and workplace research (e.g., May et al., 2004; Soane et al., 2013).

### 2.3. Theoretical lens of the current study

To provide a theoretical foundation for our hypotheses and structural model, in this subsection, we go through the two identified aspects contributing to meaningfulness in LARGs: (1) imagination; and (2) social experience.

#### 2.3.1. Harnessing imagination to scaffold meaningfulness

Human imagination has been shown to have at least four distinct aspects: frequency, emotional valence, complexity and directness (Zabelina & Condon, 2019). In this work, we focus in particular on the frequency of imagining the game world while playing. As discussed, most LARGs provide stories to support and engage the players' imagination. Additionally, the games support imagination by transforming real-world environments into playgrounds using AR (Jensen et al., 2019; Woods, 2020). Waern et al. (2009) stress the importance of encouraging players to pretend that the game world is real and act in the real world accordingly. This strategy harnesses the human imagination to work for the game world, fill in technology gaps, and suspend disbelief arising from unrealistic game-related content (Waern et al., 2009). Kruse (2020)

**Table 1**
Previous selected work on use intention and engagement with LARGs.

| Authors | Theoretical approach | Data | Key findings related to engagement and intention to play the game. |
|---|---|---|---|
| Alha et al. (2019) | Exploratory analysis of reasons to start, continue and quit playing | Qualitative, cross-sectional | Previous experiences and curiosity were the main reasons to start playing, while progression was overwhelmingly the most popular reason to continue playing. |
| Bueno et al. (2020) | Uses & Gratifications | Quantitative, cross-sectional | Escapism, enjoyment, social interaction, social presence and achievement predict use continuance. Fantasy does not. |
| Butcher, Tucker, and Young (2020) | Path to discontinuance for pervasive mobile games (P2D_PMG) | Quantitative and qualitative, cross-sectional | Discontinuance is not merely the flip side of use continuance, and there are several stages in which discontinuance can occur. Furthermore, not all discontinuance is permanent. |
| Caci et al. (2019) | Exploratory analysis of personality and motivation | Quantitative, cross-sectional | Highly engaged Pokémon GO players are low in agreeableness, introverted and conscientious. Social and recreational needs increase engagement. |
| Ghazali et al. (2019) | Uses & Gratifications | Quantitative, cross-sectional | Enjoyment was the most essential factor in predicting use continuance. A unique construct missing from other studies, "need to collect," predicted continued use - suggesting players might exhibit compulsive behaviour and symptoms of addiction. |
| Hamari et al. (2019) | Uses & Gratifications | Quantitative, cross-sectional, | Enjoyment, challenge, outdoor activity, nostalgia and ease of use predicted intention to reuse. |
| Jang and Liu (2019) | Uses & Gratifications | Quantitative, cross-sectional | Catching pokémon, entertainment, game knowledge and game level predicted use continuance. |
| Rauschnabel et al. (2017) | Uses & Gratifications | Quantitative, cross-sectional | Enjoyment, nostalgia, physical activity, flow and image predicted a positive attitude towards Pokémon GO, which subsequently predicted use continuance. |
| Vaterlaus et al. (2019) | Uses & Gratifications | Qualitative, cross-sectional | The most commonly given motivations for playing Pokémon GO were exploring the neighbourhood while getting exercise and accomplishing objectives. |
| The current study | Meaningfulness, sociality and imagination | Quantitative, cross-sectional | Nostalgia supports the use of imagination while playing. Imagination while playing, social self-efficacy and community identification are associated with the perceived meaningfulness of playing. |

argues that imagination is an authentic experience, which games may stimulate. Through imagination, players can experience meaningful stories, events, thoughts and ideas related to their playing (Kruse, 2020). Thus, the use of imagination can provide added meaningfulness in playing. Hedonic and eudaimonic feelings are connected to an overall appraisal of the activity's meaningfulness (Løvoll, 2019). Following Kruse (2020), experiences governed by imagination are real experiences, and therefore capable of facilitating the same hedonic and eudaimonic feeling as, for example, glacier hikes (Løvoll, 2019). In LARGs, as players are actively engaging in playing with their imagination, the use of imagination may give added meaning and increase players' affection towards the in-game content.

AR's capability to transform real-world environments into playgrounds is a central component of LARGs (Jensen et al., 2019; Liberati, 2018; Woods, 2020). For example, in Walking Dead: Our World, the marketing material includes footage of zombies invading a birthday party, and the game itself has an AR -mode where zombies can be seen walking in the same environment the player is in. These aspects, (1) including augmented content to our world that build a fictional narrative; and (2) having a specific AR -mode, are common across popular LARGs such as Pokémon GO and Harry Potter: Wizards Unite. AR's core idea is to add something more to reality, and by doing so, AR technology supports the human imagination (Stapleton et al., 2002). Players may also find this aspect as one reason to play AR games, as demonstrated by research building off the "desired enhancement of reality" construct (Rauschnabel, 2018). LARGs can introduce novel and exciting content to the otherwise familiar and uninteresting environments. Players may therefore actively seek AR games to revitalise their interest in, for example, their daily commute and outdoor exercise (Rauschnabel, 2018).

### 2.3.2. *Intersubjective beliefs and shared experience*

The ability to imagine shared fictional worlds is unique to our species (Harari, 2014). We can discuss, defend and criticise a fictional universe that only exists in stories and our shared imagination. Popular franchise brands such as Pokémon, Star Wars and Harry Potter all include mostly the same physical laws as the reality we know. They have cities, cultures, schools, and many other things familiar with the human population and twists and tweaks that make the worlds unique. We can learn the rules of these fictional universes and even criticise franchise games, movies and books that do not align with these rules. Our imagination enables us to discuss fictional worlds and imagine ourselves in them (Gotz et al., 2014). With the help of technology, we can experience audiovisual content about fictional worlds, supporting our imagination.

In prior studies, the role of social experience in player engagement has been operationalised as "socializing" (Hamari et al., 2019) and "community involvement", and "network externality" (Ghazali et al.,

2019). In the more recent study social influence was found to be a strong predictor of use continuance (Ghazali et al., 2019), while data collected from 2016 showed an insignificant relationship (Hamari et al., 2019). In LARGs with static teams, players can exhibit altruistic behaviour towards their teammates (Riar et al., 2020) and harbour negative feelings towards the opposing team members (Laato, Inaba, et al., 2021). Fear of missing out (Przybylski et al., 2013) has been found to increase players' playing intensity, and subsequently, increase their intention to play socially (Laato et al., 2020). Bhattacharya et al. (2019) conducted an in-depth analysis of temporally and geographically aligned LARG playing, which demonstrated the complexity of the technology-mediated group interactions in the context of raids in Pokémon GO. Together, these studies speak of social networking's complexity in LARGs, being a mix of technology-assisted face-to-face synchronous communication and online asynchronous communication. In this complex field of research, one aspect that has yet to receive attention is the concept of intersubjective beliefs and the construction of the socially shared game world (Harari, 2014). One measure for holistically understanding social involvement in this context is community identification (Kordyaka et al., 2020; Mael & Ashforth, 1992).

The Pokémon fictional world is controlled, regulated, and monitored by the Pokémon Company, ensuring that the brand stays logical and high quality. This world can support social collaboration better than a confusing fictional world, as logic enables players to predict others' behaviours, share experiences and connect in a harmonious way (Harari, 2014). As the logic of fictional worlds is tied to social collaboration, franchises' fans produce a strong emotional response to franchise products that go against this logic. As an example, Star Wars Episode 8: The Last Jedi was popular among new fans to the franchise, breaking stereotypes and being in many ways a fresh take on the series. However, it also broke the established laws of the fictional universe, causing outrage among older fans. Based on the concept of shared subjective worlds and intersubjective beliefs (Harari, 2014), this was primarily caused by the illogicalities in the fictional worlds having negative consequences on the unity and social identity of fans.

## 3. Research hypotheses

### 3.1. The role of imagination, nostalgia and love for nature

Nostalgia in games arises from past experiences (Harborth & Pape, 2019, pp. 1–21). These may be related to earlier games, or other experiences with the franchise. Nostalgia directs the expectations players have for new and upcoming games, and influences the way they perceive them. As the Pokémon franchise has been around since 1996 and was a global craze, especially during 1999–2001 and afterwards (Elza, 2009), a significant number of players can be predicted to feel nostalgic about it. This effect is amplified by a significant number of Pokémon GO players who reported having started playing the game precisely because of past experiences with the franchise or other AR games (Alha et al., 2019). Consequently, studies have discovered an association between engagement with the game and nostalgia (Hamari et al., 2019; Rauschnabel et al., 2017).

Nostalgia also manifests as knowledge about the game and related stories. With AR applications, nostalgia has been shown to be a stronger predictor of behavioral inspiration than, for example, the wow-effect of being impressed by the technology (Hinsch et al., 2020). This finding highlights the importance of nostalgia, and subsequently the fictional game world in LARGs. In Pokémon GO, players can have prior knowledge about, for example, the pokémon creatures and the lore of the fictional world. We postulate that this translates into increased ability and willingness to imagine pokémon creatures in the real world while playing Pokémon GO, as players have existing thought patterns which may inspire their imagination. Gomez et al. (2019) showed that having played Pokémon games in childhood correlated with brain activity in a specific region when shown pokémon creatures' images. This activity was not present with those unfamiliar with Pokémon, providing evidence for the argument that nostalgia and previous experiences with the franchise support imagination (Gomez et al., 2019). At the same time, fond memories from childhood time spent with Pokémon can help players form affection towards the pokémon creatures in Pokémon GO, or translate already formed affections into the new Pokémon game. Thus, we propose the following two hypotheses:

**H1**. Childhood brand nostalgia increases imagining the Pokémon world while playing.

**H2**. Childhood brand nostalgia increases affection towards the fictional pokémon creatures.

In 2002, Balmford et al. proposed that biophilia, the inner human desire to recognise, catalogue and spend time with other lifeforms, might explain engagement with the Pokémon franchise. In this work, we measure biophilia with love and care for nature scale (Perkins, 2010), which measures feeling closeness to nature and being content when among nature. As Pokémon GO was marketed as an AR game where people walk in nature exploring the wild to find fictional creatures, the game seems to intentionally invoke the feelings of biophilia and love for nature (Laato & Rauti, 2021). In fact, following Balmford et al. (2002), love and care for nature could direct players to imagine pokémon creatures as real living creatures while playing. Perkins (2010) proposed that humans have a varying desire to spend time in nature and care for it. People higher on the love and care for nature scale could, in addition to imagining pokémon creatures in the real world, also form an affection towards them as they imagine them as real creatures (Balmford et al., 2002). Accordingly, we propose the following two hypotheses.

**H3**. Love and care for nature increases imagining the Pokémon world while playing.

**H4**. Love and care for nature increases affection towards the fictional pokémon creatures.

People are actively engaging with their imagination while playing games (Kruse, 2020). The more frequently players engage their imagination with the fictional world, the more they think about it, and the more engaged they are (Waern et al., 2009). As proposed, in Pokémon GO this could lead to an increased affection towards the pokémon creatures. However, many other factors are also present in players' forming an affection towards games, for example, the sunk cost fallacy (Lohse, 2019), which is the human ability to perceive something as necessary simply because they have spent resources on it. Still, with imagination, players can create additional meaning to the digital creatures. Koskinen et al. (2019) showed that the memorable early moments of Pokémon GO players were often related to specific pokémon rather than rare, new or strong pokémon. Players can map the creatures to the real world, create additional stories to connect memories to specific creatures and distinguish individual pokémon from others (Koskinen et al., 2019). Pokémon GO supports the individualisation of pokémon in four ways: (1) each pokémon can be given a unique nickname; (2) each pokémon has three random individual values between 0 and 16 and a level (1–50); (3) pokémon species can be shiny or regular; and (4) some pokémon can have permanent clothing or decorations on them. Together these three factors make pokémon feel unique and allow players' imagination to further associate specific creatures with stories and experiences during play. Thus, we propose our fifth hypothesis.

**H5**. Imagining the Pokémon world while playing increases affection towards the pokémon creatures.

### 3.2. Predicting the meaningfulness of playing

Players' social perceptions and connections influence meaningfulness; it is linked to social norms, social responsibility, and the surrounding community's behaviour (Aguinis & Glavas, 2019; Chaudhary,

2019). The social aspect of meaningfulness can be approached, for example, by looking at the salaries of top athletes. The world's top football players earn millions per season because many people enjoy watching football and respect highly skilled players. By contrast, professional curling players are paid significantly less, with a rough correlation to the number of people valuing and enjoying curling as a sport. The value people give to a skill or achievement is not only monetary, and relates to social capital as well (Bourdieu, 1986). It follows that people gravitate towards activities and skills that give them social capital and other gratifications. Whether an activity feels meaningful is linked to the surrounding community and intersubjective beliefs regarding what is valuable (Aguinis & Glavas, 2019).

Previous work on Pokémon GO has discovered social interaction to lead to use continuance (Bueno et al., 2020) and sociality to increase engagement (Caci et al., 2019). However, the "socializing" construct showed a non-significant association with intention to reuse in one study (Hamari et al., 2019). For these reasons, a more detailed look into social factors is warranted. A player playing socially and being involved with the playing community can receive praise and support for playing. In contrast, a player disconnected from this community does not enjoy these social benefits (Rauti et al., 2020). Similarly, players who have high social self-efficacy and the ability to form social connections are increasingly likely to form social bonds and get praise and support for playing, leading to the increased attachment to video games and even addiction (Jeong & Kim, 2011). By contrast, if players high on social self-efficacy do not find the company from other players, the self-efficacy trait may direct them to other activities. Subsequently, they may perceive playing to be less meaningful.

While some work has differentiated between social self-efficacy in real and virtual space (Jeong & Kim, 2011), in LARGs, these abilities are intertwined while playing. Therefore, social self-efficacy and being involved with the player community in Pokémon GO can enjoy both online and offline social benefits. Simultaneously, being involved with a playing community can increase meaningfulness through shared playing experience (Daneels et al., 2020). This allows players to discuss the game with each other and have a shared activity. Furthermore, community identification enables players to form the desired self-representation of themselves, which also increases purchasing behaviour (Kordyaka & Hribersek, 2019). Because of these predicted impacts, we propose the following.

**H6**. Social self-efficacy increases the meaningfulness of playing.

**H7**. Community identification increases the meaningfulness of playing.

An emotional bond with specific pokémon and an overall affection towards pokémon creatures gives players positive emotion when engaging with Pokémon games. Players can recall events and occurrences associated with specific pokémon (Koskinen et al., 2019) and even desire to associate themselves with pokémon as they would with real-world wildlife (Balmford et al., 2002). Affectionate feelings help boost the meaningfulness of an activity (Løvoll, 2019). In Pokémon GO, this means that caring for the fictional creatures in the game makes playing feel more meaningful. It also offers gameplay mechanics that enable players to take screenshots of pokémon in various places, allowing players to showcase their favourites to others on social media (Alavesa & Xu, 2020). Having the ability to share affection socially can also boost its meaningfulness. For these reasons, we propose the following.

**H8**. Affection towards the fictional pokémon creatures increases the meaningfulness of playing.

The final proposed research model displaying all the constructs, hypotheses and control variables is displayed in Fig. 1.

## 4. Materials and methods

### 4.1. Construct development

Most of the constructs and their measurement items for this study were derived from prior literature and slightly adapted to Pokémon GO's context (see Appendix 1). We chose these measurement items, as multiple prior studies found these scales reliable. However, we could not find adequate survey items or scales for some critical phenomena, so we engaged in developing them ourselves. In doing so, we followed the construct development guidelines of Moore and Benbasat (1991). For this study two constructs were developed: (1) Imagining the fictional world (pokémon world) while playing; and (2) affection towards the fictional world (pokémon creatures).

We initially formulated five survey items per construct based on our extensive experience of playing Pokémon GO and previous Pokémon games and discussion with fellow players. Our other survey items influenced these items' wordings not to make any items stand out because of the language. After the items were drafted, we asked an

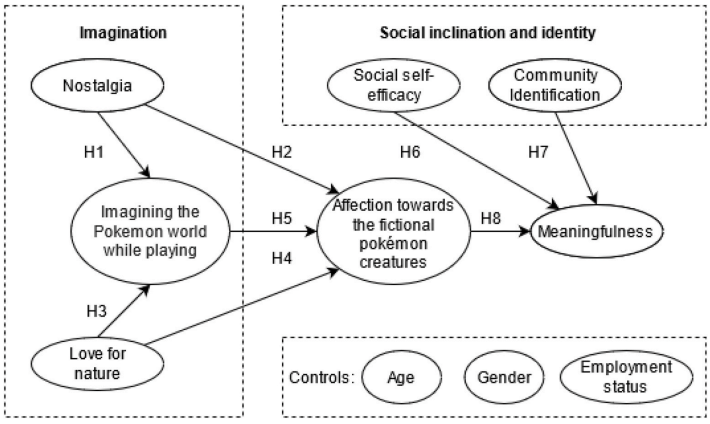


**Fig. 1.** Proposed research model.

experienced information systems researcher and two LARG researchers to comment on the items. Based on this feedback, significant changes were made to the items, particularly addressing items that were not accurately measuring the same thing. We removed items that were not describing the construct, reworded some items making them more accurate and included new items to replace the removed ones. Following the construct development guidelines (Moore & Benbasat, 1991) next, we proceeded to perform a card-sorting exercise among Pokémon GO players. We included the ten developed items and five extra items concerning territoriality and gave them to players in two small chat groups, asking them to sort the items into clusters based on what they were measuring. Four players responded, and at this stage, the only items that were always placed together were the extra five items. Because of the variance in how players viewed the items, we decided to rework these items to be more narrow and precise.

After consulting a senior information systems scholar again and discussing the card-sorting exercise with participants about the items, another card-sorting exercise was performed with Pokémon GO players who did not participate in the first round. This time, the five extra items were removed. Thus, ten new revised items were included. Three Pokémon GO players participated in sorting the items, and this time, two groups emerged among two of the participants (full agreement) while the third formed three categories. The items were again reworked together with the experienced scholar and renamed a little until the constructs' final five survey items were agreed upon. The rest of the constructs we adopted from previous literature: love and care for nature (Perkins, 2010), childhood brand nostalgia (Harborth & Pape, 2019, pp. 1–21), meaningfulness (Spreitzer, 1995), social self-efficacy (Jeong & Kim, 2011), community identification (Mael & Ashforth, 1992).

### 4.2. Data collection

The survey containing the items of the constructs was implemented using a professional online questionnaire service, Webropol. Additionally to the survey items (available inAppendix A) for our constructs, we included a small introduction to the beginning of the survey, explaining to respondents why the study was carried out and what we would do with their data. Before distributing the survey further, we sent it to a small (n = 15) Pokémon GO group. We asked participants to comment on the understandability of the survey and point out any mistakes they could find. The group's minor adjustment recommendations were taken into account, and afterwards we proceeded to the main data collection.

To get reliable global data from Pokémon GO players, the popular/r/pokemongo subreddit was chosen as a suitable venue. We contacted the moderators and kindly requested them to pin our survey to their frontpage for increased visibility. We explained the study's purpose and offered to answer any question they might have regarding the survey. The moderators complied with our requests and assisted us by pinning the survey to the/r/pokemongo subreddit on June 24th, 2020. The survey remained pinned until June 29th, 2020. During this data collection period, we replied to whatever questions Redditors had on the survey to the best of our ability. We also upvoted all comments to encourage commenting. Our post concerning the survey was upvoted by 96% of Reddit users who gave either an upvote or a downvote, indicating wide community acceptance. Responses with incomplete data were removed, and finally, we were left with 515 responses. The demographic data of participants are shown in Table 2.

### 4.3. Validity and reliability

Once the data was collected, we proceeded to test the convergent and discriminant validity. First, we calculated the average variance extracted (AVE) and composite reliability of the constructs for measuring convergent validity. Following the widely accepted criteria of Fornell and Larcker (1981), AVEs have to be above 0.5 and CRs above 0.7. These analysis results are shown in Appendix 1, together with the construct items and their loadings. All our constructs fulfilled the criteria of convergent validity. We then measured the discriminant validity of the data by calculating the square root of the AVEs of our constructs. Following Fornell and Larcker (1981), we checked that the square root values of the constructs' AVEs are greater than any correlations between constructs. Table 3 displays the results of this analysis. Based on these analyses, we confirm that our data fills the criteria for convergent and discriminant validity.

**Table 2**
Demographic data of participants.

| Gender | | Employment status | |
|---|---|---|---|
| Male | 66% | Employed | 52% |
| Female | 31% | Student | 32% |
| Non-binary | 2% | Unemployed | 12% |
| Prefer not to tell | 1% | Stay-at-home parent | 1% |
| | | Other | 1% |
| **Age** | | **Country of residence** | |
| 18–25 | 48% | USA | 43% |
| 26–34 | 36% | UK | 12% |
| 35–44 | 10% | Finland | 10% |
| 45–64 | 5% | Canada | 6% |
| Over 65 | 15 | Germany | 3% |
| | | Other | 26% |

In order to see how well the proposed structural model fits the data, we calculated the goodness-of-fit (GoF) and standardized root mean square residual (SRMR) statistics (Henseler et al., 2013). With regards to GoF, we followed the formula and thresholds provided by Wetzels et al. (2009). Here, a GoF value above 0.36 can be considered a good fit. With our data, GoF was 0.44, indicating a great fit. According toHu and Bentler (1999), SRMR should be below 0.08 for the model to be a good fit for the data. The SRMR value in this case was 0.07. Subsequently, following the validity, reliability and model fit tests, we proceeded to calculate the structural model results.

## 5. Results

The structural model results are displayed in Fig. 2. Childhood brand nostalgia (Harborth & Pape, 2019, pp. 1–21), operationalised as having played Pokémon games, played with Pokémon figures or watched Pokémon movies as a child, had significant relationships on both imagination while playing (beta = 0.32; $p < 0.001$) and affection towards the fictional pokémon creatures creatures (beta = 0.15; $p < 0.001$), thus supporting H1 and H2. Love and care for nature (Perkins, 2010) had a significant relationship on imagining the Pokémon world while playing (beta = 0.19; $p < 0.001$) but no direct relationship with affection towards the pokémon creatures (beta = 0.05; $p > 0.05$). The support for H3 but lack of support for H4 suggests that enjoying nature and caring for it enables players to better imagine pokémon in the real world environment, but does not directly lead to the formation of affection towards these virtual creatures. This seems to contradict Balmford et al. (2002), who postulated that the Pokémon franchise invokes biophilia and the love for nature in humans by presenting them with creatures to identify, collect and catalogue. Instead, our findings suggest that a love for nature enables players to imagine the location-based fictional world of Pokémon better and develop affection towards pokémon only through imagination.

While playing, imagining the Pokémon world had a strong significant impact on forming an affection with the pokémon creatures (Beta = 0.42; $p < 0.001$), supporting H5. This aligns with Waern et al. (2009). They postulated that in the context of LARGs, one of the essential elements for creating engaging location-based AR gameplay is harnessing the players' imagination by motivating players to pretend as if the game they were playing was real.

With regards to the social aspects of location-based gaming, social self-efficacy (beta = 0.17; $p > 0.001$) and identification with the players'

**Table 3**
Latent variable correlations (Square roots of AVEs).

| | Affection towards the fictional pokémon creatures | Childhood brand nostalgia | Imagining the Pokemon world while playing | Love and care for nature | Meaningfulness | Social self-efficacy | Team identification |
|---|---|---|---|---|---|---|---|
| Affection towards the fictional pokémon creatures | 0.824 | | | | | | |
| Childhood brand nostalgia | 0.283 | 0.942 | | | | | |
| Imagining the Pokemon world while playing | 0.475 | 0.325 | 0.808 | | | | |
| Love and care for nature | 0.130 | 0.008 | 0.193 | 0.847 | | | |
| Meaningfulness | 0.493 | 0.138 | 0.374 | 0.073 | 0.843 | | |
| Social self-efficacy | 0.179 | 0.090 | 0.187 | 0.086 | 0.337 | 0.817 | |
| CommunityIdentification | 0.325 | 0.211 | 0.283 | 0.108 | 0.410 | 0.430 | 0.778 |

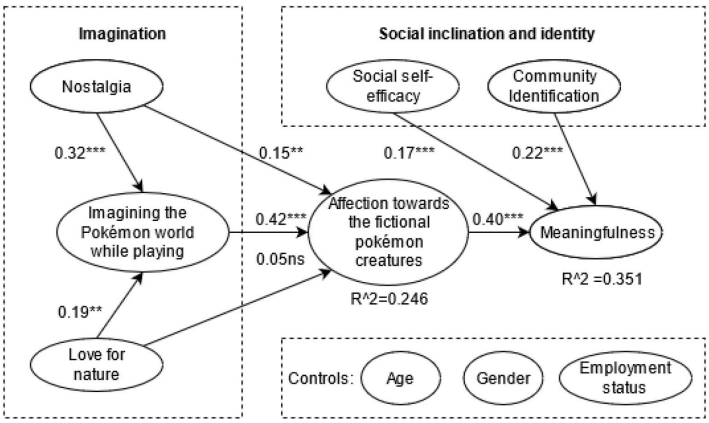


**Fig. 2.** Results of the structural model. (***p < 0.001; **p < 0.01; *p < 0.05, ns = non-significant).

team/community (beta = 0.22; p > 0.001) had substantial effects on the meaningfulness of playing. Thus, H6 and H7 were supported. Based on our theoretical reasoning, these findings can be partially attributed to the social sharing of the fictional stories and ideas relating to the Pokémon world. In the same way, as money gets its value from people believing in it (Harari, 2014), Pokémon GO gains additional meaning in the eyes of players due to other real players playing it. This finding is in line with Daneels et al. (2020).

Finally, affection towards the pokémon creatures had a strong significant effect on the meaningfulness of playing (beta = 0.40; p < 0.001). Therefore, H8 was supported. This finding shows that being emotionally invested in caring about one aspect of the game (the pokémon creatures) translates to an overall increase in playing's meaningfulness. Out of the control variables, only age had an impact in that an older age was positively associated with the meaningfulness of playing (beta = 0.12; p < 0.05). The rest of the control variables' effects were insignificant.

## 6. Discussion

### 6.1. Theoretical implications

Our findings provide empirical support for the previous work on LARGs which suggest that imagination is a key factor in making playing feel more meaningful (Waern et al. (2009). We demonstrated that projecting oneself to the game world (through imagination) was significantly associated with affection towards in-game creatures, which subsequently led to increased meaningfulness of playing. Among the predictors of meaningfulness, affection towards the fictional pokémon creatures was the strongest. This may be explained by Pokémon GO being fully focused on the pokémon creatures, with all activities being somehow tied to collecting or training them, or battling with them. The social component of the game is voluntary for players, and that too mostly serves to help players collect more powerful pokémon and win more difficult gym and raid battles (Bhattacharya et al., 2019).

Van Tilburg et al. (2013) suggested that nostalgia can act as an antidote to boredom by creating meaningfulness. Similar findings have also been reported in the context of Pokémon GO (Wulf & Baldwin, 2020). Relatedly, Jang and Liu (2019) found that knowledge of the Pokémon world is the most significant predictor of continued use. Our model contributes to these works by showing that nostalgia leads to increased ability and willingness to imagine the AR world while playing. Hence, imagination in playing is a crucial component that connects players' knowledge about the game world and prior experiences (nostalgia) to the meaningfulness of playing (Jang & Liu, 2019; Van Tilburg et al., 2013; Wulf & Baldwin, 2020).

Previous work on engagement with LARGs have used the uses & gratifications theoretical approach (Bueno et al., 2020; Ghazali et al., 2019; Hamari et al., 2019; Rauschnabel et al., 2017) and qualitative exploratory analysis (Alha et al., 2019). While these approaches have accounted for the role of nostalgia (e.g. Hamari et al., 2019), they directly measure its relationship to use continuance intention. We propose and show that nostalgia, at least in the Pokémon franchise context, has effects on meaningfulness through imagination and increased

affection towards the game content. Previous work (e.g. May et al., 2004; Soane et al., 2013) have demonstrated that meaningfulness and engagement are strongly correlated. Accordingly, our work may be compared to the literature on engagement with LARGs. This comparison is shown in Table 1, where the findings of the current study are depicted as the last row. Furthermore, we extend the previous work on engagement with LARGs by suggesting meaningfulness as an essential variable for predicting engagement in AR games.

### 6.2. Practical implications

The finding that meaningfulness of playing can be scaffolded via social factors and imagination has practical implications for stakeholders who wish to increase player engagement with their products. Players themselves may wish to voluntarily increase their engagement with LARGs, as previous research has identified several benefits of playing these games including mild exercise (Hino et al., 2019), social interaction (Bhattacharya et al., 2019; Laato et al., 2020; Vella et al., 2019), learning about local geography (Laato, Rauti, et al., 2021) and supporting cartographic knowledge and navigation skills (Colley et al., 2017). Studies have further suggested that LARGs could help with social withdrawal and increase wellbeing (Ewell et al., 2020). Therefore, voluntarily increasing engagement with LARGs might be recommendable, and for this, our model provides two recommendations. First, players can actively seek social relationships among fellow players and engage with the community. Second, players can engage in the game more with their imagination.

One implication of the finding that social self-efficacy increased meaningfulness of playing is that introverted people and others uninterested in the social aspect of LARGs might perceive the games to be less meaningful. However, because LARGs mix online and offline social self-efficacy (Jeong & Kim, 2011), players may decide to be active either in live situations or online. Viewing our findings together with previous work on sociality in LARGs, which universally report the games to increase social connectedness (e.g. Bhattacharya et al., 2019; Laato, Inaba, et al., 2021; Riar et al., 2020; Vella et al., 2019); we suggest that the shared subjective belief and understanding of the Pokémon world is an essential component that brings players together and makes playing feel more meaningful. This, together with our findings, highlight the importance of sharing game experiences with others, and implies that this can be supported with a coherent and logical fictional narrative. As is the case with the Pokémon, this narrative can be part of a larger cross-media experience where various franchise products from movies to merchandise extend and build the fictional world.

### 6.3. Design implications

Our findings support game design and contribute to the debate about what we are missing in our current society compared to the hunter-gatherer societies and how game design could address this. This was evidenced by our findings on the love and care for nature scale and the affection towards the pokémon creatures. Previous work has also suggested that the Pokémon franchise utilises the hunting and gathering aspects of the hunter-gatherer society (Laato & Rauti, 2021). Another thing oftentimes missing from urban life is natural physical activity and travelling to new places, which Pokémon GO also addresses (Colley et al., 2017). While this was not in particular focus in our empirical work, the summary of previous literature on engagement with the game (Table 1) suggests that these factors are deemed valuable by the players (Hamari et al., 2019; Rauschnabel et al., 2017; Vaterlaus et al., 2019).

For game designers, to engage players, LARG should focus on scaffolding an emotional bond between the game and the players. To do so, designers can make use of, for example, evolutionary psychology by harnessing players' love and care for nature (Perkins et al., 2010; Balmford et al., 2002) and imagination (Kruse, 2020) to fill in gaps in the game world. This can make the game feel real despite limitations in technology. As a consequence and as AR technology develops, it may start to replace physical objects (Rauschnabel, 2021). Designers can make use of new technology, but ensure it does not get in the way of a logical narrative, players' imagination and their social relationships. Thus, at least in the current stage, AR should be used to support, not replace human imagination.

### 6.4. Limitations

Our empirical study has the following limitations. To study our research topic, we had to narrow the study to a single LARG, which we decided to be Pokémon GO. This brings into question whether the findings can be generalised to cover other similar games. While earlier work has suggested this can be done to some extent (e.g. Hamari et al., 2019), there are specificities to Pokémon GO that need to be disclosed. First, the Pokémon brand and narrative fits particularly well with adventure and exercise. Second, as a long-standing popular franchise, Pokémon is unique in invoking nostalgic feelings in players (Harborth & Pape, 2019, pp. 1–21). Third and finally, the Pokémon world uniquely leverages primal human instincts (Laato & Rauti, 2021), such as biophilia (Balmford et al., 2002). To address the limitation of generalisation, we encourage future work on the topic of imagination and perceived significance in LARGs to study a wider variety of games.

Another limitation is that the cross-sectional data to test the research model was collected from self-selected participants through the/r/pokemongo subreddit. This might have introduced some bias to our findings despite tests on the validity and reliability of the data and the use of standard control variables (age, gender, education level). To address this limitation, longitudinal field data could be collected. Our structural model was heavily contextualised to Pokémon GO in order to account for nostalgia and imagination. While similar phenomena are sure to be present in other LARGs, the structural model itself should not be generalised into other contexts without review. Still, our findings pinpoint essential aspects that have been widely dismissed in the extant literature on engagement with LARGs.

### 6.5. Future work

The measure of meaning used as a dependent variable in our model is particularly interesting in studying engagement and gratification with video games. In addition to utilitarian and functional value, it encompasses eudaimonic gratification (Weise, 2004). Meaningfulness can be regarded as a particularly tricky question for unemployed or otherwise marginalised groups. In our sample, 12% of participants were unemployed. While employment did not significantly correlate with meaningfulness, future work may explore how LARGs could create meaning to those players who have none. While we measured meaning as a whole, aspects of it could be studied separately. For example, the concept of eudaimonic gratification can be used to study how games create meaning that extends beyond temporary value.

Another dimension for future work arising from our findings is the role of imagination in engagement (related to meaningfulness) with LARGs. In their exploratory factor analysis of imagination items, Zabelina and Condon (2019) arrived at four distinct clusters: (1) frequency; (2) emotional valence; (3) complexity; and (4) directness. Based on their findings, they argue that imagination should not be measured as a single construct. Instead, specific aspects of imagination should be measured (Zabelina & Condon, 2019). As our scale for imagination captures the first dimension, frequency, in the context of playing the AR game Pokémon GO, future work could explore the remaining three dimensions' roles. Future work studying the role of imagination could also draw from a more comprehensive AR-games sample to provide more generalisable findings. As LARGs remain popular, new implementations are constantly released and new technological innovations are developed, scholars need to see how findings from previous research translate into the new contexts.

## 7. Conclusion

In this work, we investigated social factors' and imagination's role in scaffolding the meaningfulness of playing AR -games. Our work suggests that the human ability to imagine is boosted by nostalgic experiences and a predisposition (such as the love and care for nature trait in our case) towards the AR content. We further show that nostalgia and imagination while playing increased affection towards the in-game fictional content. This affection and the measured social factors all significantly predicted the meaningfulness of playing. However, as our model explains, 35,1% of the meaningfulness construct variance, further work on perceived meaningfulness in AR games is warranted. In the near future, as new technological developments occur, we may see an increasing amount of physical objects replaced with AR technology and completely new AR experiences and games. Amidst these developments, we posit that AR technology should aim to support human imagination and build experiences that can be socially shared and understood.

## Appendix 1. constructs, corresponding items, CRs, AVEs and loadings/weights

| Construct | Corresponding items | Loadings |
|---|---|---|
| Love and care for nature scale (Perkins, 2010) | LCN1: I feel joy, just being in nature. | removed |
| CR: 0.884 | LCN2: I feel that closeness to nature is important for my well-being. | 0.704 |
| AVE: 0.718 | LCN3: I feel content and somehow at home when I am in unspoilt nature. | 0.919 |
| | LCN4: When in natural settings, I feel emotionally close to nature. | 0.884 |
| | LCN5: I feel spiritually bound to the rest of nature. | removed |
| Affection towards fictional pokémon creatures (self-developed) | PHB1: The pokémon I've trained and battled with have no special meaning to me. (reversed) | 0.811 |
| | PHB2: I have formed a bond with the pokémon I've trained. | 0.889 |
| CR: 0.894 | PHB3: There are some pokémon I would rather not trade away because I have an emotional attachment to | 0.788 |
| AVE: 0.680 | them. | 0.805 |
| | PHB4: I feel that the pokémon I've trained and used are unique individuals. | removed |
| | PHB5: I have memories related to specific pokémon I've collected. | |
| Childhood brand nostalgia (Harborth & Pape, 2019, pp. 1–21) | CBN1. I have fond memories of Pokémon from my childhood. | 0.940 |
| | CBN2. Pokémon features in happy memories of when I was younger. | 0.949 |
| CR: 0.969 | CBN3. I still feel positive about Pokémon today because it reminds me of my childhood. | 0.939 |
| AVE: 0.888 | CBN4. Pokémon is one of my favourite brands from my childhood. | 0.940 |
| Imagining the game world while playing (self-developed) | IMG1: I often visualise pokémon living in the real world environment I am playing in. | 0.837 |
| CR: 0.904 | IMG2: Imagination is a big part of my Pokémon GO playing experience. | 0.821 |
| AVE: 0.653 | IMG3: I view myself as a pokémon trainer when I'm playing. | 0.818 |
| | IMG4: I sometimes imagine my buddy pokémon walking beside me. | 0.812 |
| | IMG5: I don't think about nor immerse myself in the pokémon world when I'm playing. (reversed) | 0.750 |
| Community identification (Mael & Ashforth, 1992) | CI1: When someone praises my Pokémon GO team, it feels like a personal compliment | 0.786 |
| CR: 0.821 | CI2: I feel I am a typical member of my Pokémon GO team. | 0.718 |
| AVE: 0.605 | CI3: My Pokémon GO team's successes are my successes. | 0.825 |
| Social Self-efficacy (Jeong & Kim, 2011) | SSE1: I can easily become friends with other Pokémon GO players. | 0.828 |
| CR: 0.857 | SSE2: I often participate in community activities such as legendary raids. | 0.757 |
| AVE: 0.667 | SSE3: I love to meet unfamiliar people while playing Pokémon GO. | 0.811 |
| | SSE4: It is not important for me to meet other people while playing Pokémon GO. (reversed) | removed |
| Meaningfulness (Spreitzer, 1995) | P_SIG1: Playing Pokémon GO is meaningful to me. | 0.867 |
| CR: 0.881 | P_SIG2: My playing and how I play Pokémon GO is personally meaningful to me. | 0.863 |
| AVE: 0.711 | P_SIG3: I am doing something meaningful when I play Pokémon GO. | 0.797 |
| | P_SIG4: I feel levelling up and collecting things in Pokémon GO is worth my time. | removed |

## Credit author statement

Samuli Laato: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Validation, Writing – original draft preparation, Writing – review & editing. Sampsa Rauti: Writing – original draft. A.K.M. Najmul Islam: Supervision, Writing – review & editing. Erkki Sutinen: Supervision.

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