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# Requirements for Location-based Games for Social Interaction

Xavier Fonseca<sup>1</sup>, Stephan Lukosch<sup>2</sup>, Heide Lukosch<sup>2</sup>, Frances Brazier<sup>1</sup>

<sup>1</sup>Faculty of Technology, Policy and Management, TU Delft, Netherlands

<sup>2</sup>HIT Lab NZ, University of Canterbury, New Zealand

xavier.fonseca.phd@gmail.com; stephan.lukosch@canterbury.ac.nz; heide.lukosch@canterbury.ac.nz;  
f.m.brazier@tudelft.nl;

**Abstract**—Social interaction is part of the fabric of society, and is essential to challenge many types of social barriers. Location-based games provide a means to foster such interaction in local communities. The design of such games is currently based primarily on designer experience and on literature on game design in general, and not on an understanding of user requirements. This article explores the preferences and desires of adolescents in neighbourhoods of Rotterdam South to socially interact with others and engage with their own neighbourhood via location-based games. Adolescents are informants in the exploration of gaming activities for social interaction, which, when subjected to expert review with the MDA framework, produce gameplay requirements for the desired purpose: social interaction in public space. Such requirements provide researchers and game designers insights on the game dynamics best suited to foster location based social interaction.

**Keywords**—Gameplay requirements, social interaction, location-based games, public space, adolescents

## I. INTRODUCTION

Social interaction is an exchange between individuals and is a building block of society [1]. It is pinned as being one of the simplest, most straightforward ways to overcome several barriers found in society such as the lack of wellbeing, sense of “not belonging” in a community, or simply the lack of engagement with the neighbourhood and its citizens [2]. It is particularly of importance when social interaction is local and meaningful and has the power to truly contribute to societal cohesion [3, 4]. Meaningful interaction, according to [1], is first and foremost described as being positive, i.e. that do not involve arguments or unpleasant experiences [5].

Games like Pokémon Go are games that are played outside, with a lot of interaction [6]. These games have become so successful that cities have explored their use for civic engagement in local communities, to boost participation in local festivities within the order of thousands of people [7]. Yet, no study yet has analysed the requirements such games fulfil, other than that they are played outside with a smartphone, with points of interest (POIs) and mapping data, and potentially augmented

reality<sup>1</sup> [8], or has formulated a methodology to identify requirements for games of such type. The development of such games are often based on ideas generated during in-house brainstorming or pitching sessions by game designers [9], on the basis of insights found in the literature or on the designers/developers personal experience [8, 10-13]. Requirements elicitation with future players during the early stages of game conceptualization is not current practice, despite existent guidelines and methods for end-user involvement in game design/development [9, 14-20]. In general, knowledge on how to design games based on requirements is limited [10, 21, 22], let alone for location based games that foster social interaction. This means that during early phases of game design, designers/developers are not informed by what users want and desire, while taking people and disciplines into account is associated with creating meaning in games [101] such as the purpose to foster social interaction. The problem with our current lack of understanding of requirements for games to foster social interaction and an effective way to identify these is to miss out on a powerful opportunity to develop stronger social cohesion in neighbourhoods.

This article seeks to understand the preferences and desires, and thus the requirements, of adolescents, for gaming activities designed for social interaction and to be played in their own neighbourhood. This entails a two-folded challenge. Firstly, individuals all have their own preferences and wishes on how to pursue interaction in public space [1, 23]. This holds true in particular for adolescents who are in a stage in life in which they are working on their own self-definition, their own identity [24]. Secondly, the explicit goal to foster social interaction in public space mandates consideration of factors that directly relate to location-based social interaction that do not necessarily hold for game design in general [25-27]. These challenges have to be addressed in a novel game requirements elicitation and analysis methodology for this specific type of game.

The research question this article explores is: “**what are the requirements adolescents have for location-based games that foster social interaction in their own neighbourhood and how can they best be identified?**”. Adolescents between 12-16 years of age in a neighbourhood perceived to be socially

This paragraph of the first footnote will contain the date on which you submitted your paper for review. It will also contain support information, including sponsor and financial support acknowledgment. For example, “This work was supported in part by the U.S. Department of Commerce under Grant BS123456.”

<sup>1</sup> <https://mashable.com/2016/07/10/john-hanke-pokemon-go/?europe=true>, How the gurus behind Google Earth created ‘Pokémon Go’, last visited on 6 May 2021.

challenging in Rotterdam, Netherlands, were the informants for this study. The results of this study are a set of requirements for location-based games for social interaction that appeal to this target group, and lessons learned from the requirements analysis methodology developed in this study to elicit requirements for these games. Two well accepted game design frameworks are deployed in our study. The Triadic Game Design (TGD) philosophy as proposed by [101] has been used to structure the workshop with the adolescents in Rotterdam. This design method allows to address the three aspects of reality, meaning, and play of a game. The results of the workshops have been analysed along the Mechanics-Dynamics-Aesthetics (MDA) approach by [122]. While mechanics explain the hidden parts of a game, as its rules and interactions, dynamics are the emergent game behaviour that arises during gameplay after the mechanics are put to use by the player, such as the feedback of the game to a given action of a player. Aesthetics in this approach are understood to be the desirable emotional responses of the player. The requirements analysis methodology developed in this study focuses on the dynamics of games that players want to have.

The next section presents the current state of the art on existing games that foster social interaction in some way, as well as existing guidelines and requirements for social engagement and interaction in general. The following chapter describes the research context, the requirements elicitation process deployed for game design with adolescents as informants, the workshops, and the findings. The fourth section analyses the data collected during these workshops, presenting an approach designed to this purpose, to identify a list of game dynamics, conceptualized as requirements, that are core to these findings. Finally, the following sections discuss the findings, limitations of the study, and present a conclusion. The supplementary material provides additional detail on the initial and revised structure of the process deployed, and the full analysis of the results from which the proposed requirements are based.

## II. BACKGROUND

Several location-based games (LBGs) have been designed that have the potential to foster social interaction. This section first reviews these LBGs and focuses specifically on LBGs that are to be played in public space, i.e. places that are generally open and accessible to people (e.g. roads, public squares, parks, benches), and that are not limited for public use. This section then reviews generic guidelines and requirements for social interaction or engagement in games. This analysis provides first insights into requirements for location-based games to foster social interaction as basis for our own approach.

### A. Location-based Games for Social Interaction

Playful experiences between people in different urban environments is the goal of games such as *Koppelkiek*<sup>2</sup>, and *Hello Lamp*<sup>3</sup>, that foster social interaction. *Koppelkiek* is a game

designed for a neighbourhood in Utrecht, NL, to foster face-to-face interaction by players taking pictures of themselves together with other people (friends, family, or complete strangers) and uploading them online to acquire points. *Hello Lamp* promotes digital communication between players and street objects. This digital interaction game is location-based (people need to be co-located throughout Bristol, UK), even though all communication is digital (based on text messages or Facebook messenger) [28].

Other games foster social interaction by bringing the digital and the physical world together with keeping track of players' location in real time, to enable them to advance through the game play. Examples of commercial games that foster social interaction this way include: *Pokémon GO* [29], *Google Ingress* [30], *BotFighters* [31], *Shadow Cities*<sup>4</sup>, *Feeding Yoshi*<sup>5</sup>, *Field Trip*<sup>6</sup>, *Endgame: Proving Ground* [32], and *Mogi* (later called *Geocaching*)<sup>7</sup>. Examples of games designed for research purposes include *Koppelkiek* and *Hello Lamp* as discussed above, *Insectopia* [33], *Mythical: The Mobile Awakening* [15], *Day of the Figurines* [34], and *CityConqueror* [35].

*BotFighters*, *Shadow Cities*, *Field Trip*, *EndGame Proving Ground*, *Pokemon GO*, *Feeding Yoshi*, *Google Ingress*, and *Mogi/Geocaching*, motivate players to walk around the real environment and collect digital and real items, explore individually or in a group, compete with other players in battles for the ownership of items such as Pokémons or landmarks in the real world, and collaborate with other people in unique digital item exchanges or in team formation.

*Insectopia* is a prototype game that allows players to digitally compete to collect the highest number of insects. It advocates the need for social interaction and nudges players to send insects to other players during the game. *Mythical: The Mobile Awakening* is a mobile game designed for players to play together as wizards in a parallel reality. It exploits asynchronous gameplay to allow players' avatars to interact with one another during encounters, even though the players are not online at the same time. *Day of the Figurines* is a physical board game in which players build a shared narrative of a digital city in a cooperative way. During the players' daily routines and throughout several weeks, they send text messages to interrupt the stories of other players and advance the narrative of the game. Lastly, *CityConqueror* is a game that promotes competition through beating other players in the ownership of digital territory layered on top of the real environment. The researchers of this game explicitly chose digital mechanisms of interaction such as friendly fire and the attack of a region by fellow team members to maximize digital interaction between players [35].

Analysis of the literature and information releases online, shows that either (1) requirements are chosen by the designers and not the future players (in-house process that generated its own requirements), or (2) this information is simply not known or public. In *Koppelkiek*, the researchers reported online<sup>2</sup> that the process of game development started off with a fruitful in-

<sup>2</sup><https://whatsthehubbub.nl/projects/koppelkiek/>, Koppelkiek, 'couple snapshot' in Dutch, last visited on 6 May 2021.

<sup>3</sup><http://www.hellolamp.co.uk/>, Hello Lamp Post, The playful, city wide system that lets you talk to street furniture, last visited on 6 May 2021.

<sup>4</sup><https://www.giantbomb.com/shadow-cities/3030-35591/>, Shadow Cities, last visited on 6 May 2021.

<sup>5</sup><http://www.freewarepocketpc.net/ppc-download-feeding-yoshi-v1-2.html>, Feeding Yoshi v1.2, last visited on 6 May 2021.

<sup>6</sup><https://itunes.apple.com/us/app/field-trip/id567841460?mt=8>, Field Trip, last visited on 6 May 2021.

<sup>7</sup><https://www.geocaching.com/play>, Geocaching, last visited on 6 May 2021.

house idea generation stage, followed by quick playtests with people on the streets of Utrecht. In parallel to the playtests, a field study was organised to discover useful information to be later added on to the final concept of the game, which was again resultant from in-house choices.

In *Mythical: The Mobile Awakening*, the researchers purposefully developed a game to elicit an initial set of design guidelines for pervasive mobile games, and using game elements such as contextual information, asynchronous game play, and predefined interval updates. [15]. The description of the design process of this game clearly shows that the requirements used for this game stem from the researcher's choices [15].

For *Day of the Figurines*, the requirements and why those and not others were chosen are unknown. Again, the researchers' reasoning suggests that the design decisions that were made came from them (e.g. "to ensure as many players as possible would be able to play the game using their own mobile phones, it was decided early on ... to base the game on SMS text messaging" [34]).

*CityConqueror* has design choices made by the authors (e.g. no story line such as in *Pokémon GO*, a real map of the city, and the turn-based game mechanic) that are simply justified with the rationale "as it is popular in ...", and do not have a better motive to support them. *Hello Lamp* is a playful initiative for which the source of the requirements or the design is unknown. This also holds for the commercial games named. As an example, press releases on *Pokémon GO* reveal that the company that created the game has the ability to understand what works and what does not on players, and that it follows a play-centred approach to test its own design choices<sup>8</sup>.

Above examples show that requirements are not explicitly related to the preferences of players, but based on game designers' assumptions, and that they do not relate to a shared method of requirements elicitation and analysis for this type of games.

### B. Guidelines/Requirements for Digital Games

To the best of our knowledge, there are no requirements identified and commonly accepted that are specific to games designed to foster social interaction in public space. Game design practitioners have shown to explore non-user-centred requirements during early-stages of game conceptualization, but this knowledge is most often not shared with the "outer world" [22]. The requirements that are documented are scattered across different types of games, such as requirements for pervasive games in general [12, 14, 15], serious games [36-39], movement-based exergames [10, 11, 17, 40-44], online gaming sites [45], electronic computer games [8, 46, 47], mobile multiplayer (AR) games [48-51], massive multiplayer online games [52], non-digital multiplayer games [53], AR (augmented reality) indoor-based games [13, 16, 54], and guidelines for education [55]. These guidelines, requirements, and heuristics often pertain to games for children and the elderly, covering quality requirements for emotions, exertion, motivation, engagement and awareness levels, behaviour

education, presence, social adaptability, accessibility, intergenerational and indoor gameplays both with computers, toys and table tops, and they also include recommendations specific to user experience for impaired users, mobile learning experiences, and user-game interaction.

The above research is helpful to increase understanding of how different types of games have included social interaction as a sub-component. In [53], the authors consider social interaction as purposeful bilateral communication that is either natural (spontaneous) or stimulated (necessary to the game), and that these can either be triggered by the game (e.g. via competition and cooperation that can be synchronous or not), or in the existence of meta-gaming (side-games in parallel to the actual game). Other researchers strengthen this point, and argue that communication outside the game world is key for a gameplay happening in public space, both in-line with meta-gaming [48] and natural face-to-face communication [15]. Even though digital interaction is still the most common form of interaction advocated across literature [38], research regarding balanced gameplay between a pure virtual and real world game play experience, with the use of multiple communication channels, was documented multiple times [12, 13, 50]. This suggests that social interaction is best triggered when involving play settings allowing for the full range of exchange between individuals (players and non-players alike) in a balanced way [8, 16, 21]. Involving people from different generations can contribute to a richer and more unique social experience [51, 56], and the deployment of tangible objects bears the power of bringing people to the same space and set novel ways of interaction [54]. Exceptions exist, however: players afflicted with an impairment showed unwillingness to play with other people [39]. There are also guidelines that focus on LBGs for learning purposes that cover "social aspects", which, even though meant for a specific purpose, hint on ways to bring pupils together based on the level of their skills, role variation, and imposition of competition.

Most of the presented design recommendations stem either from literature [8, 10-13, 21, 38, 47, 49, 51, 53, 55, 56], game analyses [15, 46, 48, 57], or the personal experience of design practitioners in the field [10, 17, 40, 50, 54]. One study was the exception, i.e. as proposing user-centred guidelines with some connection to social interaction. Choi et al. [45] performed a large survey study to understand which features players thought were responsible for optimal engagement in online games. Even though digital interaction is covered in their guidelines (e.g. chat functions and a user id for communication), their guidelines focus on online user engagement and completely leave offline-based forms of interaction unexploited. Such insights are necessary for the design of games for social interaction in public space.

This analysis shows that the vast majority of guidelines and requirements discussed in the literature are not player-centric (i.e. do not come from the players) but play-centric (i.e. game prototypes are firstly created by designers, involving users later in gameplay) [22], and thus do not shed light on player preferences and requirements. This lack of understanding results in a lack of design principles (dynamics) that can be used

<sup>8</sup>[https://www.gamasutra.com/view/news/338986/Pokemon\\_Gos\\_PvP\\_was\\_designed\\_to\\_appeal\\_to\\_players\\_new\\_and\\_olddand\\_it\\_worked.php](https://www.gamasutra.com/view/news/338986/Pokemon_Gos_PvP_was_designed_to_appeal_to_players_new_and_olddand_it_worked.php), Pokémon Go's

PvP was designed to appeal to players new and old--and it worked, last visited on 6 May 2021.



by game designers and researchers when their goal is to foster social interaction. This is the knowledge gap on which this paper focuses.

### III. RESEARCH CONTEXT

This study is embedded in a research programme that aims to foster meaningful social interaction in urban environments, as a way to positively influence social cohesion [2]. Literature on social cohesion argues that there are three types of actors that should be taken into account to impact social cohesion best, which are the individual, the community, and formal institutions [4]. In the study on which this paper reports (in Feijenoord, Rotterdam, Netherlands, a neighbourhood in the south of Rotterdam that could benefit from a positive approach towards social cohesion), the primary formal institution that plays a role in the lives of the citizens is the Municipality of Rotterdam. A Cultural Thinktank and two different secondary schools contributed to this study as the community, with their knowledge and strong connection to individuals from the neighbourhoods involved. Lastly, individuals in the neighbourhoods participated directly in this study. All actors recognized the need for more presence and social interaction on the streets.

This need resonates with public statistics of the city. In 2019, Rotterdam is a city with an estimated number of 644,527 citizens with 50.3% foreign ethnicity<sup>9</sup> (Fig. 1), and it ranks top in the Netherlands as the city with the highest rate of reported crime incidents<sup>10</sup>. Feijenoord is even more diverse with regard to ethnicities, with less than 40% being native Dutch<sup>11</sup>. Feijenoord also ranks low in the social and safety quality indexes that include indices for e.g. contact with local residents, crime and nuisance<sup>12</sup>.

The actors involved in this research programme argue that a game targeting children, if engaging enough, could trigger a cascading interest strong enough to reach their parents and fellow neighbours in the area, to bring more people to the streets and enhance security overall.

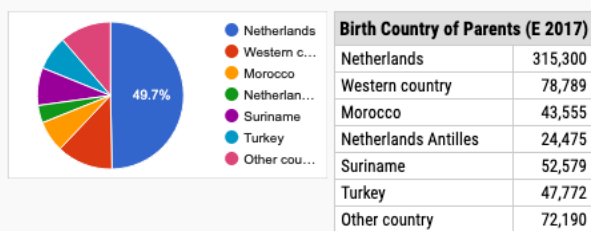


Fig. 1. Birth Country of Citizens in Rotterdam<sup>9</sup>.

Adolescents between 12-16 years of age were the selected target group for this study. First, because they know how to work with and own smartphones as technology for mobile games, (69% of European adolescents use smartphones [58, 59]) and as games have characteristics that appeal to this target

group [60]. Secondly, this age group were chosen to create a sustainable impact in the neighbourhood, as older adolescents (17 onwards) are likely to start changing their lives substantially (including the neighbourhood in which they live)<sup>13</sup>.

### IV. RESEARCH DESIGN FOR REQUIREMENTS ANALYSIS

The methodology of research deployed in this study is research through design (RtD) [61], and cooperative inquiry [62, 63]. RtD uses methods and processes of design practice to develop new knowledge [64]. The knowledge developed in this study is knowledge of the preferences and desires adolescents have with respect to the use of a location-based game designed for interaction with other citizens in their neighbourhood (which are translated into requirements). This knowledge comes from the adolescents themselves, the future players of such games, and as such involves cooperative inquiry, that draws from the design methods of participatory design and contextual inquiry [62, 65].

To elicit preferences and desires of adolescents, and understand the way they prefer to interact socially in their own neighbourhood, adolescents were involved as informants in a set of structured workshops. The role of informant is one of several that end-users can be given in the making and shaping of digital technology [20]. For this study two game design workshops were organised at two different schools in Feijenoord to increase understanding of adolescents' preferences with respect to 1) the types of games they would like to play in their neighbourhood, 2) co-players - with whom they would prefer to play, and 3) locations within their neighbourhood. The structure of both workshops is based on the Triadic Game Design (TGD) approach, following a design philosophy that aims to balance the three elements of *reality* (of players), *meaning* (goal for the game), and *play* (the game play) [66]. The gamification techniques used during the workshops included game elements and dynamics of collaboration, competition, points, prizes at the end, and a commercial card deck toolkit to trigger adolescents' creativity.

The selection of the participants for the two workshops was handled by the schools themselves, with no influence from the researchers, and no restrictions (e.g. gender or ethnicity) other than their age and the neighbourhood. The two schools announced the workshops within their schools as an event for students living locally (in the area of Feijenoord) in the target group age of which they could volunteer, and contacted adolescents personally. Consent forms for parent approval for both participation and data collection were distributed (and collected) by the schools. The schools were the "Rotterdams Vakcollege De Hef" (RVC De Hef), and the "Scheepvaart en Transport College" (STC).

All participants were told beforehand that they will be asked to think of a game that (1) is fun, (2) is meant to be played in

<sup>9</sup><https://www.citypopulation.de/php/netherlands-admin.php?adm2id=0599>, Provinces and municipalities in the boundaries of January 2019, last visited on 6 May 2021.

<sup>10</sup>[https://www.numbeo.com/crime/country\\\_result.jsp?country=Netherlands](https://www.numbeo.com/crime/country\_result.jsp?country=Netherlands), Crime in the Netherlands, last visited on 6 May 2021.

<sup>11</sup>[https://www.ggdrotterdamrjmonnd.nl/wat-doet-de-ggd/onderzoek/GGD\\\_Factsheet\\\_eenzaamheid\\\_juli\\\_2014.pdf](https://www.ggdrotterdamrjmonnd.nl/wat-doet-de-ggd/onderzoek/GGD\_Factsheet\_eenzaamheid\_juli\_2014.pdf), Fact Sheet, last visited on 6 May 2021.

<sup>12</sup><https://wijkprofiel.rotterdam.nl/nl/2018/rotterdam/feijenoord>, Feijenoord, last visited on 6 May 2021.

<sup>13</sup><http://www.amchp.org/programsandtopics/AdolescentHealth/projects/Documents/SAHRC.%20AYADevelopment.%20LateAdolescentYoungAdulthood.pdf>, Late adolescence, last visited on 6 May 2021.

your neighbourhood, (3) with your smartphone, and (4) involving everyone in it, providing an initial frame of reference.

### A. Workshop Structure

The structure of both workshops followed a modified version of the TGD approach, including all three of its elements, **Reality**, **Meaning**, and **Play** [66]. The world of **Reality** describes the reality of the players, i.e. the social situation in which gameplay occurs. It contains information about the actors responsible for either the problem or its solution/mitigation, and the relationships between them. The world of **Meaning** is intertwined with the purpose of the game, i.e. the creation of value (in this case, social interaction that is meaningful to players). This value proposal is the value that the game brings beyond the game itself, or the purpose intended for the game to achieve. The world of **Play** is the medium used to deliver such value, i.e. the tools, elements and mechanisms used to land the desired game play. The game can have different genres (game characteristics), scenarios, and technology used for it to be played. These three worlds (Fig. 2) were defined for the workshops with the adolescents as: 1) the characterization of the neighbourhood (adolescents' **Reality**), 2) brainstorming on game requirements (the **Meaning** to give to the game), and 3) the design of a game (what and how to **Play**).

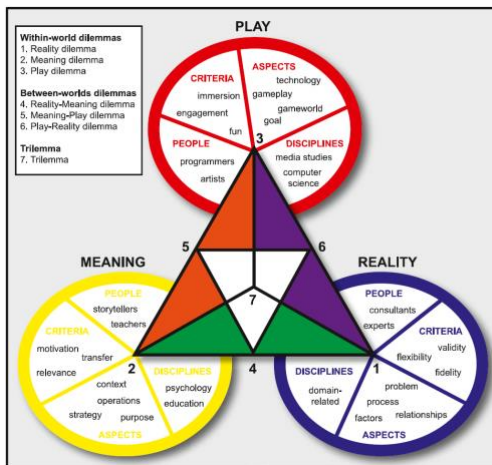


Fig. 2. Triadic Game Design philosophy [66]

For **Reality**, i.e. the characterization of the neighbourhood, the questions are:

- 1) "Identify your neighbourhood by indicating the area on a map of Rotterdam"
- 2) "Characterize the neighbourhood, and the things and people that play a role in your neighbourhood (people, organizations, artefacts, phenomena, etc.)"
- 3) "Draw a picture showing the relations between the identified people/objects".

For the brainstorming on game requirements related to the **Meaning** of the game (fostering social interaction), the following questions are posed in smaller groups:

- 1) "Think of activities for you to do (or could do) with other people"
- 2) "Brainstorm activities that would lead to the joint game activities"
- 3) "Identify the major players of the game (who do you think should be part of the game, even if not directly playing the game)"
- 4) "Where (major locations), when (the game is to be played), and how (with which devices) will the game be played?"

For the design of the game play (world of **Play** from TGD), the workshop follows a gamified approach using a commercial card deck<sup>14</sup> included in the AddingPlay toolkit<sup>14</sup>, to help participants generate game ideas by proposing game mechanics, social mechanics, player motivators, and victory conditions [67]. The gamified card deck was translated to Dutch for the target group, and was chosen because it offers a playful focus on game design in a simpler and easier to learn and use way [68] when compared to other tools in standard practice for the brainstorming of game mechanics [69-73]. This approach follows the technique "bags of stuff" from cooperative inquiry, to create multiple solutions [62], and represents the second step in the new game design methodology. The card deck itself supports a process of 5 steps: (1) definition of title, topic, and audience of a game, (2) definition of motivations to play the game, (3) definition of victory conditions, (4) setup of the rules of play, and (5) making the game social (how players can interact with others). Participants in the workshop draw a number of cards (the number differs per step) that, in turn, are used to create the game play they have in mind. These cards act as creativity triggers that guide the adolescents by incrementally exploring how their idea(s) translate to their own world of play.

With this workshop structure, the worlds of **Reality**, **Meaning**, and **Play** of the participants are defined in a flexible way, which in turn are used to inform the researchers in this study on their preferences and desires (and the resulting requirements).

### B. Procedure

Following the workshop structure, the resulting overall procedure of our study is:

- Execution of the first workshop
- Analysis of results and of the execution of the workshop
- Revision and improvement of the workshop structure
- Execution of the second workshop
- Analysis of results and of the execution of the workshop

During the workshops, data were collected from three types of sources: The first is the direct feedback provided by the facilitators of both workshops, as written down right after each workshop; the second are the notes and other writings made by facilitators and participants during the workshops at group level; the third is the audio recordings made during the workshops.

<sup>14</sup> <http://gamification.playgen.com/>, AddingPlay, powered by PlayGen, last visited on 6 May 2021.

Information that was collected from the observations of the facilitators was structured along the questions on how the workshops went, on the process of the workshops, the game ideas developed, and further remarks made by the participants. The facilitators knew beforehand that they should take notes related to these topics. Data collected also include information on activities that participants normally like to do, locations where they would like to play, and with whom they would consider playing a game: this data were informative but not with respect to game dynamics involved (and therefore not considered in our analysis).

### C. Workshop 1: Practical Secondary School De Hef

The first workshop is set up to last three and half hours with one break in between, and is composed of the three major parts described above: characterization of the neighbourhood, brainstorming on game requirements, and the design of the game play. The first part, the characterization of reality – the neighbourhood – is based on questions presented above to describe their own neighbourhoods in terms of where they are on the map, positioning and describing people and/or organizations, artefacts and activities (phenomena), and drawing relationships between the identified people/objects on a separate piece of paper. Participants are asked to indicate the ideal location for their envisioned gameplay on a provided paper-based map of Rotterdam South.

Brainstorming on game requirements related to the envisioned meaning of the games as second step is introduced as a challenge. Participants are primed with several videos that showcase the goals defined above: a game that (1) is fun, (2) is meant to be played in your neighbourhood, (3) with your smartphone, and (4) involving everyone in it. The videos show examples of relatively well-known games (e.g. Pokémon Go<sup>15</sup>, and Google Ingress<sup>16</sup>), but also examples of hardware artefacts that could be used in their games (e.g. interactive projections<sup>17</sup>, 3D projection mapping<sup>18</sup>, and art installations<sup>19</sup>). After showing the videos, each small group identifies a set of activities that they like to do (or could do) on their own, and a set of activities that they would like (or would like) to do with other people in the identified neighbourhood. As indicated above participants brainstorm on the types of activities that could lead to joint game activities, and by whom (i.e. the major players). The adolescents then define where (major locations), when (the game is to be played), and how (with which devices) the game is to be played, and agree on a name for the game.

The design of the game play ideas, the last part, follows the procedure described above. Gamification of this phase for the adolescents in this study entailed inclusion of competition between the groups: the group with the best game play idea determined on the basis of voting wins a prize. Groups are advised to have at least one game play idea throughout this process, with at most three ideas at any one point. Once each of the groups has agreed on their game play idea they are asked to pitch this idea to the other groups; all participants vote for the

game play idea they like best (other than that of their own group).

Once the winning game is identified, there is an open debriefing session with all participants that aims at discussing all game play ideas presented. The debriefing session is led by one facilitator along the questions why the participants chose the game play ideas they did, what they liked the most about those ideas, and what they liked about the ones they did not choose. The verbal feedback of the participants is audio recorded, and later transcribed and analysed to identify requirements mentioned by the participants when discussing their preferences and desires.

#### 1) Requirements analysis method - Execution of Workshop 1

The first workshop had 16 participants (4 girls, 12 boys) between 12 and 16 years old. After the introduction, these adolescents were divided into 3 smaller groups (5-6 people each). Each group had two facilitators (teachers and researchers) to help with group dynamics.

The participants were interested in creating a game and working together. During the course of the workshop they realised that they would not be creating a game, but that they would be creating a game idea. Thus, prolonged participant engagement was an issue, and the workshop was shortened to 2.5 hours total, including the debriefing session.

#### 2) Requirements analysis results – Game play Ideas of Workshop 1

In total 5 game play ideas were identified, as described below:

1. *Keep on Running*: Accomplish challenges given by other players, earn ‘gold’, the virtual currency of the game, with them, and showcase players’ progress with a virtual avatar. The game fosters competition between two groups of players, by allowing each group (and single players) to create new challenges for the other group to complete (and therefore rendering the winning group some points). Players who create challenges receive a small amount of ‘gold’, and a bit more when the other team completes their challenge. The game can also produce random tasks for both groups, and the group that accomplishes the challenge first wins the ‘gold’. The challenges are of physical nature (in the real world), but also in the virtual game, where the players have to deal with monsters that try to hinder the team in their quest to accomplish the task at hand. When a challenge is performed as a group, all of the elements involved have to provide partial solutions for the challenge for the group to win the ‘gold’. Players can also choose a single-player mode, where individual contributions or physical exercises are attributed to their group (e.g. going to the box club, or sports club). Players have a digital avatar that is representative of their condition in the game: the leaner the avatar, the stronger the player’s commitment in the game. Items collected through challenges can be used to

<sup>15</sup> <https://www.pokemongo.com/en-us/>, Pokémon Go, last visited on 6 May 2021.

<sup>16</sup> <https://www.ingress.com/>, Google Ingress, last visited on 6 May 2021.

<sup>17</sup> <https://www.youtube.com/watch?v=t9hniaziHXY>, Urban interaction design – Projected Games, last visited on 6 May 2021.

<sup>18</sup> <https://www.youtube.com/watch?v=CpRLwLcLHNA>, ‘Axioma’ - 3D projection mapping, last visited on 6 May 2021.

<sup>19</sup> <https://www.youtube.com/watch?v=BZNqOSP5w9Y>, Best Art installations, last visited on 6 May 2021.



personalize and enhance the avatar. The game starts when someone enters the game world and forms a group; to do this, a player can send out messages to anyone in the game who is nearby and wants to join the game.

2. *RealCraft Zuiderpark*: This game idea is based on Minecraft™©, in which players can collect assets and build virtual objects. The game has a storyline and allows for players to fight against enemies (e.g. zombies, and the creeper as in Minecraft™©). Players can collect assets from the environment (e.g. wood, stone, or sand), earn points with battles won but also based on their objects built, improve and customize their avatar (new clothes, more colours, more haircuts, etc.), exchange messages (e.g. to trade, collaborate, or build), trade and exchange assets with other players they meet in the game, and build virtual objects in the environment (when together with other players and with a combination of different types of assets). Once such virtual objects are built, other players can see them too, and at first it is meant to be played in Zuiderpark (but could scale up to whole Rotterdam/Netherlands).
3. *The Voice of South*: The game consists of recording people singing or making music at a specific spot in the neighbourhood, and the game would enable others around to listen to it on the spot and rate player's performances. The best songs/raps/clips would be on top of the leader boards resulting in increased social status and visibility.
4. *Water Ball*: This game idea consists of having people throw virtual balls at each other with their smartphone. Instead of losing when being hit, a player receives points from the thrower/attacker, and he or she only receives points when different people throw balls at him/her. The purpose of the game is to increase contact on the street, as a means to meet new people. This game of throwing balls is considered to be a way of interacting.
5. *Eat & Go*: This game consists of collecting points by walking around Zuiderpark, a park in the south of Rotterdam, or challenging other people in sports competitions. The points collected by the players (either individually or as a group) can be used to acquire food from supporting companies for free, and the more points collected, the more variety of food the player can get. This game can be adapted to things other than food, and can also consider joint activities among the players (e.g. Flash Mobs, voluntary work like garbage collection or helping others repairing things). Players randomly encounter challenges while walking around Zuiderpark, and these challenges make players win or lose points.

### 3) Requirements analysis method - Analysis of Workshop structure 1

The first lesson learned from the first workshop is that the adolescents were willing to talk about their homes, where they lived, but also about criminality and boredom. In some cases facilitator intervention was needed to prompt participant contribution. The examples of real games and game elements presented in the brainstorming part of the workshop seemed to work well, as did the competitive nature of the challenge to

design the best game idea (as reported by the facilitators and participants).

Another lesson learned is that the levels of productivity, interest in participation, collaborative attitude, and disruptive behaviour varied across groups (despite the voluntary nature of their participation). Adolescents varied in their knowledge of the area (i.e. was often very limited; some were not allowed to play on the streets by their parents), and their map reading skills were limited.

An addition to the lessons learned is that participants' expectations were to create a real game and not "just" a game idea. The first workshop worked well in general, but the structure and duration of the workshop were problematic as indicated above. The toolkit used to support game design was perceived by most to be more complex than necessary, and the rules of the competition between groups (i.e. the gamification of the workshop, the pitch of the ideas, attribution of the points, a winner and rewards) were not clear to all participants from the start.

Still on the lessons learned, the debriefing session was not as productive as envisioned: a few participants contributed to the discussion indicating which game they liked best (and for which they had voted) and which activities they liked best. All others agreed with what had been said, adding very little to the discussion.

### D. Workshop 2: Secondary School STC

The workshop structure was revised on the basis of the experience described above. The title of the workshop was changed from "Ontwerp een Game" (Design a Game), to "Bedenk een Game" (Devise a Game) to manage participant expectations: to indicate that the workshop is to explore and devise ideas for games, but not to create them.

The second change related to the structure of the workshop and its duration. The workshop is based on TGD's worlds of *reality*, *meaning*, and *play*, and all three are of importance. Insights on the world of reality, namely characterization of the neighbourhood, were acquired during the first part of Workshop 1.

The structure of Workshop 2 was therefore slightly different: the first part of the workshop on neighbourhood characterization was replaced by a short physical game.

#### 1) Execution of Workshop 2

The second workshop had 15 participants (12 boys, 3 girls) between 12-16 years of age. It started with an introduction of the purpose of the workshop, followed by the actual play of a game outside (Moon Ball [74]). Thereafter, participants moved inside and were introduced to the challenge of the workshop and its competitive nature, were primed in the same way as the 1<sup>st</sup> workshop, and were further divided into groups of 5. One of the groups had only one facilitator (a researcher), and the other two groups had two facilitators per group (one researcher, and one teacher from the school) to help with group dynamics.

#### 2) Requirements analysis results – Game play Ideas of Workshop 2

In total 4 game ideas were identified:

1. *Minecraft™ Go*: The game idea is to play Minecraft™ in the real world, i.e. to place Minecraft™ content in the neighbourhood and to create places to play and meet each other. Players can perceive and become part of the fantasy of others, and see whether their own buildings withstand natural disasters (e.g. flood, earthquake, or volcanos). Players can choose a specific style of building, have a personal logo, an avatar with its own style, and compete with other players for the largest number of buildings built with the different types of resources. Players can advance throughout the game by making friends with other players, trading construction objects and building with them, and going through the storyline and assignments of the game (e.g. build a structure with 100 other players). The game enables ownership of a region, i.e. for players to build walls, create their villages, and invite friends to build in their villages. Players need to move around the neighbourhood to collect unique resources, and to trade those with others.
2. *GTA Rotterdam*: As in the “normal” GTA™, a player receives assignments to follow someone, to find something or someone, to kidnap someone, or to discover hidden drugs. In the course of the game, players are equipped with a water-gun and a virtual dog to help in chasing suspects. The faster a player is in his or her assignments, the better he/she scores. The less water he/she uses from his or her water gun, the more points the player earns. Players can negotiate with other players about assignments or support for each other. They can message each other with their mobile phone. As each player can also be chased by others, there are also safe places in the environment. The winner is the player who earns the highest number of points.
3. *Habiba Challenge*: Habiba is a challenge game, related to sports and other activities. Players can assign challenges to each other, and they can collaborate and teach each other new skills, like tricks on a bike. They can also develop challenges, like eating the most chicken, or hitting each other with a soft ball. Points are gained by winning a challenge; the player with the highest score wins.
4. *The Walking Egg*: This game is similar to Pokémon Go™, as it consists of actions related to objects in the real surroundings. Each player has a map at his or her disposal showing a map with the real surroundings, the main mission (throwing digital eggs at each other to gain points) and side missions. Bonus points can be collected via the side missions and collectable items (e.g. Chicken Drops that drop extra eggs, quick egg-throwing weapons, or golden eggs that multiply the points earned), but also by walking around in real life. The players have to throw eggs to acquire points to build their farm. Every player has a farm which h/she has to manage, and new elements can be added to the farm (with either points or items collected in the virtual game). Points can be used to buy upgrades for the farm, and real money can be used to acquire such points as well.

### 3) Requirements analysis method - Analysis of Workshop structure 2

The first lesson learned from the second workshop is that it is more effective than the first one. The facilitators reported that in two of the three groups much less support was required, that most adolescents enjoyed thinking of elements for the game, and that they were less disruptive. The shorter set-up and focus on the play aspect resulted in more engagement with the card toolkit. Some of the cards in the card deck were still too difficult, although some of the adolescents really read the cards and tried to implement the elements in the game. The “world of **Meaning**” was done in less than half an hour, while the world of **Play** and the process of creating the drawings for the game took longer than the allotted 40 minutes.

Another lesson learned is that the task of thinking about games does require some attention and conceptual thinking skills, even though gaming is a mutual part of the participants’ culture, and the participants understand the elements of a game. In one particular group (the one that produced the game ideas: GTA Rotterdam, and Habiba), the facilitator noticed early on that part of this group had a clear preference for shooter games with some level of violence. The choice of facilitation was to allow for unrestrained flow of thoughts (which then resulted in the GTA Rotterdam). The group dynamics were challenging: the facilitator reported that not all participants were in favour of violence but that two of the older boys constantly tried to dominate the discussion and to intimidate the facilitator and other participants through aggressive behaviour and jokes. The game Habiba was the result of the facilitator’s intervention to guide the design process to support a game idea without violence on purpose, in particular for the younger participants of that group whom seemed to be open to collaborative games, and activities that can be shared and are challenging.

Lastly, a lesson learned from the second workshop is that the enhanced effectiveness of the second workshop structure led to more detailed and therefore better game ideas (specifically The Walking Egg). This also led to a debate by one of the groups on topics associated to the game play, such as “older” people’s willingness to engage in a game, and the feasibility of going outside and doing “something with strangers in their neighbourhood” although appealing.

## V. DATA ANALYSIS

Games often purposefully evoke different emotions in players by deploying a certain number of game dynamics. Understanding the emotions and the related game dynamics of a game is therefore an important step in the analysis of game requirements for a certain purpose, such as social interaction. Hunicke et al. [75] define game dynamics as: “the run-time behaviour of the mechanics acting on player inputs and each other’s outputs over time”, thus the external elements a game player can experience. Building upon the dynamics, this article employs the MDA framework for requirements analysis of games for social interaction, designed together with the youth as envisioned target group. Though several other frameworks exist [76, 77] (e.g. Elemental Tetrad [78], MTDA+N [79], DPE [80], DDE [81], and gamification-related [82-86]), the MDA framework, in comparison, enables game developers and practitioners to decompose, study, and design game designs and

artefacts in a structured way, and provides one fundamental approach to game design: it decomposes every game into a set of rules that lead to a system of play, and that, in turn, generate a “fun”-based play experience [75]. MDA establishes a counterpart relationship (from the rules → system → play experience) that provides a functionality-oriented perspective (mechanics → dynamics → aesthetics) that has shown to be useful to analyse games [87]. MDA offers a “workable” mental model for how information is created and received in a game, and simplifies the chain of events by creating a hierarchy of game components and basic elements (where mechanics are at the foundation of a game) [88]. This model makes it possible to analyse existing game ideas and designs in their underlying functionality, to identify requirements on which they are based.

In summary, this research uses the MDA framework due to 1) its wide acceptance by the scientific community [81], 2) its practical functionality-oriented approach, 3) its grounding in emotions (aesthetics) and involvement of players, and 4) its value for analysis of game ideas and identification of requirements reported in this paper (see supplement).

The requirements analysis process described in this section focuses on understanding the dynamics of the 9 game ideas. This paper focuses on the analysis of the game dynamics, as these are the explicit runtime behaviour of the game experienced by players, and easiest to discuss with participants of game design workshops. The workshops were conducted following the TGD design approach in their structure. Detailed analysis on the game ideas can be found as supplementary material of this paper.

#### A. Protocol of Analysis

Each of the game ideas developed by the adolescents was analysed by 2 researchers to identify the game dynamics that were identified by the workshop participants. The set of possible game dynamics used during the analysis is based on different sources: a library of game mechanics [89], game mechanics from the AddingPlay card deck toolkit [68], and the SCVNGR’s secret game mechanics/dynamics play deck<sup>20</sup>, that were used during the workshops. In the first stage of analysis, two researchers independently analysed and classified the dynamics they identified in the game ideas given by the participants. In the second stage of analysis, they used this set of possible game dynamics to code, per game idea, the way that the identified dynamics are technically supported. The resulting lists of game dynamics were cross-validated, adapted when necessary through agreement on what dynamics best describe the entailed gameplay ideas. The supplement material to this paper provides a detailed account on the identified list of dynamics, and where and how often each of them occurs.

#### B. Game Dynamics for Location-based Games Fostering Social Interaction

Table I shows the number of times the game dynamics identified by the participants in their frequency. It shows that *achievement* occurs most frequently, 45/81 times. *Real-world play* (27/81), *reinforcement* (25/81), *social interaction* (24/81), and *collaboration* (18/81) are the dynamics that are then most

frequently deployed. *Digital interaction*, *ownership*, and *winning condition* (17/81) scored equally. On the lower spectrum, *collection* (12/81), *exertion* (10/81), *virtual representation* (10/81), *mission* (8/81), *community contribution* (6/81), and *lottery* (3/81) are the dynamics least used by the participants.

Table II on the following page shows the game dynamics that were identified in the game ideas from the two workshops. This list presents the name of each specific game dynamic in the left column, and to the right descriptions derived from the game ideas. This sorted list of game dynamics reflects the preferences and desires of the participants in this target group with regard to gameplay and functionality of future location-based games designed for social interaction. This list, in fact, represents these participants’ high-level requirements (see the supplementary material for a detailed analysis).

Table I. Frequency (**Frequency**) of the game dynamics (**Dynamics**) in the game ideas (refer to the supplementary materials for a full analysis). Also shows references to the literature (**Literature**), i.e. how each requirement compares to other guidelines.

| Dynamics               | Frequency | Literature                                   |
|------------------------|-----------|----------------------------------------------|
| Achievement            | 45        | [11, 17, 38, 54]                             |
| Real-world play        | 27        | [8, 12, 13, 21, 50, 53, 54]                  |
| Reinforcement          | 25        | [11, 17, 37-39, 51]                          |
| Social Interaction     | 24        | [8, 10-12, 14, 21, 48, 50, 51, 53, 54]       |
| Collaboration          | 18        | [12-14, 21, 38, 48, 50, 51, 53, 54]          |
| Digital Interaction    | 17        | [11, 12, 14, 15, 17, 21, 38, 45, 48, 50, 53] |
| Ownership              | 17        | [17, 38]                                     |
| Winning Condition      | 12        | [14, 17, 38, 48, 53]                         |
| Collection             | 10        | [11, 13, 14, 16, 21, 50, 54]                 |
| Exertion               | 10        | [8, 12, 14, 17, 21, 38, 40, 48, 50, 53, 54]  |
| Virtual Representation | 10        | [8, 10, 14, 38, 39, 50]                      |
| Mission                | 8         | [11, 14, 38, 39, 51, 54]                     |
| Community Contribution | 6         | [8, 12-15, 21, 38, 48, 50, 51, 53]           |
| Lottery                | 3         | [16]                                         |

## VI. DISCUSSION

This chapter discusses the results of this study, and compares these results to the non-user-centred guidelines and requirements found in the literature (the rightmost column in Table I). A new aesthetic is proposed in this discussion, and limitations discussed.

#### A. Discussion of Results

From the sorted list of game dynamics found in Table I, the game dynamic *achievement* stands out most (it is present in 56% of the dynamics in the game ideas). This means that a sense of accomplishment is of importance to this target group. At a lower level but still prominent are the dynamics *real-world play*, *reinforcement*, and *social interaction*, mentioned for just over 30% of the dynamics in the game ideas.

<sup>20</sup> <https://techcrunch.com/2010/08/25/scvng-r-game-mechanics/>, SCVNGR’s Secret Game Mechanics Playdeck, last visited on 6 May 2021.

Table II. Game dynamics resulting from the game idea analysis.

| Dynamic                | Description                                                                                                                                                                                                                                                                                                                              |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Achievement            | Provide a sense of accomplishment to the player, either as an individual or as a group, resultant from task completion.                                                                                                                                                                                                                  |
| Collaboration          | Enable players to achieve a shared goal by working together, that may be necessary to advance the game play.                                                                                                                                                                                                                             |
| Collection             | Promote player's return to the game by creating an objective of collecting items in the game that can be accomplished over time and several gameplay sessions. Collection is the act of gathering game elements in the game environment (either digital or real world) for the purpose of ownership, trade, or improvement of condition. |
| Community Contribution | Impact the real environment, outside of the game, by involving other people whom are not actively playing the game, or by creating positive influence of gameplay for the neighbourhood.                                                                                                                                                 |
| Digital Interaction    | Promote play and engagement by influencing communication between players, whilst also allowing them to influence the gameplay of other players in the digital world. Digital interaction happens for example in the form of communication, digital group formation, or multiplayer mode.                                                 |
| Exertion               | Motivate players to do activities involving physical effort, to advance in the game. This involves physical effort that is required to perform an activity or solve a challenge linked to the game.                                                                                                                                      |
| Lottery                | Add surprise to the game and prevent the player from getting used to the game with random events that affect the gameplay or its outcome.                                                                                                                                                                                                |
| Mission                | Add fantasy and overall purpose to the gameplay, through a tale, general narrative, or as overall mission or smaller missions that add to the overall tale.                                                                                                                                                                              |
| Ownership              | Enable players to participate, own and be responsible for part of the game content, to (partially) own the game and influence other players' gameplay.                                                                                                                                                                                   |
| Reinforcement          | Foster play and engagement, e.g. provide a reward when a certain action or outcome occurs.                                                                                                                                                                                                                                               |
| Real-world play        | Embed the play in the physical environment and allow players to be physically active.                                                                                                                                                                                                                                                    |
| Social Interaction     | Establish interaction and face-to-face communication, either with other players or with other people not actively playing the game.                                                                                                                                                                                                      |
| Virtual Representation | Increase the player's presence in the game by digitally representing the player's state, visibility, or social status.                                                                                                                                                                                                                   |
| Winning Condition      | Quantify success and accomplishment within the game. A winning condition either implies a comparison and competition between players, or a competition between the player and the game. These are required conditions to complete game tasks.                                                                                            |

This means that after the sense of accomplishment, the participants prefer gameplay with physical movement embedded in the real world, with rewards, and with interaction with people. In addition *collaboration* (22%), *digital interaction*, *ownership* (21%), and *winning condition* (15%), and to a lesser extent, the dynamics *collection* (12%), *exertion* (12%), *virtual representation* (12%), *mission* (9.8%), *community contribution* (7.4%), and *lottery* (3.7%) appear to interest adolescents as well. Future designers of a location-based game for social interaction can take heed of these preferences, i.e. requirements of this target group in future design.

The list of game dynamics identified in this research is not extensive, complete, or closed, and results from the two described workshops. New game ideas can potentially extend and advance these definitions of dynamics. Nonetheless, the list of game dynamics is well founded, and can guide future game design for social interaction.

### B. Comparison between study results and guidelines from literature

The majority of the game dynamics identified in this study, identified as requirements to build location-based games for social interaction in public space, are strongly linked to existing work (with the exceptions of *ownership* and *lottery*) [90]. The requirements this paper identifies for digital and social interaction (*collaboration*, *exertion*, *real-world play*, and *community contribution*), and for different modes of play to support different types of gaming activities (*collaboration*, *winning conditions*, *collection*, *exertion*, and *small/large missions*), are endorsed by [12, 14, 15, 48, 53]. These studies cover “the usage of multiple channels for communication” [12], the “allowance of different modes of play and support various player types”, “as much free communication between players as possible” and the “support of the formation of teams and alliances” [12, 14], “playability heuristics for online player-to-

player interaction with mobile phones” and “off-line communication with others” [15, 48], and lastly “natural (out-of-the-game) and stimulated (in-game) interaction” and “their association to collaboration and competition”, and “how games should allow for meta-gaming (with physical interaction)” [53].

Note that although the requirements proposed in this article are related to those proposed in existing work they are not necessarily directly applicable.

Firstly, some of the requirements found in other studies have a focus that is not compatible with the purpose explored in this study. Some stress digital interaction or indoor interaction [8, 10, 16, 45], that can be related to, for example, *virtual representation* and *reinforcement*, are mainly providing a game play experience compatible with indoor spaces [37]. Social interaction is included in guidelines for games with very different goals such as learning environments [37, 38, 91], for children with special needs such as deaf children [39], but also for blogs, wikis, and discussion groups [38]. Many of our requirements relate to these purposes and media (*reinforcement*, *mission*, *virtual representation*, *ownership*, *community contribution*, *exertion*, *collaboration*, *winning condition*, *achievement*, and *digital interaction*), but to different extents and outcomes. A particular example of this incompatibility with our recommendations is the work of Mascio et al.'s, that reports that deaf children 1) do not enjoy interaction with others, 2) often suffer from excessive distractions by other people (i.e. multiple communication channel reported above), and 3) often their (single player) gameplay does require support from other people (parents or teachers) - which defeats the playability of location-based games for social interaction in public space [39].

Secondly, many of the requirements proposed in this article are directly endorsed by research on object tangibility and the interpersonal interactions these support [13, 16, 21, 51, 54], which prioritises physical mobility and the different affordances of the real-world play. Such guidelines deviate



from the focus on digital online interaction and move towards exertion in the real environment (e.g. in AR games) [10, 17, 21, 40, 50] where the role of various social elements takes lead [8, 11]. These guidelines propose recommendations for players to “be social”, “swap sedentary with active games”, and to promote games with “positive social content” that lead to “fun”, and are directly endorsing many of the requirements released in this study: *digital and social interaction, exertion, community contribution, real-world play, collection, collaboration, collaboration, lottery, mission, real-world play, virtual representation, and achievement*. Yet, many of these guidelines are very diverse: some focus on the importance of novel interactions afforded by tangible objects, others on the importance of the interface and how to balance the elements of the game, or inclusion of players of different age groups [13, 51].

The guidelines found in current literature show that the foci of researchers is spread across numerous aspects of serious games, and that, although with an overlap, not all guidelines are aligned. The lack of consensus is primarily due to differences in the types of games and purposes on which they focus, and none of the research discussed focussed specifically on location-based games for social interaction. No study has yet analysed and recommended a set of guidelines particularly focused on location-based games designed to foster social interaction in public space.

Two of the requirements proposed in this paper (*ownership* and *lottery*) are not strongly linked to existing guidelines, and are thus novel to the adolescents in the studied neighbourhoods of Rotterdam.

### C. Suitability of the requirements analysis method based on the TGD and MDA frameworks

The dynamics identified during our study show that the MDA framework provides a strong basis for requirement analysis for location-based social interaction games. The study shows that game workshops can make use of both the TGD structure (**Reality, Meaning, and Play**) to elicit game ideas, and the MDA framework to derive game dynamics (i.e. requirements) from such ideas. Many are the lessons learned from the method used, that was capable of eliciting and analysing requirements from the participants’ preferences and desires.

Considerations must be made when working with young game players in such process: the questions must be clear and adjusted to the participants’ cognitive level, and expectations have to be well managed.

With regard to the MDA-based analysis method, one game idea was not covered: the game description of Eat and Go mentions the adaptation of the game to aspects other than food, to joint deeds such as voluntary work or providing help in repairing assets for others, or engaging in activities such as cooking or eating (without winning conditions). For this case in particular, this paper proposes to extend Hunnicke et al’s list of aesthetics [75] to include **Care**, an element for players looking for a *gameplay aimed at contributing to the community*. Games implementing this element invite players to engage in offline community building, care for the community, the environment, and the people in it.

### D. Limitations

A major limitation of this study is the small data set gathered from the participants. More game ideas, from a varied pool of participants, can in future address this limitation and provide support for more significant claims. The results reported in this paper are, however, of scientific value, especially due to the exploratory nature of the study in complex and realistic settings to understand adolescents’ preferences for interaction with the neighbourhood in which they live, and the people it includes.

Participation in the study was voluntary, and the selection procedure open. The assumption was that adolescents who volunteer to participate in workshops for the design of a game are motivated and interested in this challenge. As indicated above adolescents’ expectations for the first workshop were not aligned with the goals of the workshop, and was thus adapted for the second workshop: a limitation in itself.

In addition with respect to gender, the sample of participants in total is not gender-balanced (of the 31 participants, 24 were boys and 7 were girls). This fact may skew the findings towards more male-oriented values and styles of gameplay, which, when coupled with the gamified workshops (designed towards mild competition). The sample of participants was, however, judged by the schools to be representative of both the students in these schools and of the neighbourhoods involved. Future work can explore the effects of this possible bias on requirements for LBGs for social interaction.

An aspect not covered in this paper is the priming effect of participants’ prior knowledge of non-location-based games. Game ideas such as RealCraft ZuiderPark, Minecraft Go, GTA Rotterdam, and The Walking Egg are similar to location-based counterparts of known commercial games such as GTA, Minecraft, and Pokémon Go. Future work should take previous gaming experience of participants into account.

## VII. CONCLUSION

This paper seeks to understand the preferences and desires of adolescents living in two neighbourhoods in the south of Rotterdam, Netherlands. It explores which requirements adolescents have to play outdoor digital games for social interaction in their neighbourhood, and understand their context. Different social contexts, even inside the same country, can potentially reveal details that are not apparent to game designers, highlighting not only the importance of involving future players in the process of requirements elicitation, but also the potential for games to explore novel ways to expose adolescents to their surroundings and the people in them.

This article addresses the question posed “**what are the requirements adolescents have for location-based games that foster social interaction in their own neighbourhood and how can they best be identified?**”, by 1) proposing a list of game dynamics as high-level requirements for these games, and 2) developing an analysis method for in-depth analysis of requirements. The method is based on TGD and MDA, and is capable of extracting game dynamics (conceptualized as requirements) from adolescents’ own game ideas. From this method, this paper offers lessons learned so that future practitioners can elicit game ideas and analyse them with respect to what participants want and desire to play.

This article proposes to extend the MDA framework [75] with a new aesthetic called "Care", given that the original framework does not cover certain details that are important to the participants. This element covers games aimed at contributing to the community, by caring for the neighbourhood in general, and promoting engagement meant to nurture and maintain it. The game dynamic *achievement* is predominant (in over 50% of the aesthetics and game ideas) indicating the adolescents' strong need to have a sense of accomplishment, resultant from completing tasks either by themselves or with others. This paper argues that all identified game dynamics are important, and indicates to a varying degree what participants of this age would like to experience in future games fostering social interaction.

For future work it is important to understand how different participants in different locations can contribute to the proposed list of game dynamics for location-based games fostering social interaction (even from the same target group used). The identified game dynamics are at a high level and need to be further specified, e.g. proposing possible design patterns describing how to put game mechanics and elements together to provide these dynamics of play. As human emotions are numerous and complex, further research is recommended on the topic: having a more complete taxonomy of aesthetics can help structure the process of game design and make it less dependent on individual game designer's preferences. In addition, the relationship between the list of game dynamics identified in this paper and the degree to which social interaction is fostered, should be further explored. That will shed light on the relative importance of each requirement with respect to (the type of) social interaction involved.

#### SUPPLEMENTARY MATERIAL

Supplementary material is available online at <http://ieeexplore.ieee.org>. This includes documentation of the game idea analysis with the MDA framework, that may be valuable to assist anyone seeking to replicate the procedure reported here.

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#### CONFLICT OF INTERESTS AND FUNDING

The authors declare that there are no potential conflicts of interest. This research received no specific grant from any funding agency in any sector.

#### STATEMENT OF COMPLIANCE

Approval from the Ethics Committee of the Technical University of Delft was granted for this study. GDPR-compliant consent forms for participation and data collection were given to the adolescents' legal tutors, and the workshops were designed and executed in strict accordance with the

recommendations given by the ethics committee.

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