Design Framework for Social Interaction with Location-based Games

Fonseca, Xavier; Lukosch, Stephan; Brazier, Frances

DOI
10.17083/ijsg.v9i1.481

Publication date
2022

Document Version
Final published version

Published in
International Journal of Serious Games

Design Framework for Social Interaction with Location-based Games

Xavier Fonseca[1], Stephan Lukosch[2], Frances Brazier[3]
[1]*Polytechnic Institute of Porto, Portugal, xavier.fonseca@portic.ipp.pt*
[2]*HIT Lab NZ, University of Canterbury, New Zealand, stephan.lukosch@canterbury.ac.nz*
[3]*Delft University of Technology, Netherlands, f.m.brazier@tudelft.nl*

Abstract

Location-based games invite players to have new forms of meaningful social interactions with others and provide opportunities for players to engage with their own neighbourhood's public space. Earlier research on user requirements for such games have identified seven different activity types that have proven to initiate social interaction and capture real life exchanges for meaningful play-based social experiences. Yet, current understanding on what makes these games successful in such endeavours is still insufficient. This study furthers current understanding on the effects of location-based games for social interaction in local communities: it studies the forms of social interaction that the previously identified seven types of game activities elicit by analysing the nature and types of the exchanges they trigger. Based on this analysis, a design framework is proposed to 1) analyse existing location-based games and describe the forms of social interaction they trigger, and 2) help practitioners design new game activities that target specific forms of social interaction. This contributes to the enhancement of current understanding on the impact that these games can have in local communities, and on the way they can be better designed and used to promote social exchanges that are desired by players.

Keywords: *Location-based; Digital; Games; Social Interaction; Public Space; Design Framework.*

1 Introduction

Digital location-based games (LBGs) are a relatively new type of game that distinguish themselves from traditional ones [1]: they expose players to the real world and invite them to both actively engage and interact with their physical surroundings through digital technology [2]. LBGs invite new forms of play that are based on a blend between digital and physical environments, where the real surroundings of players are involved in a "fun" and "serious" way [3-11]. Their ability to merge the fictitious and the real environment of players make them a very capable tool to address existing societal challenges in a unique way [12]: they invite players to have meaningful social interactions with others, and provide opportunities for players to engage with their own neighbourhood's public space. Meaningful interactions have shown to provide a means to approach diversity and help address local levels of resilience, which carries the potential to impact players' sense of belonging in local communities and influence their local cohesion [11, 13, 14].

The way LBGs can best sustain and mediate such meaningful social exchanges in local communities is being researched but is still at an early stage. On the one hand, researchers argue that for individuals to experience meaningful play-based social experiences, these need to be designed around players' preferences and desires [11, 15]. Yet, common practice

in game design is still not participatory in nature: methods exist for end-user involvement [9, 16-22], but the development of such games is often based on ideas generated during in-house brainstorming by game designers [21], from insights found in the literature, or on a designer's/developer's personal experience [23-27]. On the other hand, although the potential of LBGs to promote meaningful social interaction has been recognized [23], knowledge on the implications for the design of such games is limited. From a technical perspective, the way such games have been created resembles a trial and error approach, where LBGs designed are put to test to validate previously made design choices and assumptions from game design practitioners [11]. Current research does not agree on guidelines for the design of games for specific behavioural change such as social interaction [28-31] or playful behaviour [32]. Knowledge at various levels is lacking and has yet to be brought together in cohesive guidelines, ranging from game design and design patterns [33-36], to game worlds and the game components and processes needed for very specific gameplay [1, 9, 11, 15, 16, 26, 37], and to the technical implications for system functionality [11, 14, 15, 38] and architecture [1, 37, 39, 40]. These are issues that hinder practitioners in the development of LBGs that can successfully invite players to social exchanges of quality, given that existent guidelines are disperse, not cohesive, and are mostly not based on what players want and prefer playing.

This paper addresses some of the knowledge gaps identified: the 1) lack of understanding about the relationship between game design choices and their probable implications; and 2) the lack of knowledge on how best to design for social interaction that matters to local neighbourhoods. It contributes with knowledge relevant to these issues by leveraging on what is known about types of activities that players wish to play in location-based games [14, 38], and the theory of social interaction. These insights lead to the characterization of the forms of social exchanges that the known types of activities that are preferred by adolescents and adults are expected to trigger: do physical exertion (Athlete), propose creative solutions (Inventor), search for factual knowledge (Detective), engage with the neighbourhood and random people (Explorer), find specific people or objects (Hunter), create artwork and share it (Artist), and contribute towards a better community (Volunteer) [11, 14, 15, 38, 41].

With such analysis, the following research question is asked in this paper: **can a theoretical design framework be proposed to describe the forms of social interaction that specific user-centred game ideas are expected to trigger, and be used in practice?** In addressing this question, this study aims at proposing a theoretical design framework to 1) analyse the forms of social interaction that existing LBGs trigger, and 2) help practitioners design new game activities that target specific forms of interaction. This study validates the proposed design framework and presents a research design where adolescents are exposed to their neighbourhood and co-design content for LBGs in the future. The resulting game ideas of the case study are then analysed to understand the applicability of the design framework in describing the several forms of social interaction contained in the participants' ideas.

Section 2 covers the current State of the Art on existing guidelines on how to prepare LBGs for social interaction in public space, as well as preparing games for specific behaviour. Section 3 presents a definition of social interaction and a characterization of the forms it can manifest, presents the previously researched seven types of activities that are central to this study, and proposes the design framework that is based on these. Section 4 presents the research design used to put the design framework into practice, and analyses how practical the proposed design framework is on actual game ideas for LBGs. Sections 5, 6 and 7 discuss findings, present limitations, and conclude the article.

2 Background

Existing research on games is vast and spread across numerous game genres and aspects. This background section focuses on 1) what is known so far about game design guidelines and requirements that can be used to design a game specifically for social interaction in public space, and on 2) existing theory on game characteristics leading to specific behaviour (such as social interaction) through games. This background check is relevant to understand what is known about the effects that games can have both for individuals and local communities through interaction-based playful experiences, how games have been prepared to trigger such social exchanges, and to highlight current gaps in knowledge.

2.1 Guidelines and requirements specific to social interaction

Beyond the work developed by the authors on player-centred activity types for social interaction in LBGs (section 3), there are only a few design guidelines or "design implications" that can be associated to LBGs designed specifically for the promotion of social interaction in public space. A few studies come close to this by focusing on famous LBGs [42] and their social impact [43, 44], which offer "design implications" on social outcomes that can have a direct effect on social interaction [44-46]. These are centred on what players have informed, and include the design recommendations: using points of interest and walking to instigate social dynamics [45], and using any localised multiplayer game mechanic (e.g., trading and raids) to support social bonding [46]. These design recommendations seem to be untested, though, and stem uniquely from the most famous LBGs (e.g., Pokémon Go and Google Ingress). This means these studies lack support and are limited by the design space offered by the selected games.

Beyond the studies identified above, the reminiscent literature does not offer gameplay requirements that focus specifically on this type of game, and for the mentioned social interaction. Standard practice for the creation of commercial games is to deploy a play-centred development approach: the early-stages of requirements elicitation and game conceptualization are done "in-house", and future players are only involved to play-test the game. As result, tacit knowledge on the game creation is not made explicit and is not publicly available [47]. Most design recommendations stem either from literature [23-27, 48-54], game analyses [9, 45, 55-57], or the making experience of designers in the field [18, 24, 58-60], and spread across types of games that are mostly different from LBGs: mobile games in general [9, 16, 26], serious games [51, 61-63], movement-based exergames [18, 24, 25, 60, 64-68], online gaming sites [69], electronic computer games [23, 52, 57], mobile multiplayer (AR) games [49, 50, 56, 59], massive multiplayer online games [70], non-digital multiplayer games [53], and AR (augmented reality) indoor-based games [17, 27, 58, 71]. Most of the work does not specifically target LBGs for social interaction in public space, nor are they based on what players would like and desire to play (they are play-centric versus player-centric) [45, 47, 68, 72, 73]. An exception exists, where player-centred guidelines for online social interaction are offered [69].

Even though this is the case, such literature still contributes to better comprehending the different ways that interaction has been triggered in the most varied studies. Even though the most conveniently deployed way of interaction in games is digital [51], researchers consider that out-of-the-digital-game communication is key for outdoor-based play [56], and that social interaction can be seen as a purposeful bilateral communication that is either stimulated (required by the gameplay) or natural (emergent) [53]: stimulated communication can be triggered via mechanics such as (a)synchronous competition/collaboration, whereas natural face-to-face communication can emerge through meta-gaming (activities parallel to the main game) [9]. For play in the outer world, research suggests balanced gameplay between the digital and the real world is recommended [26, 27, 59], and proposes that social interaction is best triggered when involving play settings allowing for the full range of exchanges between people (players or

not) [17, 23, 48]. Further tacit recommendations are in line with the inclusion of players of different generations and tangible objects, as they enable novel play experiences that have the power to expand what is currently known about interaction [58]. Yet, exceptions exist to such tacit knowledge and must be considered in isolation, e.g., in case of citizen's impairment [63].

This paper argues that such body of research (even the one on LBGs) does not focuses on LBGs promoting social interaction, nor does it focus exactly on social interaction. Research covers guidelines, requirements, and recommendations for the most varied topics, which can be associated to but are not exactly on LBGs for social interaction (e.g., exertion, impairment, education of social skills, and indoor gameplays with stationary media). Even though relevant knowledge is starting to appear (e.g., on tensions of design for social outcomes), the lack of guidelines for social interaction in public space, together with mostly non-player-centred insights, are issues that hinder the proper development of LBGs that trigger meaningful social experiences. An LBG that fails to expose players to the forms of social interaction they are most comfortable experiencing will struggle in engaging users [41]. This is particularly relevant when the motivation for such games is strengthening local social cohesion and sense of belonging in a player's local community [13].

2.2 Designing games for social interaction as specific behaviour

Research has actively been trying to study the strategic applicability, usefulness, and impact of specific design choices on games, and particularly on those developed for serious purposes, as these can have positive and negative effects on players [74]. Knowledge gathered includes the values that designers should have in mind when designing games for purpose [74-80], the applicability of games in specific domains [81-83], and design recommendations for serious games to be built for specific domains that are most often successful [44, 64, 84, 85]. Research has also focused on the values that are important for serious games and gamified tools, which range from traditional usability goals such as efficiency, learnability, good utility, and ease of use [74], to values such as fun [75], play and playful experiences [76, 77], motivation [78], emotional fulfilment [79], and learning [80]. Games have been successfully used to impact players and invite them to experience specific behaviour change ranging from citizen engagement with their surroundings [41], to behavioural change (e.g., in entertainment, competition, or education) [43, 81, 86]. Even though not targeting social interaction in public space, the numerous arrangements of game elements and more complex game components have led to motivational and behavioural changes (such as graphics, rules, storylines, or levels) [87, 88], and comprehension on what drives player engagement is slowly emerging [44, 45]. This does affect social interaction, and such knowledge does contribute to an understanding of individuals and their relationship with games, that assists researchers in understanding how to keep designing games for individuals to relate socially with one another and engage with their surroundings [11, 89].

Still, the lack of understanding about games and the relationship between design choices ↔ implications is substantial. Despite decades of efforts done to 1) demystify games, 2) their impacts on players, and 3) what game components work for given purposes [74, 75, 88, 90-92], it is still unclear how to best design for specific behavioural change or outcome [11, 15, 81, 93]. No agreement exists on whether, for example, a game with specific characteristics (e.g., a violent game) leads to specific player conduct (e.g., being violent) [81, 94-97]. This is an issue, as preparing game-based experiences for meaningful social interaction in public space is person-dependent, and mandates consideration of the impacts that certain design choices have in local communities [11, 13, 15, 38, 41]. For example, studies cover social interaction in games only as digital/face-to-face but fail to provide an in-depth analysis on the forms that such social exchanges can have. Such gap in current knowledge hinders practitioners in tailoring gameplay experiences around desired social outcomes, as they do not fully understand the dynamics their game design choices trigger, and how these can best be used.

3 Theoretical framework to design for social interaction in LBGs

In this section, we describe the process of theoretically deriving a design framework to describe the forms of social interaction in LBGs. It starts off by defining the construct of social interaction used in this study and characterizing the nature and types of interaction that LBGs enable. Then, it analyses and proposes a theoretical association between user-centred activity types for LBGs fostering social interaction, and the respective forms of social interaction they are expected to promote. With this analysis, the section derives the design framework that is presented in Figure 2.

The method used to produce the theoretical design framework is that of research through design (RtD) [98-100], as a way to construct the truth (the description of social interaction) from different viewpoints (the theories associated to social interaction, with identified user-centred forms of play afforded by LBGs) [98].

3.1 Definition of social interaction

The definition used in this research for social interaction is "***a social exchange between individuals***", i.e. a dynamic and reciprocal exchange of social actions and reactions [101]. These exchanges are defined as "social processes" that contain several characteristics (e.g., purpose, repetition, structure, direction, and quality). Interaction can happen between oneself (intrapersonal), person to person, person to group, and between groups: the intrapersonal interaction is seen as having zero degree of social interaction (i.e. social isolation), whereas the other forms of social interaction (between 2 or more individuals/groups) display different degrees of intensity of social exchange [14, 102]. The forms of social interaction are defined in the literature based on their **nature**, and **type**.

3.2 Nature of social interaction

The nature of social interaction is defined by literature as **focused** (i.e., people with common goals, e.g., a group) and **unfocused** (i.e., no common goal, no familiar or common aspects, even during the process of interacting) [102-106]. Definitions used in this research for focused and unfocused interaction are the ones originally published by Bartis [102] and Goffman [107, 108]:

> "**Focused interaction** is interaction in a group of persons that have a common goal. These persons may have been familiar with one another in the past or they may become familiar for the first time during their focused interaction (e.g. a group of students studying together for a final examination)" [102].

> "**Unfocused interaction** includes neither a common goal nor such familiarity even during the process of interaction. In fact, the interacting persons may be unaware of their interaction (e.g. interaction between pedestrians who avoid disastrous collisions by following traffic etiquette and regulation)" [102].

3.3 Types of social interaction

Literature argues that social interaction occurs through several types of exchanges (synthesis offered in Figure 1) [101, 102, 108, 109]. Social interaction often refers to face-to-face encounters, but it is also common for interaction to be remotely mediated through digital communication via technological artefacts [101, 110]. Both fall within the symbolic type of communication, as they communicate through symbols (either images/icons, or language as a structured exchange of symbols) that bear meaning to the interlocutors.

The symbolic type of communication, together with interaction through physical actions such as for e.g., fighting or touching, fall into the direct type of exchange: they can

occur synchronous or asynchronously, use multiple channels (e.g., voice, or the form of speaking – paralanguage), but they occur directly between the interlocutors interacting [111]. Alternatively, interlocutors A and B can also interact through the involvement of intermediary people, which propagate the message from A to B. These fall within an indirect form of interaction, as direct interaction occurs between the intermediaries, but no direct interaction between A and B. Mode detailed coverage on social interaction and related concepts can be found in [102, 108, 109, 112].

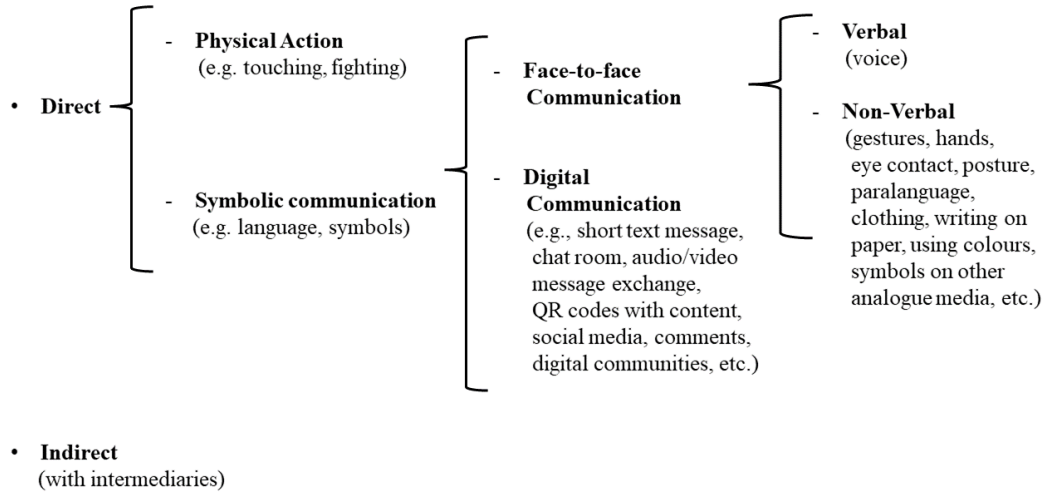

Figure 1. *Types of Social Interaction [14].*

3.4 Player-centred activity types for in-situ social interaction in LBGs

From the understanding of user requirements at the functionality level [11, 13-15, 38, 40, 41, 113-115], the authors studied the sort of game play activities that LBGs should offer (game content). After several case studies that tested LBG prototypes and researched which activity designs appeal best to players [38, 41, 114], seven types of activities were identified that capture the forms of play that players - both adolescents and adults - want to experience in their neighbourhoods and with others: *Athlete*, *Inventor*, *Detective*, *Explorer*, *Hunter*, *Artist* and *Volunteer* [14, 38]. In another case study [14], these activity types were shown to initiate social interaction and capture the real life exchanges that players require for meaningful play-based social experiences [11, 14, 15, 38, 41]:

- **Do physical exertion** (*Athlete*);
- **Propose creative solutions** (*Inventor*);
- **Search for factual knowledge** (*Detective*);
- **Engage with the neighbourhood and random people** (*Explorer*);
- **Find specific people or objects** (*Hunter*);
- **Create artwork and share it** (*Artist*);
- **Contribute towards a better community** (*Volunteer*);

Table 1 displays the definition of each activity type:

Table 1. *Types of activities for LBGs for social interaction [14, 115].*

Type	Description
Artist	This type of activity requires players to design artwork in and about their neighbourhood, based on creative processes individually or collaboratively. Such artwork might be abstract and personal or collective and represents a creative expression about the player's neighbourhood. For example, creating a song or musical performance (rapping), writing a poem, or storytelling.
Athlete	This type of activity requires physical activity to be solved. The activity can be solved by either doing a specific challenge requiring physical action (e.g. engaging with at least five people for a given purpose), or by varying the quality of the performance itself (e.g. see who can finish the free-running the fastest).
Detective	This type of activity requires finding information and answering questions about factual knowledge related to the surrounding environment. Players have to search for information in their neighbourhood, such as asking people about local heroes depicted in tiles in the footpaths in their neighbourhood.
Explorer	Players are required to explore their neighbourhood, i.e. by learning and comprehending more about their own neighbourhood and the people who live there. Activities of this type might include discovering the origins of a neighbourhood. It might lead players to an unknown point of interest of the neighbourhood (e.g., an old building, a local initiative) and ask them to engage with random people to discover its origins.
Hunter	The behaviour elicited by this type of activity is linked to finding specific type of people or objects, as opposed to finding random people. Hunter is about finding tangible things that can be human, animal, or an object. For example, finding the person responsible for the community centre to ask what types of activities can be done there. When such people cannot be found at a given time, players can find ways to still address the challenge (e.g., finding a QR code attached to the community centre explaining exactly what they would like to ask the person).
Inventor	Inventor type of activity requires players to propose new ideas to address an issue in the neighbourhood. Players in this type of challenge may explore interventions for their neighbourhood and explore opportunities to increase the liveability of their neighbourhood. Examples of this activity are possible interventions to change their neighbourhood, designing a new playground, or a new colour scheme for the location.
Volunteer	Players are invited to contribute towards the community and are incited to help others or contribute to the quality of life in the neighbourhood. An example of an activity of this type is picking up trash at a specific location to make a nice piece of art with it and taking a picture of it to publish in the media of the local community, before the trash is collected.

3.5 Conceptual analysis: types of location-based game activities and promoted social interaction

Given the nature and types of social interaction presented in the literature, and the description of the location-based activity types from Table 1, it is possible to argue about the possible forms of social interaction that these activity types enable (below). Based on these, this paper proposes in Figure 2 a visual design framework that depicts this theoretical association:

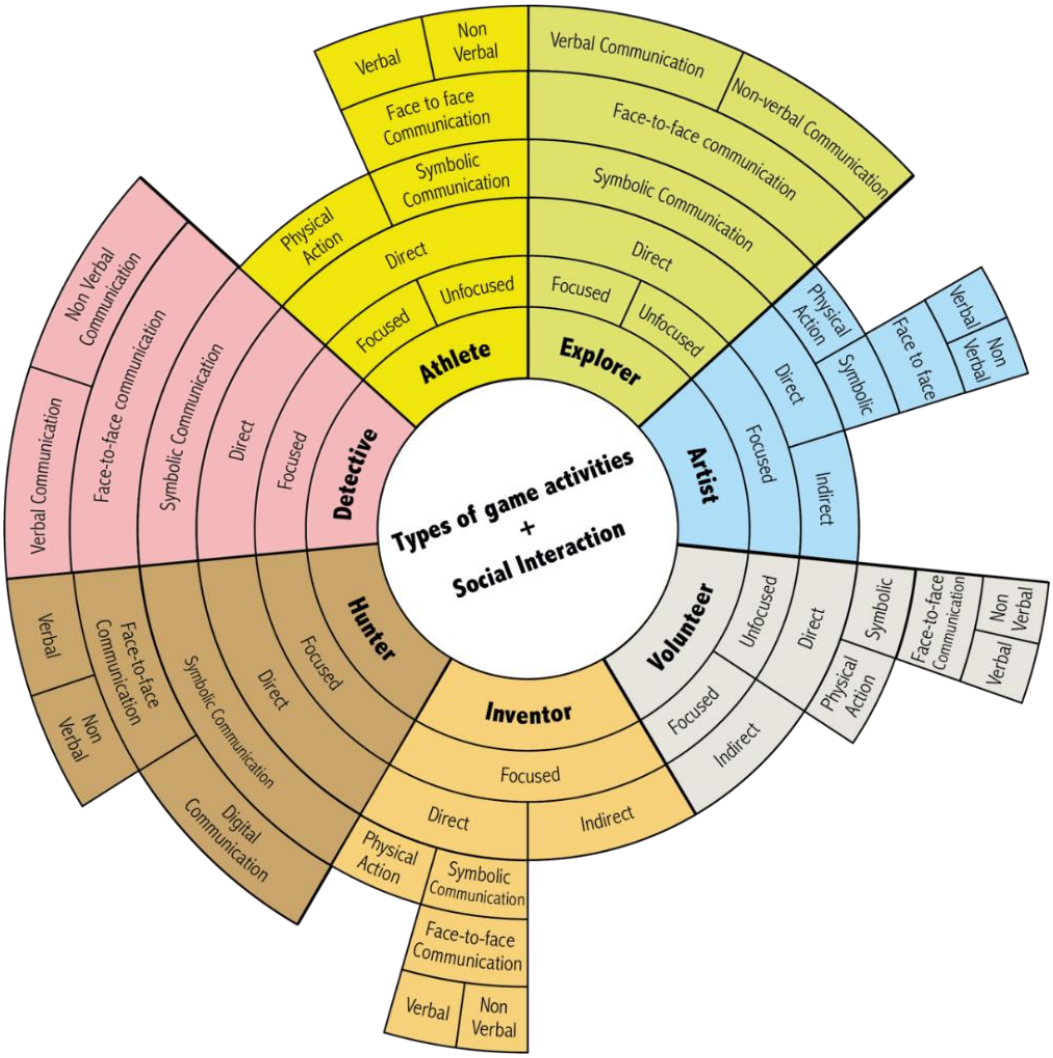

Figure 2. *Design framework: location-based activity types and their interaction.*

Figure 2 is based on the following type-based analysis:

Artist:

Ideas fitting this type of activity are expected to invite players to do activities together with the group, thus having a common purpose (**focused** interaction). Interaction within a group of players can be both **indirect** and **direct**. On the one hand, indirect interaction can happen because indirect means are used by the first interlocutor to communicate (e.g., drawing, poetry), a means that which will likely be converted into meaning by a second unknown interlocutor. On the other hand, direct interaction occurs when players of these activities perform, i.e., during a joint performance (**physical action**). Direct interaction also happens via **symbolic communication**, that is materialised in both **verbal** (talking while performing) and **non-verbal** (the way people perform) **communication,** both **face-to-face**.

Athlete:

Ideas fitting this type of activity are expected to involve doing an activity within a period, with potential exertion, and with/against others. The ideas for activities fitting this type are both focused and unfocused: a number are to occur within a competing group (**focused**), with a common goal (often involving competition); and a number contain goals (e.g., finding under 1 minute …) that are fast paced and do not really set a "stage" for the interlocutors to get to know one another or share an overall goal (**unfocused**). All the ideas within involve **direct** interaction between both a group of players and passers-by in the

neighbourhood, and potentially involve **physical actions** (e.g., touching/grabbing) and the use of **verbal** and **non-verbal** communication during **face-to-face** encounters.

Detective:

Ideas of this type of activity are expected to require players to find specific information and investigate a specific topic about the neighbourhood. These activities are all **focused** in nature: the person interacting has to find specific information. The type of interaction is **direct** and is mostly based on **face-to-face** dialogues (**verbal**) and the way these are conducted (**non-verbal**).

Explorer:

These activities are expected to invite players to engage with both the environment and the people in it, thus providing both focused and unfocused interactions. **Focused** interactions occur in the activities where there is a clear goal (e.g., finding what can be done by talking to …). In turn, **unfocused** interactions can also occur with this type, when activities are not so clear in purpose (e.g., collect information about the neighbourhood, or interview people about what they do). With both focused and unfocused, players engage **directly** with both the group (e.g., coming up with ideas for …) and with passers-by (e.g., interview people), which use **face-to-face verbal** and **non-verbal** language.

Hunter:

The ideas fitting this type are expected to invite players to find specific objects around the neighbourhood or ask about specific information to passers-by. The nature of this interaction is **focused**: players have an objective to find specific information or objects, even when talking to strangers. Communication is **symbolic** and can occur in two ways, either **digitally**, or **face-to-face**. Digital communication occurs when players must find given objects that can contain messages left by another unknown person (e.g., a QR code displaying text, or a picture linked to the activity). In turn, face-to-face communication occurs when players engage with passers-by to find information and solve the activity, in situations where both **verbal** and **non-verbal** types of interaction can occur.

Inventor:

Ideas fitting this type are expected to address problems, to for example provide more options to share information across citizens and improve the neighbourhood. The nature of the interaction is **focused**, as there is a clear goal (proposing ideas), and it occurs through **indirect** and **direct** means. Similar to the type *Artist*, indirect means are used by the first interlocutor to propose new ideas that are likely to be interpreted by a second interlocutor not known à priori by the first one. Direct communication, on the other hand, happens in activities where players solve/perform an activity together, that can include both **physical action** (e.g., while sharing the same canvas) and **symbolic communication** during **face-to-face** exchanges. The latter can, in turn, be **verbal** (e.g., discussing ideas), or **non-verbal** (e.g., the design itself can contain symbols).

Volunteer:

The ideas fitting this type are expected to promote a **focused** and **unfocused** exchange: focused, because there is a goal among players competing; and unfocused, because the volunteering act in the neighbourhood can set up dialogues with passers-by that are random (e.g., someone asking what players are doing and why). These exchanges also may require indirect and direct communication. On the one hand, **indirect** communication happens when a player contributes to the community including people in that community: caring about the neighbourhood through actions sends an indirect message to other members of the community saying that that specific person minds him/herself about the good upkeep of the environment, which in turn can have a cascading effect. On the other hand, direct communication happens between 1) a group of players competing to win an activity, and 2) passers-by. A group of people who perform this activity together can physically interact

with one another while performing (**physical action**). At the same time, this type of activity also promotes **face-to-face** dialogues both between players and strangers, who use **verbal** and **non-verbal** cues to communicate.

4 Evaluating the proposed design framework

The previous section offers a theoretical design framework in Figure 2 and details it through a type-based analysis. This section explores the research question posed in this article: **can a theoretical design framework be proposed to describe the forms of social interaction that specific user-centred game ideas are expected to trigger, and be used in practice?** It does so by presenting an experimental design to explore the validity of the theoretical framework, by eliciting user-centred game ideas and analysing in practice the forms of social interaction these ideas invite.

This research question focuses on describing forms of social interaction objectively via a theoretical framework, but because social interaction is a social phenomenon that can be complex [101, 102, 116-119] to objectively identify through traditional research methods, this research uses a post-positivist approach [120]. Such approach advocates for empirical studies producing observations and measurements to be interpreted by more than one researcher, so that manifestations of larger patterns can be identified and bias mitigated [121, 122]. Given that the knowledge this study centres itself on comes from users, a participatory design approach is followed [123, 124] with adolescents as design partners [22]. Adolescents and researchers co-designed ideas together in a co-located manner, by having researchers exposing adolescents to their own neighbourhood and having them propose ideas for game activities they would want to play in their neighbourhood and with others. The results of this research design are a set of game ideas, which, given their nature, are then analysed by multiple researchers in the forms of interaction they invite.

4.1 Participants and location

64 young adolescents (10-11 years of age) in the overall area of Feijenoord and Tarwewijk, Rotterdam, NL, from 3 different classes of a primary school in the area (Christelijke Basisschool De Akker) participated in this study in the context of their technology curriculum. The group was balanced in terms of gender, and, according to their teachers and the school director, representative of the local neighbourhood with respect to ethnicity (very diverse). Dutch was the only language used.

4.2 Procedure

Each of the 3 classes of students participated in the workshop over a course of 2 days. On the first day, two researchers visited the class of students to brief them about the context of the research (on location-based games for social interaction tailored to their neighbourhood), to provide them with examples of activities that could be played, to explain that 3 routes would be walked a week later, and to provide them with a hand-out with exercises with which they could prepare: to find more information on the neighbourhood and its local history (e.g. by asking their parents). They were told that their ideas would be implemented in a LBG for them to play later. They were also handed consent forms for both participants and data collection, to be signed by their legal guardians/parents to be returned to school prior to the second day of the workshop (a week later).

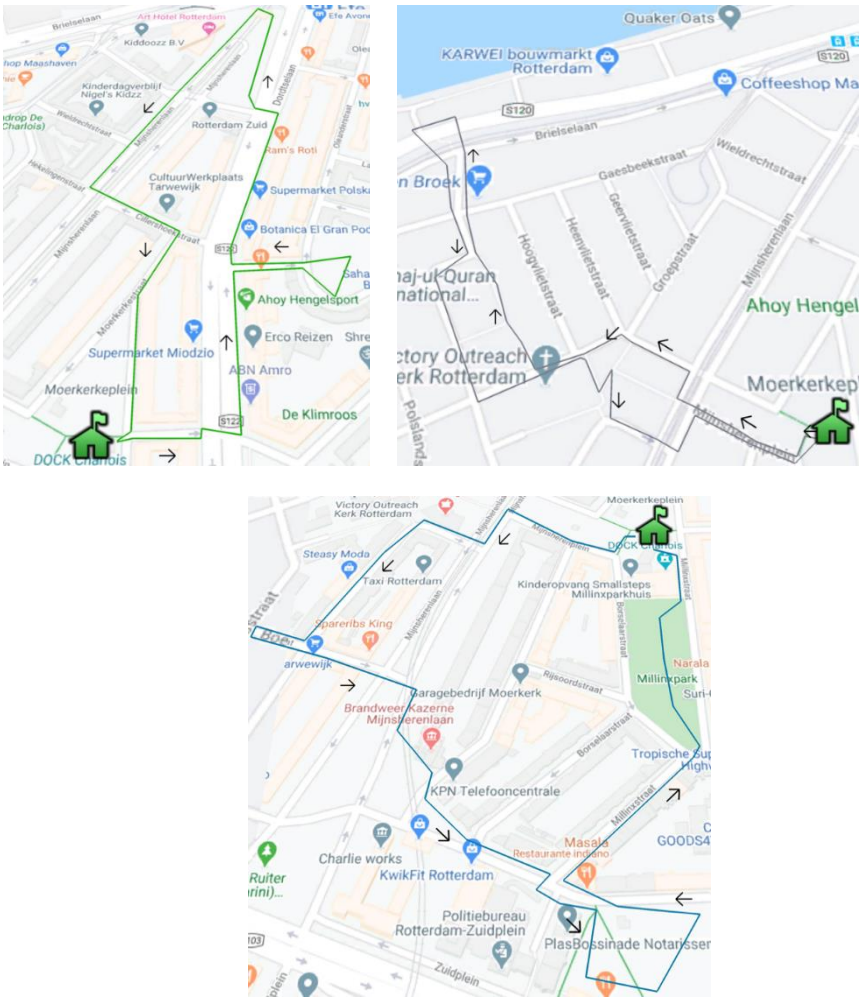

Figure 3. *3 Routes used: 1 (top left), 2 (top right), and 3 (bottom).*

On the second day of the workshop the class was split up into smaller groups of 4-6 adolescents each (by the teachers), with at least 2 researchers and one teacher for each. In total, 9 groups participated. Each group was randomly assigned to one of the 3 predefined routes. These 3 routes (Figure 3) were on average 1.4 kilometres long, around the school (with start and finish points at school), and participants walked their assigned route for a period of up to 1 hour and half. Each group was tasked to propose gaming activities en route to be included in an LBG later. Lastly, on return to school, participants were asked to reflect on their experience, again briefed on what would happen to their ideas (i.e. to be included in an LBG prototype – later called the *Secrets of the South* [115]), and reminded that a few months later the researchers would come back for them to test their ideas in a gameplay session (see [14]). The two days per class were held sequentially.

4.3 Method and data collection

When walking each route, the teacher and researchers were responsible for guaranteeing that the young adolescents would stay on route, participating in, and fostering, debate on what participants found interesting to do and where, and writing observations down on paper. Each participant was assigned an initial role: *interviewer* (asking questions to people), *photographer* (taking pictures), *note taker* (writing down ideas), *recorder* (audio-record interviews), and *navigator* (keeping the group on track). Participants could change roles throughout the route, to try new tasks and maintain engagement. Data collected

consists thus of observations made by researchers written down on paper, writings of participants, audio recordings, and photos.

4.4 Data processing and analysis

Data collected was then processed through a 2-step approach that produced one list of specific game ideas desired by the participants to play in their own neighbourhood. As a first step, transcriptions of the audio recordings collected by the adolescents were analysed by 2 Dutch-speaking research staff, who annotated the ideas of gaming activities proposed. As a second step, the researchers associated the annotated ideas with the writings of the participants, and, when available, with the pictures taken. This step increased understanding of the data produced by participants (which was not always comprehensible, e.g., in writing, or ideas expressed), and to curate the data into a list of gaming ideas. The result was then translated to English by the researchers. This produced a list of game ideas that the participants of the workshop would like to play in their own neighbourhood, and that is made available to the reader as supplement material to the article. All game ideas focused on collocated play and need to be considered in the specific context in which they were produced.

4.5 Research design results

The research design produced 56 game ideas related to the locations where the participants walked. One theme that appears within these ideas is related to improving the environment: ideas such as “coming up with a colour scheme for the square”, “collect the most litter”, or “increase the amount of lights” at the location”. Another theme is trivia questions: “how long does the school exist”, “how high are the apartments”, or “how many schools are there”. A theme of open-ended investigation is found as well: “… measure, ask the residents…”, “there is a tube on the ground, what kind of water goes through it”, or “why did they built it and when”. Physical competition and challenge are themes strongly present: “the person who collects …. wins”, “race and play … together”, “running against each other”, or “how many challenges can you do within one minute”. The supplement material to this paper provides the full list of game ideas produced by the research design.

4.6 Analysis of research design results

The ideas for game activities of the previous section are subjected to further analysis to understand whether the theoretical design framework can properly describe the social interaction mentioned in each of the participant’s game ideas. The analysis aims at answering the research question: **can a theoretical design framework be proposed to describe the forms of social interaction that specific user-centred game ideas are expected to trigger, and be used in practice?** Such analysis is composed by three steps, that are detailed in the protocol of analysis below. Supplement material to this paper includes the data files used in this analysis.

Protocol of analysis

To answer the research question, three steps are used to analyse the results of the research design. The first step focuses on classifying each game idea into the types of activities that the framework refers (Artist, Athlete, Detective, Explorer, Hunter, Inventor, and Volunteer). The second step separates the game ideas involving social interaction from the ones having no interpersonal interaction. These two steps have the purpose to identify game ideas that are compatible with the design framework. The third step applies the design framework to the game ideas identified in step 2 to describe the social interaction they contain.

The categorization of the game ideas (steps 1 and 2) and the analysis of the game ideas and their interaction for the design framework (step 3) was performed independently by two authors of this article. After the independent analysis, the results were compared and differences were discussed with the third author of this article, to jointly capture the most accurate meaning of the ideas expressed by the participants. When perspectives varied, the third author would untie the vote.

In step 2, the analysis identifies game ideas containing interaction compatible with the design framework (i.e., social interaction), by using the following criteria:

a. Assess whether the ideas mention involving other people or having some game dynamic (e.g., comparison, competition) with other people.

b. Assess whether the proposed game idea can be done purely individually, or whether it could involve (in)direct social interaction. If social interaction can occur but is a mere remote possibility, then the game idea is categorised as not involving social interaction at large. Even if some ideas could be executed while involving others, that is not the way they come across.

In step 3, both researchers applied the design framework to describe the social interaction of the game ideas identified in step 2, to observe its practical applicability.

Step 1: Categorization of game ideas into activity types

The results of the research design (provided as supplement material to the article) are digested in Table 2 and Figure 4. The categorization and distribution of the participants' game ideas across the location-based activity types are as follows:

Table 2. *Categorization of game ideas by location-based activity types.*

Activity Types	Game Ideas	Count
Artist	9, 12, 35, 37, 43, 44, 55, 56	8
Athlete	18, 20, 26, 27, 31, 41, 42, 49	8
Detective	7, 8, 14, 15, 16, 17, 19, 24, 25, 32, 33, 36, 38, 39, 40, 45, 47, 50, 51, 53, 54	21
Explorer	10, 11, 28, 29, 30, 34, 48, 52	8
Hunter	13, 21, 23, 46	4
Inventor	1, 2, 4, 5, 6, 22	6
Volunteer	3	1

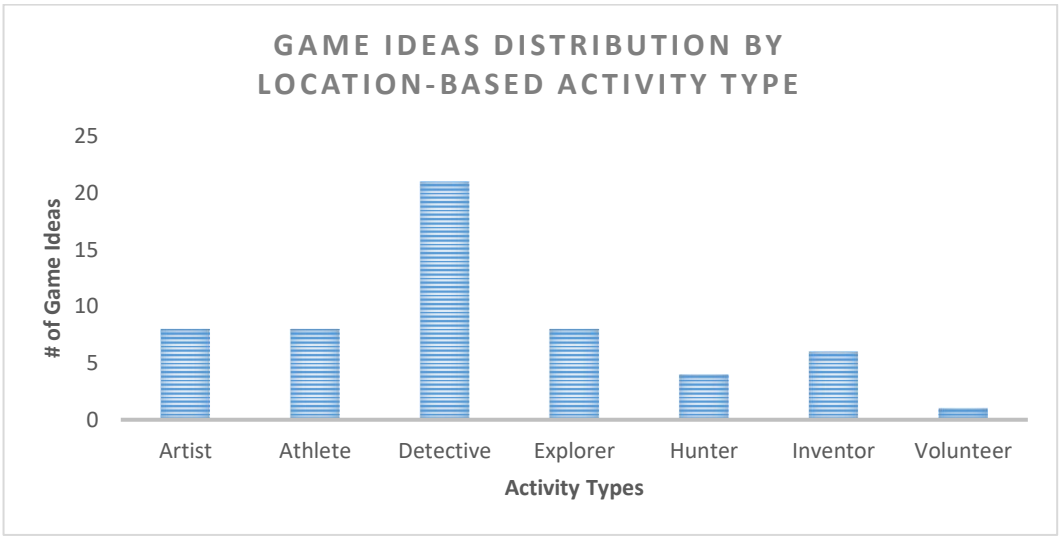

Figure 4. *Distribution of game ideas across activity types.*

Step 2: Game ideas compatible with the design framework

Many ideas produced by participants focus on intrapersonal interaction (i.e., having no social interaction), and therefore cannot be fitted with the proposed design framework. Table 3 shows the distribution of the same game ideas in terms of the interaction they involve: as involving some sort of social interaction (*social interaction*), and as involving no social interaction (*intrapersonal interaction*).

Table 3. *Sort of interaction involved in each game idea.*

Interaction Involved	**Game Ideas**	**Total (%)**
Social Interaction	2, 3, 6 ,7, 8, 9, 13, 19, 20, 21, 22, 23, 25, 27, 28, 29, 35, 39, 41, 42, 46, 47, 56	41.1%
Intrapersonal Interaction	1, 4, 5, 10, 11, 12, 14, 15, 16, 17, 18, 24, 26, 30, 31, 32, 33, 34, 36, 37, 38, 40, 43, 44, 45, 48, 49, 50, 51, 52, 53, 54, 55	58.9%

Game ideas that can be categorized as "intrapersonal interaction" are not directly compatible with the proposed design framework for social interaction, and therefore outside the scope of this framework. Such ideas can be executed by the player him/herself with no social contact, even in the scenario of encountering no person on the street.

Step 3: Applicability of the design framework

For all game ideas categorised as having social interaction in Table 3, the proposed design framework can be used to describe the forms of social interaction they trigger. None of the game ideas included interaction types that had not been covered, and that would thus require the theoretical design framework to be extended. For the game ideas involving some sort of social interaction, the analysed interactions that are produced by the design framework are shown next with the following scheme:

> *Ideas fitting this type and involving social interaction* (**Ideas**), and *Characterization of social interaction*: focused interaction (**F**), unfocused interaction (**UF**), indirect (**IN**), direct (**D**), physical action (**PHA**), symbolic communication (**SYM**), face-to-face communication (**F2F**), digital communication (**DIG**), verbal (**V**) and non-verbal (**NV**).

Artist:

Ideas	**Characterization of social interaction**
35, 56	F | D | SYM | F2F | V
9	F | D | SYM | F2F | NV

Athlete:

Ideas	**Characterization of social interaction**
20, 27	F | D | PHA | SYM | F2F | NV
41, 42	F | D | PHA | SYM | F2F | V | NV

Detective:

Ideas	**Characterization of social interaction**
7, 8, 25	F | D | SYM | F2F | V
19, 39, 47	UF | D | SYM | F2F | V

Explorer:

Ideas	Characterization of social interaction
28, 29	UF | D | SYM | F2F | V

Hunter:

Ideas	Characterization of social interaction
13, 46	UF | D | SYM | F2F | V
21	F | D | SYM | F2F | V
23	F | D | SYM | F2F | V | NV

Inventor:

Ideas	Characterization of social interaction
2	UF | D | SYM | F2F | NV
6	F | D | SYM | F2F | V
22	UF | D | SYM | F2F | V

Volunteer:

Ideas	Characterization of social interaction
3	F | D | PHA | SYM | F2F | NV

5 Discussion

This paper contributes with knowledge relevant to the identified gaps by leveraging on what is known about the types of activities that players wish to play in location-based games, and the theory of social interaction. This knowledge consists of seven types of activities that contain the forms of interaction and exposure that adolescents and adults prefer to have in the public space of their neighbourhoods. This research strengthens these findings by proposing a theoretical analysis on the forms of interaction that the seven location-based activity types can foster, and by describing a research design to explore its validity in practice. The research question posed by this article is: **can a theoretical design framework be proposed to describe the forms of social interaction that specific user-centred game ideas are expected to trigger, and be used in practice?**

The elaborated research design provided meaningful results: not only has it provided a pool of specific game ideas that were co-created by the participants themselves and that can be characterized by all the seven activity types previously found [11, 15, 38, 41], but it also enabled an analysis that could answer the research question affirmatively. The fact that the seven activity types could describe all the 56 activities produced by the adolescents is a good indicator in itself of the usability of the framework. For the participants' game ideas involving some sort of social interaction, the proposed theoretical design framework could be used to describe and detail the forms of social interaction that such ideas contain and be used in practice. For the participants' game ideas with intrapersonal interaction (i.e., no social interaction), the framework cannot be used directly: this design tool is meant to describe social interaction, which is inexistent in such ideas. For the game ideas involving social interaction, the design framework can describe the forms of social interaction that an idea will invite future players to have and can do that for all the collected ideas.

This contributes directly to the knowledge gaps identified earlier: the 1) lack of understanding about the relationship between game design choices and their probable

implications; and 2) the lack of knowledge on how best to design for social interaction that matters to local neighbourhoods. This paper argues that the design framework of Figure 2 is a tool that can be used by practitioners to 1) analyse existent LBGs that implement the mentioned activity types in the forms of social interaction they trigger, and 2) help practitioners design more deterministic location-based game activities that target specific forms of interaction. It advances current knowledge on the forms of interaction that each type of activity is likely to promote, by providing a theoretical bridge between the gameplay offered by the activity types and the forms of interaction they are expected to promote in public space. When involving social interaction, activities can promote a gameplay with a clear (focused) or unclear (unfocused) goal for the interaction, which, in turn, can occur in a direct or indirect way depending on whether indirect means of expression or communication are used. In the cases where social interaction occurs in close encounters (directly between interlocutors), it is further categorised into several types: involving physical interaction (physical action), symbols (e.g., language, signs), and other forms of communication present in face-to-face exchanges (verbal, and non-verbal) or digital ones (e.g., asynchronous messages).

Looking more closely to the design framework of Figure 2 and the developed research design, it can be observed that the types *Inventor*, *Hunter*, *Detective*, and *Artist* offer activities that are clearer in purpose and guide social interaction both within a group of players and passers-by, whereas activities of the type *Athlete*, *Explorer*, and *Volunteer* involve less purposeful engagement with people on the street. The types *Artist* and *Inventor* include examples of activities where players are invited to draw or express an idea for improvement of the environment in which they live. The activities of type *Volunteer* also promote indirect interaction, but in such cases the interaction is indirectly communicated through giving an example of behaviour. In direct interactions: the types *Inventor*, *Volunteer*, *Artist*, *Athlete* invite players to do activities with physical exchanges (e.g., touching, grabbing); the type *Hunter* is the only type that includes examples of activities involving explicit digital communication; and all types of activities with face-to-face interaction, may afford verbal and non-verbal exchanges (or both).

With the proposed framework, not only LBGs can be better designed and used by practitioners to promote a gameplay that is desired by players, but also target this playful behaviour to specific social exchanges most fitting to a specific neighbourhood. This contributes to more focused research in the future on the exploration of the impacts that LBGs for social interaction can have in local communities and their social resilience. This design framework also underlines the different forms of activities that adolescents prefer to play in public space, which is confirmed by the results of the elaborated research design.

6 Limitations

This case study explores a research question with young adolescents in the areas of Tarwewijk and Feijenoord in Rotterdam, NL. The first limitation of this study is that the findings are based on the preferences of these participants, the playfulness that the involved physical environment affords, and further research should be conducted to generalise findings both regarding different locations and other participants of the same target group. Another limitation is the fact that there was an association between previously found types of location-based activities and the forms of social interaction supported by the literature. It is possible that future research reveals more types of activities, or that the preferences of users change for example in function of time (different generations) or place (different countries), which, in turn, produce new location-based activity types. Nonetheless, the findings of this case study, even though tested only in the studied target group, have a strong theoretical foundation that are not weakened by these limitations.

7 Conclusion

This article leverages on existent understanding on both 1) theory of social interaction, and 2) knowledge on types of activities for location-based games, to propose a design framework for the characterization of the forms of interaction that such activity types promote. These activity types sum up current understanding on the activities that players – both adolescents and adults – wish to play in their own neighbourhood, and they are extended in this article with the theory on the forms of social interaction they are expected to promote.

This paper puts this theoretical design framework to test in a participatory-design workshop with adolescents in Rotterdam, NL. In this workshop, future players became co-designers on the sort of playful behaviour they want to experience in their own neighbourhood. The co-designed ideas for game activities are then subjected to an analysis to understand how the forms of social interaction that the produced game ideas contain can be described and detailed by the proposed framework. As result of this analysis, this paper shows that the proposed design framework can be used to detail game ideas that are co-designed by future players in the forms of social interaction they trigger. The proposed design framework can be used to 1) analyse existing LBGs in the forms of social interaction they trigger, and 2) help practitioners design new game activities that target specific forms of interaction. This enhances the current understanding on the impact that LBGs can have in local communities, and on the way LBGs can be better designed and used to promote social exchanges that are desired by players.

Future work can enhance this study with more case studies that are designed to practically experiment and observe the several forms of interaction that different location-based play activities trigger, to compare them with the proposed design framework. Such future work can reveal if and how adolescents' preferences change regarding the game dynamics desired by them, or if they tend to be similar/the same. The authors argue that all the lessons learning about gameplay requirements are important and indicate to a varying extent what players of different target groups would like to experience in LBGs for social interaction. Still, future work can reveal other predominant game dynamics, especially if other ethnicities, gender balances, and cultures are accounted for.

References

[1] N. M. Avouris and N. Yiannoutsou, "A review of mobile location-based games for learning across physical and virtual spaces," *J. UCS*, vol. 18, no. 15, pp. 2120-2142, 2012.

[2] J. D. Mullen, "Location-based games and augmented reality systems," ed: Google Patents, 2013.

[3] M. Flintham *et al.*, "Day of the figurines: A slow narrative-driven game for mobile phones using text messaging," in *Virtual Storytelling. Using Virtual Reality Technologies for Storytelling: 4th International Conference, ICVS 2007*, Saint-Malo, France, 167-175, 2007: Springer, doi: 10.1007/978-3-540-77039-8_14.

[4] O. Sotamaa, "All The World's A Botfighter Stage: Notes on Location-based Multi-User Gaming," in *Proceedings of Computer Games and Digital Cultures Conference, ed. Frans Mayra*, Tampere, Finland, 35-44, 2002: Tampere University Press.

[5] A. Pyae, M. Luimula, and J. Smed, "Investigating Players' Engagement, Immersion, and Experiences in Playing Pokémon Go," in *Proceedings of the 2017 ACM SIGCHI Conference on Creativity and Cognition*, 2017: ACM, pp. 247-251, doi: 10.1145/3059454.3078859.

[6] A. M. Clark and M. T. Clark, "Pokémon Go and research: Qualitative, mixed methods research, and the supercomplexity of interventions," *International Journal of Qualitative Methods*, vol. 15, no. 1, 2016, doi: 10.1177/1609406916667765.

[7] H. Hodson, "Google's Ingress game is a gold mine for augmented reality," *NewScientist*, vol. 216, no. 2893, 2012, doi: 10.1016/S0262-4079(12)63058-9.

[8] J. Peitz, H. Saarenpää, and S. Björk, "Insectopia: exploring pervasive games through technology already pervasively available," in *Proceedings of the international conference on Advances in computer entertainment technology*, 2007: ACM, pp. 107-114, doi: 10.1145/1255047.1255069.

[9] H. Korhonen, H. Saarenpää, and J. Paavilainen, "Pervasive Mobile Games–A New Mindset for Players and Developers," in *Markopoulos P., de Ruyter B., IJsselsteijn W., Rowland D. (eds) Fun and Games. Fun and Games 2008. Lecture Notes in Computer Science, vol 5294*, Berlin, Heidelberg, 2008: Springer, pp. 21-32, doi: 10.1007/978-3-540-88322-7_3.

[10] K. Papangelis, M. Metzger, Y. Sheng, H.-N. Liang, A. Chamberlain, and T. Cao, "Conquering the city: Understanding perceptions of mobility and human territoriality in location-based mobile games," *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*, vol. 1, no. 3, p. 90, 2017, doi: 10.1145/3130955.

[11] X. Fonseca, S. Lukosch, H. Lukosch, and F. Brazier, "Requirements for Location-based Games for Social Interaction," *IEEE Transactions on Games*, vol. 1, no. 1, pp. 1 - 14, 2021, doi: 10.1109/TG.2021.3078834.

[12] T. M. Căşvean, "Serious Games: Oxymoron or opportunity to increase the interest towards education and learning?," in *Conference proceedings of eLearning and Software for Education (eLSE)*, 2015, no. 02: "Carol I" National Defence University Publishing House, pp. 41-49.

[13] X. Fonseca, S. Lukosch, and F. Brazier, "Social Cohesion Revisited: A New Definition and How to Characterize It," *Innovation: The European Journal of Social Science Research*, vol. 32, no. 2, pp. 231-253, 2018, doi: 10.1080/13511610.2018.1497480.

[14] X. Fonseca, G. Slingerland, S. Lukosch, and F. Brazier, "Designing for Meaningful Social Interaction in Digital Serious Games," *Entertainment Computing*, vol. 36, no. 100385, pp. 1-23, 2020, doi: https://doi.org/10.1016/j.entcom.2020.100385.

[15] X. Fonseca, S. Lukosch, H. Lukosch, S. Tiemersma, and F. Brazier, "Requirements and Game Ideas for Social Interaction in Mobile Outdoor Games," *CHI PLAY '17 Extended Abstracts, Publication of the Annual Symposium on Computer-Human Interaction in Play*, pp. 331 - 337, 2017, doi: 10.1145/3130859.3131304.

[16] L. Ermi and F. Mäyrä, "Player-centred game design: Experiences in using scenario study to inform mobile game design," *Game Studies*, vol. 5, no. 1, pp. 1-10, 2005.

[17] A. Al Mahmud, O. Mubin, S. Shahid, and J.-B. Martens, "Designing social games for children and older adults: Two related case studies," *Entertainment Computing*, vol. 1, no. 3-4, pp. 147-156, 2010, doi: 10.1016/j.entcom.2010.09.001.

[18] S. Consolvo, K. Everitt, I. Smith, and J. A. Landay, "Design requirements for technologies that encourage physical activity," in *Proceedings of the SIGCHI conference on Human Factors in computing systems*, 2006, pp. 457-466, doi: 10.1145/1124772.1124840.

[19] R. Khaled, V. Vanden Abeele, M. Van Mechelen, and A. Vasalau, "Participatory design for serious game design: truth and lies," in *CHI Play'14 Proceedings of the first ACM SIGCHI annual symposium on Computer--human interaction in play*, Toronto, Canada, 457-460, 2014: ACM; New York, pp. 457-460, doi: 10.1145/2658537.2659018.

[20] D. Plevier, M. Mac Gillavry, T. van Tussenbroek, A. Bharos, T. Pelser, and B. Engbers, "CupHunt: Gamification of Social Interaction," in *Extended Abstracts of the Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts*, 2019, pp. 287-305, doi: 10.1145/3341215.3358241.

[21] J. Kasurinen, A. Maglyas, and K. Smolander, "Is requirements engineering useless in game development?," in *International Working Conference on Requirements Engineering: Foundation for Software Quality*, 2014: Springer, pp. 1-16, doi: 10.1007/978-3-319-05843-6_1.

[22] M. Kinnula and N. Iivari, "Empowered to Make a Change: Guidelines for Empowering the Young Generation in and through Digital Technology Design," in *Proceedings of the FabLearn Europe 2019 Conference*, 2019, pp. 1-8, doi: 10.1145/3335055.3335071.

[23] L. Straker, R. Abbott, R. Collins, and A. Campbell, "Evidence-based guidelines for wise use of electronic games by children," *Ergonomics*, vol. 57, no. 4, pp. 471-489, 2014, doi: 10.1080/00140139.2014.895856.

[24] K. Isbister and F. F. Mueller, "Guidelines for the design of movement-based games and their relevance to HCI," *Human–Computer Interaction*, vol. 30, no. 3-4, pp. 366-399, 2015, doi: 10.1080/07370024.2014.996647.

[25] J. Yim and T. Graham, "Using games to increase exercise motivation," in *Proceedings of the 2007 conference on Future Play*, 2007: Citeseer, pp. 166-173, doi: 10.1145/1328202.1328232.
[26] D. Eriksson, "Socially adaptable games," presented at the DiGRA 2005: Changing Views: Worlds in Play, 2005 International Conference, 2005.
[27] T. Nilsen, "Guidelines for the design of Augmented reality strategy games," 2006.
[28] J. Paay and J. Kjeldskov, "Understanding situated social interactions in public places," in *IFIP Conference on Human-Computer Interaction*, 2005: Springer, pp. 496-509, doi: 10.1007/11555261_41.
[29] M. Bilandzic and M. Foth, "A review of locative media, mobile and embodied spatial interaction," *International Journal of Human-Computer Studies*, vol. 70, no. 1, pp. 66-71, 2012, doi: 10.1016/j.ijhcs.2011.08.004.
[30] R. Hossenlopp, R. H. PMP, K. B. Hass, and K. B. H. PMP, *Unearthing business requirements: elicitation tools and techniques*. Berrett-Koehler Publishers, 2007.
[31] D. Avison and G. Fitzgerald, *Information systems development: methodologies, techniques and tools*. McGraw Hill, 2003.
[32] G. Slingerland, S. Lukosch, T. Comes, and F. Brazier, "Exploring design guidelines for fostering citizen engagement through information sharing: Local playgrounds in The Hague," *EAI Endorsed Transactions on Serious Games*, 2020.
[33] S. Björk and J. Holopainen, "Games and design patterns," *The game design reader*, pp. 410-437, 2006.
[34] C. Dormann, J. R. Whitson, and M. Neuvians, "Once more with feeling: Game design patterns for learning in the affective domain," *Games and Culture*, vol. 8, no. 4, pp. 215-237, 2013, doi: 10.1177/1555412013496892.
[35] Staffan Bjork and J. Holopainen, *Patterns in Game Design* (Game Development Series). Charles River Media, 2004.
[36] C. Reuter, V. Wendel, S. Göbel, and R. Steinmetz, "Game Design Patterns for Collaborative Player Interactions," in *DiGRA*, 2014.
[37] K. Naliuka, T. Carrigy, N. Paterson, and M. Haahr, "A narrative architecture for story-driven location-based mobile games," in *International Conference on Web-Based Learning*, 2010: Springer, pp. 11-20, doi: 10.1007/978-3-642-20539-2_2.
[38] G. Slingerland, X. Fonseca, S. Lukosch, and F. Brazier, "Location-based Challenges for Playful Neighbourhood Exploration," *Behaviour and Information Technology*, 2020, doi: https://doi.org/10.1080/0144929X.2020.1829707.
[39] H. Söbke and A. Streicher, "Serious games architectures and engines," in *Entertainment Computing and Serious Games*: Springer, 2016, pp. 148-173. doi: 10.1007/978-3-319-46152-6_7.
[40] X. Fonseca, S. Lukosch, and F. Brazier, "Software Architecture for Location-based Games Designed for Social Interaction in Public Space," 2022 (Submitted to JCSG - Joint Conference on Serious Games, currently in review).
[41] X. Fonseca, S. Lukosch, and F. Brazier, "Fostering Social Interaction in Playful Cities," in *Interactivity, Game Creation, Design, Learning, and Innovation*, vol. 265. , Part of the Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering book series: Springer, 2018, pp. 286-295. doi: 10.1007/978-3-030-06134-0_33.
[42] A. Bhattacharya *et al.*, "Group interactions in location-based gaming: A case study of raiding in pokémon go," in *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 2019, pp. 1-12, doi: 10.1145/3290605.3300817.
[43] S. Laato, A. N. Islam, and T. H. Laine, "Did location-based games motivate players to socialize during COVID-19?," *Telematics and Informatics*, vol. 54, p. 101458, 2020, doi: 10.1016/j.tele.2020.101458.
[44] Y. Kim, A. Bhattacharya, J. A. Kientz, and J. H. Lee, ""It Should Be a Game for Fun, Not Exercise": Tensions in Designing Health-Related Features for Pokémon GO," in *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 2020, pp. 1-13, doi: 10.1145/3313831.3376830.
[45] S. Laato, T. Pietarinen, S. Rauti, and E. Sutinen, "Potential benefits of playing location-based games: an analysis of game mechanics," in *International Conference on Computer Supported Education*, 2019: Springer, pp. 557-581, doi: 10.1007/978-3-030-58459-7_27.

[46] S. Rauti, S. Laato, and T. Pietarinen, "Learning social skills and accruing social capital through pervasive gaming," in *2020 Workshop on Designing and Facilitating Educational Location-Based Applications, DELbA 2020*, 2020.

[47] M. Daneva, "How practitioners approach gameplay requirements? An exploration into the context of massive multiplayer online role-playing games," in *2014 IEEE 22nd International Requirements Engineering Conference (RE)*, 2014: IEEE, pp. 3-12, doi: 10.1109/RE.2014.6912242.

[48] L. Valente, B. Feijó, and J. C. S. do Prado Leite, "Mapping quality requirements for pervasive mobile games," *Requirements Engineering*, vol. 22, no. 1, pp. 137-165, 2017, doi: 10.1007/s00766-015-0238-y.

[49] S. Ganapathy, "Design guidelines for mobile augmented reality: User experience," in *Human Factors in Augmented Reality Environments*: Springer, 2013, pp. 165-180. doi: 10.1007/978-1-4614-4205-9_7.

[50] E. M. Chilufya, "HCI: Design Guidelines of Mobile Device Games for the Elderly," 2014.

[51] D. Parsons, H. Ryu, and M. Cranshaw, "A study of design requirements for mobile learning environments," in *Sixth IEEE International Conference on Advanced Learning Technologies (ICALT'06)*, 2006: IEEE, pp. 96-100.

[52] K. Miesenberger, R. Ossmann, D. Archambault, G. Searle, and A. Holzinger, "More than just a game: accessibility in computer games," in *Symposium of the Austrian HCI and usability engineering group*, 2008: Springer, pp. 247-260, doi: 10.1007/978-3-540-89350-9_18.

[53] J. P. Zagal, M. Nussbaum, and R. Rosas, "A model to support the design of multiplayer games," *Presence: Teleoperators & Virtual Environments*, vol. 9, no. 5, pp. 448-462, 2000, doi: 10.1162/105474600566943.

[54] A. I. Grimaldo, A. L. Morán, E. C. Gamez, P. Cairns, R. R. Palacio, and V. Meza-Kubo, "Promoting elderly-children interaction in digital games: A preliminary set of design guidelines," in *CYTED-RITOS International Workshop on Groupware*, 2014: Springer, pp. 169-176, doi: 10.1007/978-3-319-10166-8_15.

[55] R. L. Mandryk, K. M. Gerling, and K. G. Stanley, "Designing games to discourage sedentary behaviour," in *Playful User Interfaces*: Springer, 2014, pp. 253-274. doi: 10.1007/978-981-4560-96-2_12.

[56] H. Korhonen and E. M. Koivisto, "Playability heuristics for mobile multi-player games," in *Proceedings of the 2nd international conference on Digital interactive media in entertainment and arts*, 2007, pp. 28-35, doi: 10.1145/1306813.1306828.

[57] B. Bostan and S. Ogut, "Presence in computer games: Design requirements," ed: GAMEON, 2011.

[58] S. Hinske, M. Langheinrich, and M. Lampe, "Towards guidelines for designing augmented toy environments," in *Proceedings of the 7th ACM conference on Designing interactive systems*, 2008, pp. 78-87, doi: 10.1145/1394445.1394454.

[59] R. Wetzel, R. McCall, A.-K. Braun, and W. Broll, "Guidelines for designing augmented reality games," in *Proceedings of the 2008 Conference on Future Play: Research, Play, Share*, 2008, pp. 173-180, doi: 10.1145/1496984.1497013.

[60] K. Gerling, I. Livingston, L. Nacke, and R. Mandryk, "Full-body motion-based game interaction for older adults," in *Proceedings of the SIGCHI conference on human factors in computing systems*, 2012, pp. 1873-1882, doi: 10.1145/2207676.2208324.

[61] H. Duin and K.-D. Thoben, "Serious gaming for sustainable manufacturing: A requirements analysis," in *2011 17th International Conference on Concurrent Enterprising*, 2011: IEEE, pp. 1-8.

[62] R. Gennari, A. Melonio, and M. Rizvi, "Turn taking with turn-talk in group," *Multimedia Tools and Applications*, vol. 78, no. 10, pp. 13461-13487, 2019, doi: 10.1007/s11042-018-7090-2.

[63] T. Di Mascio, R. Gennari, A. Melonio, and P. Vittorini, "Designing games for deaf children: first guidelines," *Int. J. Technol. Enhanc. Learn*, vol. 5, no. 3/4, pp. 223-239, 2013, doi: 10.1504/IJTEL.2013.059493.

[64] K. M. Gerling, J. Schild, and M. Masuch, "Exergame design for elderly users: the case study of SilverBalance," in *Proceedings of the 7th International Conference on Advances in Computer Entertainment Technology*, 2010: ACM, pp. 66-69, doi: 10.1145/1971630.1971650.

[65] F. F. Mueller, F. Vetere, M. R. Gibbs, S. Agamanolis, and J. Sheridan, "Jogging over a distance: the influence of design in parallel exertion games," in *Proceedings of the 5th ACM SIGGRAPH Symposium on Video Games*, 2010, pp. 63-68, doi: 10.1145/1836135.1836145.

[66] F. F. Mueller, M. R. Gibbs, and F. Vetere, "Designing for Social and Physical Interaction in Exertion Games," in *Playful User Interfaces*, (Gaming Media and Social Effects: Springer, 2014. doi: 10.1007/978-981-4560-96-2_11.

[67] F. F. Mueller, M. R. Gibbs, F. Vetere, and D. Edge, "Designing for Bodily Interplay in Social Exertion Games," *ACM Transactions on Computer-Human Interaction (TOCHI)*, vol. 24, no. 3, 2017, doi: 10.1145/3064938.

[68] S. Laato, S. Hyrynsalmi, S. Rauti, A. N. Islam, and T. H. Laine, "Location-based games as exergames-from pokémon to the wizarding world," *International Journal of Serious Games*, vol. 7, no. 1, pp. 79-95, 2020, doi: 10.17083/ijsg.v7i1.337.

[69] D. Choi and J. Kim, "Why people continue to play online games: In search of critical design factors to increase customer loyalty to online contents," *CyberPsychology & behavior*, vol. 7, no. 1, pp. 11-24, 2004, doi: 10.1089/109493104322820066.

[70] M. Daneva, "Striving for balance: A look at gameplay requirements of massively multiplayer online role-playing games," *Journal of systems and software*, vol. 134, pp. 54-75, 2017, doi: 10.1016/j.jss.2017.08.009.

[71] J. B. Hauge, H. Söbke, I. A. Stefan, and A. Stefan, "Designing Serious Mobile Location-Based Games," in *Joint International Conference on Entertainment Computing and Serious Games*, 2019: Springer, pp. 479-484, doi: 10.1007/978-3-030-34644-7_49.

[72] A. de Souza e Silva, R. Glover-Rijkse, A. Njathi, and D. de Cunto Bueno, "Playful mobilities in the Global South: A study of Pokémon Go play in Rio de Janeiro and Nairobi," *New Media & Society*, 2021, doi: 10.1177/14614448211016400.

[73] S. Laato, N. Inaba, M. Paloheimo, and T. D. Laajala, "Group polarisation among location-based game players: an analysis of use and attitudes towards game slang," *Internet Research*, 2021, doi: 10.1108/INTR-03-2020-0158.

[74] Z. J. Fitz-Walter, "Achievement unlocked: Investigating the design of effective gamification experiences for mobile applications and devices," Queensland University of Technology, 2015.

[75] T. W. Malone, "Toward a theory of intrinsically motivating instruction," *Cognitive science*, vol. 5, no. 4, pp. 333-369, 1981, doi: 10.1207/s15516709cog0504_2.

[76] M. Blythe and A. Monk, *Funology 2: from usability to enjoyment*. Springer, 2018. doi: 10.1007/978-3-319-68213-6.

[77] J. Arrasvuori, H. Korhonen, and K. Väänänen-Vainio-Mattila, "Exploring playfulness in user experience of personal mobile products," in *Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction*, 2010: ACM, pp. 88-95, doi: 10.1145/1952222.1952241.

[78] Y. Liu, T. Alexandrova, and T. Nakajima, "Gamifying intelligent environments," in *Proceedings of the 2011 international ACM workshop on Ubiquitous meta user interfaces*, 2011: ACM, pp. 7-12, doi: 10.1145/2072652.2072655.

[79] Y. Rogers, H. Sharp, and J. Preece, "Interaction Design-beyond human-computer interaction," ed: Wiley West Sussex, 2012.

[80] S. de Freitas and H. Routledge, "Designing leadership and soft skills in educational games: The e-leadership and soft skills educational games design model (ELESS)," *British Journal of Educational Technology*, vol. 44, no. 6, pp. 951-968, 2013, doi: 10.1111/bjet.12034.

[81] S. Egenfeldt-Nielsen, J. H. Smith, and S. P. Tosca, *Understanding Video Games: The Essential Introduction (1st ed.)*. Routledge, 2008. doi: 10.4324/9780203930748.

[82] A. Nijholt, "Towards playful and playable cities," in *Playable Cities*: Springer, 2017, pp. 1-20. doi: 10.1007/978-981-10-1962-3_1.

[83] A. D. Cheok, T. Romão, A. Nijholt, and G. Yu, "Entertaining the Whole World," in *Entertaining the Whole World*: Springer, 2014, pp. 1-3. doi: 10.1007/978-1-4471-6446-3_1.

[84] C. Kroeze and M. S. Olivier, "Gamifying authentication," in *2012 Information Security for South Africa*, 2012: IEEE, pp. 1-8, doi: 10.1109/ISSA.2012.6320439.

[85] E. Tsekleves, J. Cosmas, and A. Aggoun, "Benefits, barriers and guideline recommendations for the implementation of serious games in education for stakeholders and policymakers," *British Journal of Educational Technology*, vol. 47, no. 1, pp. 164-183, 2016, doi: 10.1111/bjet.12223.

[86] H. Söbke, J. B. Hauge, and I. A. Stefan, "Prime example ingress reframing the pervasive game design framework (PGDF)," *International Journal of Serious Games*, vol. 4, no. 2, 2017, doi: 10.17083/ijsg.v4i2.182.
[87] S. Deterding, D. Dixon, R. Khaled, and L. Nacke, "From game design elements to gamefulness: defining gamification," in *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments*, 2011: ACM, pp. 9-15, doi: 10.1145/2181037.2181040.
[88] R. Hunicke, M. LeBlanc, and R. Zubek, "MDA: A Formal Approach to Game Design and Game Research," in *Proceedings of the Challenges in Games AI Workshop, Nineteenth National Conference of Artificial Intelligence*, San Jose, CA, 1722-1727, 2004, pp. 1722-1727.
[89] M. Foth, L. Forlano, C. Satchell, and M. Gibbs, *From social butterfly to engaged citizen: urban informatics, social media, ubiquitous computing, and mobile technology to support citizen engagement*. MIT Press, 2011. doi: 10.7551/mitpress/8744.001.0001.
[90] C. Harteveld, *Triadic Game Design: Balancing Reality, Meaning and Play*. Springer: Springer-Verlag London, 2011. doi: 10.1007/978-1-84996-157-8.
[91] Z. Menestrina, "The G3P Framework: guiding the design process of games for purpose," Ph.D., Information and Communication Technology, University of Trento, Università Degli Studi Di Trento, 2017.
[92] E. Boyle, T. M. Connolly, and T. Hainey, "The role of psychology in understanding the impact of computer games," *Entertainment Computing*, vol. 2, no. 2, pp. 69-74, 2011, doi: 10.1016/j.entcom.2010.12.002.
[93] F. Reer and N. C. Krämer, "Are online role-playing games more social than multiplayer first-person shooters? Investigating how online gamers' motivations and playing habits are related to social capital acquisition and social support," *Entertainment Computing*, vol. 29, pp. 1-9, 2019, doi: 10.1016/j.entcom.2018.10.002.
[94] C. A. Anderson, "An update on the effects of playing violent video games," *Journal of adolescence*, vol. 27, no. 1, pp. 113-122, 2004, doi: 10.1016/j.adolescence.2003.10.009.
[95] M. Barker and J. Petley, "Electronic child abuse?: Rethinking the media's effects on children," in *Ill Effects*: Routledge, 2013, pp. 38-50.
[96] A. A. o. Pediatrics, "Policy statement—media violence," *Pediatrics*, p. 200921462, 2009.
[97] D. Zendle, D. Kudenko, and P. Cairns, "Behavioural realism and the activation of aggressive concepts in violent video games," *Entertainment computing*, vol. 24, pp. 21-29, 2018, doi: 10.1016/j.entcom.2017.10.003.
[98] W. Gaver, "What should we expect from research through design?," in *Proceedings of the SIGCHI conference on human factors in computing systems*, 2012, pp. 937-946.
[99] J. Zimmerman and J. Forlizzi, "Research through design in HCI," in *Ways of Knowing in HCI*. Springer, 2014, pp. 167-189.
[100] J. Zimmerman, J. Forlizzi, and S. Evenson, "Research through design as a method for interaction design research in HCI," in *Proceeding CHI '07 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, San Jose, California, USA, 493-502, 2007: ACM, New York, doi: 10.1145/1240624.1240704.
[101] LumenLearning. "Understanding Social Interaction." Lumen Learning. https://courses.lumenlearning.com/boundless-sociology/chapter/understanding-social-interaction/ (accessed 19 Sep., 2018).
[102] P. D. Bardis, "Social interaction and social processes," *Social Science*, vol. 54, no. 3, pp. 147-167, 1979.
[103] L. Mondada, "Emergent focused interactions in public places: A systematic analysis of the multimodal achievement of a common interactional space," *Journal of Pragmatics*, vol. 41, no. 10, pp. 1977-1997, 2009, doi: 10.1016/j.pragma.2008.09.019.
[104] L. M. Coutts and F. W. Schneider, "Visual behavior in an unfocused interaction as a function of sex and distance," *Journal of experimental social psychology*, vol. 11, no. 1, pp. 64-77, 1975, doi: 10.1016/S0022-1031(75)80010-2.
[105] P. Bourdieu and J.-C. Passeron, *Reproduction in education, society and culture*. Sage, 1990.
[106] T. J. Scheff, *Microsociology: Discourse, emotion, and social structure*. University of Chicago Press, 1990.
[107] E. Goffman, "On face-work: An analysis of ritual elements in social interaction," *Psychiatry*, vol. 18, no. 3, pp. 213-231, 1955, doi: 10.1080/00332747.1955.11023008.
[108] E. Goffman, *Encounters: Two studies in the sociology of interaction*. Ravenio Books, 1961.
[109] E. Goffman, *Behavior in public places*. Simon and Schuster, 2008.

[110] J. Gião, J. Sarraipa, F. Francisco-Xavier, F. Ferreira, R. Jardim-Goncalves, and M. Zdravković, "Profiling Based on Music and Physiological State," in *I-ESA'16: Interoperability for Enterprise Systems and Applications*, 2016: I-ESA 2016, pp. 1-12, doi: 10.1007/978-3-319-30957-6_10.

[111] kdkasi. "Types of Social Interaction." https://www.sociologylearners.com/types-of-social-interaction/ (accessed.

[112] S. l. notes. "Social interaction, Definition, Elements, Types & Forms." http://studylecturenotes.com/social-interaction-definition-elements-types-forms/ (accessed.

[113] X. Fonseca, S. Lukosch, and F. Brazier, "Secrets of the South: A Location-based Game for the Development of 21st Century Social Skills and Promotion of Social Interaction," in *Proceedings of DELbA 2020 - Workshop on Designing and Facilitating Educational Location-based Applications (DELbA 2020) co-located with the Fifteenth European Conference on Technology Enhanced Learning (EC-TEL 2020)*, Heidelberg, Germany, September 15, 2020 2020, vol. 2685.

[114] G. Slingerland, X. Fonseca, S. Lukosch, and F. Brazier, "Designing Outdoor Playgrounds for Increased Civic Engagement," presented at the CHI '19, May 4-9, Glasgow, UK, 2019.

[115] X. Fonseca, "Location-Based Games For Social Interaction In Public Space," Doctoral thesis, TU Delft, 2021. [Online]. Available: https://doi.org/10.4233/uuid:9db1a0c4-89ba-4f9b-b32a-47b7bca5b55e

[116] S. E. Asch, "Group forces in the modification and distortion of judgments," in *Social psychology*. Englewood Cliffs, NJ, US: Prentice-Hall, Inc, 1952, pp. 450-501. doi: 10.1037/10025-016.

[117] M. S. Granovetter, "The Strength of Weak Ties," *American Journal of Sociology*, vol. 78, pp. 1360-1380, 1973 1973, doi: 10.1086/225469.

[118] R. Høigaard, R. Säfvenbom, and F. E. Tønnessen, "The Relationship Between Group Cohesion, Group Norms, and Perceived Social Loafing in Soccer Teams," (in en), *Small Group Research*, vol. 37, pp. 217-232, 06/01/2006 2006, doi: 10.1177/1046496406287311.

[119] J. Moreno, *Who shall survive?: A new approach to the problem of human interrelations* (Nervous and mental disease monograph series, no 58.). Washington, DC, US: Nervous and Mental Disease Publishing Co, 1934, p. 441.

[120] A. B. Ryan, "Post-positivist approaches to research," *Researching and Writing your Thesis: a guide for postgraduate students*, pp. 12-26, 2006.

[121] R. E. Floden, "Empirical research without certainty," *Educational theory*, vol. 59, no. 4, pp. 485-498, 2009, doi: 10.1111/j.1741-5446.2009.00332.x.

[122] M. Alvesson and K. Skoldberg, "positivism, social constructionism, critical realism: Three reference points in the philosophy of science," *Reflexive methodology: New vistas for qualitative research*, pp. 15-52, 2009.

[123] J. A. Fails, M. L. Guha, and A. Druin, "Methods and techniques for involving children in the design of new technology for children," *Foundations and Trends® in Human–Computer Interaction*, vol. 6, no. 2, pp. 85-166, 2013, doi: 10.1561/1100000018.

[124] D. Schuler and A. Namioka, *Participatory Design: Principles and Practices*. CRC Press, 1993.