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Picture the future, play the present: Re-imagining sustainable cities through a large-scale location-based game

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ABSTRACT

The urban sustainability transformations that are urgently needed will have significant effects on the daily lives of city dwellers. As ways to imagine and co-design sustainable urban futures, experiments within the present-day urban environment are increasingly popular. This paper investigates how such an experimental approach can serve as the base of an applied urban futures game that enables its players to reflect on and imagine ways to address complex sustainability problems. We developed a large-scale mobile urban futures game, Utrecht2040, that provides its players with sustainability content, reflection, and motivation for action. The digital infrastructure of the game and large number of players provided unique opportunities for measuring outcomes. Our results indicate that this type of experimental gaming offers a new way for players to collect existing sustainable practices or 'seeds', and use them to collectively create glimpses into relevant sustainable urban futures. At the individual player level participants reported an increased understanding of sustainability and motivation to act. We conclude that large-scale collective experimental futures games in socio-spatial urban environments are a high-potential avenue for overcoming the "crisis of the imagination" by creating inclusive urban futures that inspire action.

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1. Introduction

Historically, cities have often served as arenas for testing utopian ideals and alternative visions of society (Bulkeley & Castán Broto, 2013). Now, cities have an important role to play in meeting sustainability targets such as those stated in the Paris Agreement and the UN Sustainable Development Goals. They are centers of innovation and change, but they also bring about many of today's complexly intertwined social, economic, and environmental problems (McPhearson, Iwaniec, & Bai, 2016). In more sustainable cities, city dwellers would experience profound changes in areas of their daily lives such as eating, dwelling, education, shopping, and travel.

In this paper, we zoom in on a recent development in futures studies literature that allows for new forms of engagement with sustainable urban futures. This development can be described as the "experimental turn", which consists of work that argues for a reconsideration of practices, innovations, and institutional arrangements in the present. An experiment in this context can be defined as *"an inclusive, practice-based and challenge-led initiative designed to promote system innovation through social learning under conditions of uncertainty and ambiguity"* (Sengers, Berkhout, Wieczorek, Raven, & Raven, 2016, p. 153). Experiments offer *"glimpses"* into transformed future worlds: glimpses that offer inspiration and aim to shift the boundaries of what is considered permissible, desirable, and possible; glimpses of pathways toward change that diverge from business-as-usual; or glimpses of niche interventions that are close to finding a larger audience. The overarching design objective for these is that they evoke possibilities for new system architectures in every domain of life, such as water, food, energy, transport, and shelter (Ryan, Gaziulusoy, Mccormick, & Trudgeon, 2016).

Such glimpses can be created through active experimentation with existing components of sustainable urban futures. Bennett et al. (2016): 442) offer a useful framing of such present day practices and projects as *'seeds'*, which can grow into more mature futures. The act of experimenting with 'seeds' and the resulting glimpses into new futures could enable urban dwellers to reflect on complex sustainability problems, imagine ways to address them, and develop pathways for action (Pereira et al., 2021).

Such 'seeds'-based experimentation depends on strong interactive formats and process design (Vervoort, 2019). Applied games represent an increasingly popular and diverse suite of methods that have the potential to bring both approaches together. Such games can be designed to offer playful settings and systems that engage with 'serious' content, topics, narratives, rules, and goals to foster a specific purposeful learning outcome (Mitgutsch & Alvarado, 2012). They are already used in governance, planning, and futures processes, and to think through complex sustainability problems (e.g., Vervoort, 2019; Tan, 2014; Valkering, van der Brugge, Offermans, Haasnoot, & Vreugdenhil, 2013; Van Hardeveld, 2019). While a number of successful Alternate Reality Games (ARGs) have been developed, such as *World Without Oil* and *Evoke* (Hansen, Bonsignore, Ruppel, Visconti, & Kraus, 2013), when it comes to experimental futuring, the potential of using these futures games at scale and measuring their effect systematically can be further realized in the governance sphere (Mangnus et al., 2019). This paper aims to contribute to the literature on experimental futures by documenting and analyzing the effects of a large-scale, location-based game on the ability of its players to reflect on and imagine ways to address complex sustainability problems. The research question that guides this paper is as follows:

What elements of a large-scale, location-based futures game enable players to reflect on and imagine ways to address complex sustainability problems?

2. Theoretical framework

In this first section, we explore the urgency of urban transformations in sustainability and the role of future visions of daily life. Subsequently, we give an overview of literature on experimental futures to determine the criteria for an effective urban futures game.

2.1. Urban transformations toward sustainability

The UN Environment Program declared sustainable cities of the future *"the ultimate design challenge"*, for which a *"planning revolution"* is needed that will make urban environments more compact, green, just, and low-carbon (2018). Historically, cities have been arenas for testing new ideas that have a constitutive role in generating social, cultural, and material spaces of innovation and experimentation (Bulkeley & Betsill, 2013). The practical implications of the sustainability transformations that are now necessary will have major reverberations in the daily lives and environment of city dwellers. Moreover, the support and cooperation of residents will be crucial to making such a planning revolution successful. A key failure of sustainability transformations lies in not including societal stakeholders in transformation plans (Bai et al., 2016). Increasingly, cities are actively thinking about more sustainable and desirable futures, but an unfulfilled potential remains with regards to creating consensus and shared visions through participatory methods (McPhearson et al., 2016).

In contrast to the work done at the forefront of futures research and by urban innovators, practitioners and policy makers oftentimes still adhere to a "solutionist" way of thinking in the face of complex sustainability problems. They identify a limited range of problems and accompanying future solutions (Strengers, Pink, & Nicholls, 2019). Arguably, this focus on narrowly defined, isolated solutions and effects is not only ineffective, but misses the contexts of the local, social, and political systems that always connect seemingly isolated elements of futures. It is thus crucial to include discussions of values, emotions, and everyday experiences (Dulic, Angel, & Sheppard, 2016). Moreover, if experts are the ones that mostly feed visions, scenarios, and pathways into policy, they risk *"locking in 'futures' on behalf of the wider public"* (Garduño García & Gaziulusoy, 2021). In an era of human-induced global environmental change, the recognition of individuals as active agents in a social–ecological system opens up a range of possibilities for transformative change. Their interactions shape institutions, which in turn influence individuals (Bai et al., 2016; Strengers et al., 2019).

Bendor (2018) describes how the path to sustainability is obstructed by our own inability as individuals and as a collective to

imagine what a sustainable future may look like. In his words, *"we are facing a crisis of the imagination, or more accurately, crises of our social, economic, and political imaginaries"* (Bendor, 2018, p. 132). Bendor (2018) also proposes an approach to this that touches on the ideas behind the experimental turn. He calls this *"worldmaking interactions"*, or forms of interaction that *"aim to promote the public's own ability to imagine alternative futures – to encourage the public to find ways to collectively reformulate a sense of what is possible and gain an increased feeling of individual and collective efficacy. Their aim is to evoke and create traffic between the individual's imagination and the more collective, social imaginaries."* This kind of approach can make the *"sociology of expectations"*, or the range of future visions circulating as a result of the modes of analysis and prediction, more inclusive (Strengers et al., 2019).

2.2. The frontier of experimental futures research

Recent developments in experimental futures approaches offer opportunities for engagement with a variety of sustainable urban futures at the citizen level. Both approaches are complimentary in the way in which they make futures tangible, engage citizens in future worlds where they can get a sense of their own agency, and provide opportunities for co-design, imaginative participatory visioning, and addressing the *"crisis of the imagination"* (Bendor, 2018). Experimental futures manifest small-scale or partial futures in the present, testing the potential of innovations and institutional arrangements (Sengers et al., 2016).

Caniglia et al. (2017) define experiments as: *"a scientific practice that relies primarily on an intervention and that allows for the production of empirical evidence"*. Due to this production of new knowledge and data, experiments are often conducted in collaboration with societal stakeholders, such as energy providers, housing corporations, or citizens. They also have a certain level of popularity among policy makers, who feed or scale the results back into the larger urban context (Potjer, 2019).

Some gaps remain in the knowledge of experimental futures interventions. The city is the space where many urban experiments take place, for example in living labs or workshops (Bulkeley & Castan Broto 2013; Meijer & Rodriguez Bolivar, 2016). However, such experiments often lack an explicit futures focus (Vervoort, 2019). Secondly, the scale of experimental futures interventions in urban settings is mostly small, which is understandable due to resources and local cultural specificity (Garduño García & Gaziulusoy, 2021). This is a barrier to scaling up or out (Roddell & Moore, 2015). Finally, there are very few empirical insights into the effects of these interventions (Kuzmanovic & Gaffney, 2017). When designing interventions that aim to create change in real-world socio--environmental systems, measuring the outcomes or impacts is crucial (Mangnus et al., 2019).

By including the everyday, the objects, activities, and events we spend a lot of time with and the attitudes and relations we hold toward them, futures become democratized and concerned with the textures of the lives urban dwellers lead, instead of only focusing on extreme events (Candy, 2010; Garduño García & Gaziulusoy, 2021). One way of collecting and experimenting with everyday good practices is through 'seeds', as defined and developed by Bennett et al. (2016): 442): *"initiatives […] that exist, at least in prototype form, and that represent a diversity of worldviews, values, and regions, but are not currently dominant or prominent in the world"*. These examples of existing sustainable practices can be collected, and together they can be experimented with in order to from outlines of possible sustainable futures that are rooted in the present. According to Bennett et al. (2016): 442), such inspirational and believable images of the future are highly important, since *"they can help shape the very reality they forecast or explain"*. The original 'seeds' database consisted of initiatives and practices that could be considered ingredients of a 'Good Anthropocene'. They have since been used to guide local and regional planning processes (Vervoort, 2019; Pereira et al., 2018; Raudsepp-Hearne et al., 2020) and to offer novel ways to add bottom-up futures to global assessments (Pereira et al., 2021).

As results of experimentation with 'seeds', visions of for example a "good Anthropocene" or a sustainable city of the future arise. Because of the different worldviews, values and characteristics in each of the 'seeds', they generate a plurality of different sustainable futures (Bennett et al., 2016; Pereira et al., 2018). When visualized, such visions can be considered 'glimpses': *"evocations of possible future states that are sufficiently 'open' that they encourage interpretation and translation for the context of the viewer to 'experiment with' rather than a highly defined future that could be interpreted as a blueprint"* (Ryan et al., 2016: 65).

3. Criteria for an experimental futures game

For the purposes of this paper, we propose an experimental worldmaking interaction that can be applied at scale in the form of a large-scale location-based game. Applied games are designed to offer a playful environment that provide "serious" content, topics, narratives, rules, and goals to foster a specific purposeful learning outcome (Mitgutsch & Alvarado, 2012). The environment of a game offers players a chance to explore future urban worlds (Vervoort, Kok, van Lammeren, & Veldkamp, 2010), and challenge their boundaries, imagine futures, expose the invisible, and construct reality (Dulic et al., 2016). A change process that is connected to the local level in compelling and interactive ways is a crucial motivator for visioning, designing, and practicing futures. By carefully designing such a process, it moves beyond cognitive reflection and creates tangible and multi-modal experiences (Ibid.). Games like *World Without Oil*, *Superstruct*, and *Evoke* (McGonigal, 2011) demonstrate that games can engage large groups of players in new worlds, let them engage with complex sustainability problems, and experiment with possible ways to address them.

To contribute to the work done so far at the forefront of experimental futures, we propose a set of criteria for an effective large-scale location-based game, divided into three categories: game content, reflection, and motivation to act. These criteria are based on insights from experimental futures literature, and literature on applied games. Firstly, for game content, we argue that this type of game should offer a balance of new knowledge and insights regarding the sustainability issues at hand, and an exchange of knowledge by the players as they work together to identify "seeds" in the environment of the game. Venturing out into the city and looking for sustainable practices is a crucial element for a learning process based in experiences rather than a purely cognitive transfer of knowledge (Garduño García & Gaziulusoy, 2021; Kolb, 1984; Weiland, Bleicher, Polzin, Rauschmayer, & Rode, 2017).

Table 1
Game criteria.

Criterion	Objective
1. Game content	
1a. Knowledge of sustainability	The player's knowledge about complex sustainability problems increases
1b. New ideas for sustainable practices	The players collect examples of sustainable practices that were previously unknown to them
2. Reflection	
2a. Attitude to the future	The player's sense of optimism, neutrality, or pessimism about the future shifts positively.
2b. Re-interpretation of the present to generate futures	Players develop visions of sustainable futures that consist of sustainable "seeds" from their present-day environments
3. Motivation to act	
3a. Individual outcome efficacy	Positive change in *"a judgement of the extent to which individual's actions can contribute to the collective goal"* (Koletsou & Mancy, 2011, p. 199)
3b. Collective outcome efficacy	Positive change in *"a measure of people's judgements of whether collective action can help achieve the collective goal"* (Koletsou & Mancy, 2011, p. 199)

Secondly, we argue that this type of game should allow for reflection. The first type of reflection is on the participant's individual attitude to the future (Garduño García & Gaziulusoy, 2021). The second type of reflection takes place by thinking about and finding sustainable "seeds", and receiving feedback from other players (Dulic et al., 2016). Immediate feedback is a key characteristic of games, and this can be provided by rating the "seeds" uploaded by others or by receiving such ratings from others. A debriefing at the end of the game also provides feedback on uploads, and more importantly, on the complete vision or "glimpse" of the future that is visualized by the complete set of uploaded "seeds". These feedback procedures are an important element of successful experimentation (Sengers et al., 2016).

Thirdly, we argue that this type of game should provide players with a motivation to act: through the new sustainable seed practices that players encounter, as well as individual and collective feelings of efficacy that illustrate a solution to the crisis of the imagination and provide a sense of efficacy (Bendor, 2018). The game motivates each of the players to act, individually and collectively. Individual outcome efficacy refers to *"a judgement of the extent to which individuals' actions can contribute to the collective goal"* (Koletsou & Mancy, 2011: 199). Koletsou and Mancy (2011) define collective efficacy as *"a measure of individual judgements of the ability of the collective to conduct a particular behaviour"*. Collective outcome expectancy is then defined as *"a measure of people's judgements of whether collective action can help achieve the collective goal"*.

Table 1 summarizes our proposed criteria for an effective urban futures game.

4. Game description: Utrecht2040

Based on the theoretical framework and proposed criteria, we developed the game Utrecht2040, a smartphone app. As an intervention, Utrecht2040 was designed with a focus on scale, in terms of both measuring its outcomes and offering the possibility to play it with a large number of groups and in various contexts. The experimental aspects of the game are crucial: both the digital experience, as well as the connection with the urban socio-material environment. The location where the game takes place plays an important role: the players can collect, re-arrange and re-imagine "seeds" from their present-day socio-material environment and submit them as uploads to their location on the digital map. Because Utrecht2040 is a smartphone app, the game can be played in the city itself, adding a new immersive layer to this futures experience. From both the game data and futures process design, we are able to collect empirical data to measure the effects of the game.

4.1. Underlying principles

The game's core learning aim is to let players determine their perspective on various sustainability problems and provide a framework for individual and collective action toward sustainability transformations. Directing the players to venture into the present-day socio-material environment of the city of Utrecht together, it creates an immersive process in which players seek 'seeds' of possible, probable, or desirable sustainable futures. In the game, we call the uploads made by the teams "solutions" for clarity and to motivate players to complete or solve their mission. The elements of playing outside, competing in teams, and searching for ways to address urgent sustainability problems are added to the game to contribute to a 'let's go!' mentality or a sense of optimistic agency among the players.

4.2. Player principles

The basis of Utrecht2040 is the eponymous smartphone app. However, it was designed with a holistic approach to its staging (Hajer & Pelzer, 2018). The staging follows principles laid out by Shaffer (2007), who argues that everything, from the players travelling to the place where they will play the game to the debriefing and subsequent impact, is part of the world that the game builds. Utrecht2040 starts with an introductory lecture, with all of the players gathered in one place. A lecturer introduces the game, its background, and the game objective: to imagine and visualize the most sustainable version of the city of Utrecht in 2040. Then, the players watch a movie clip that introduces the app, as well as the challenges and "solutions" they will engage with. The speaker is a sustainability

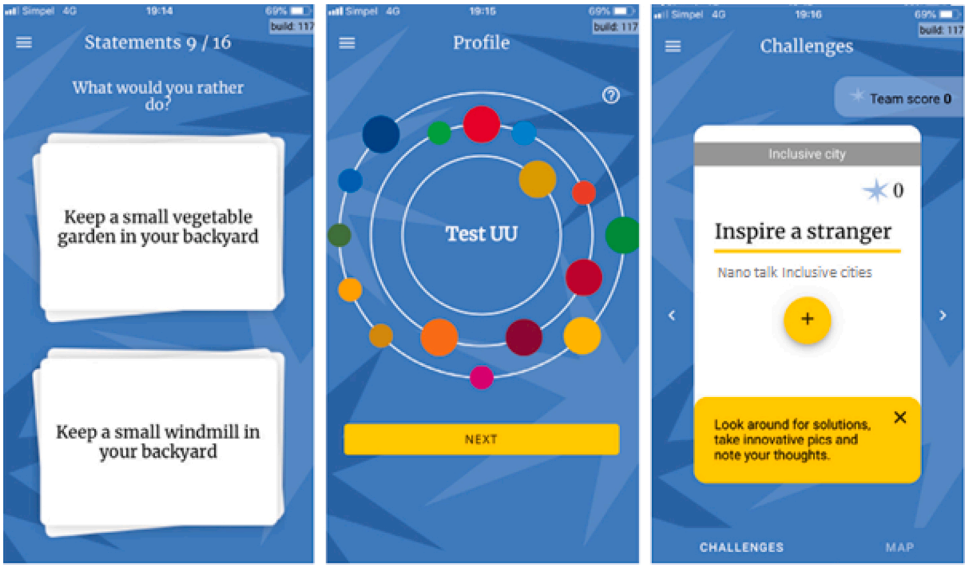

Fig. 1. Game screenshots. L-R: statements, player profile, and challenge.

professional with experience in broadcasting, displayed as a large talking head on a lecture screen, who brings the futuristic "mission" of the game to life. This clip is meant to further frame the futures perspective of the players and make them excited to go out into the city and play.

4.3. Game principles

The first action players take after logging into the Utrecht2040 app is the creation of a player profile. To capture a holistic perspective on sustainable development with humans as crucial agents of change in the game, we use the set of Sustainable Development Goals (SDGs) formulated by the UN. The app contains 16 "dilemmas": two statements between which players have to choose. For the first set of eight dilemmas, players have to indicate which they find more important, e.g.: "Invest in food production" or "Invest in forest protection". For the second set, players have to indicate what they would rather do, e.g.: "Participate in a women's march" or "Participate in a climate march" (Fig. 1). The player profile is meant to determine the position of players in a system that incorporates social, economic, and environmental sustainability. It also aims to provide a starting point for discussion between players, and to motivate players to start looking for "solutions" to issues that matter to them.

After creating the profiles, the players create teams. They can name their teams (groups of 3–5 persons) and add members by finding others through a search engine in the game. After creating and naming their teams, the players are free to leave the room. They receive no specific spatial guidance, but are encouraged to go out into the city and follow the information and challenges provided by the game.

The teams first watch a "nano-lecture": a 40-second clip of an inspiring Utrecht sustainability professional. The lecturers present the players with a complex, multifaceted, and not neatly delineated sustainability problem that is keeping them up at night. There are three nano-lectures in the game: "Inclusive cities" (on non-inclusive public space), "Preserving oceans" (on ocean acidification), and "Eat like you say it" (on the value-action gap in the behavior of consumers with regards to sustainable food).

After watching the lecture, the players receive a number of open-ended challenges, e.g., "Inspire a stranger" or "Solve it with coffee". These challenges are designed to set the teams in motion and incite creativity and inventiveness. The teams can capture their answer to this challenge in an upload: a photo and a piece of text describing the initiative or solution found by the team. This upload is then pinned onto a digital map of Utrecht where it is visible for all teams in the game. The activities in the game enable players to earn "Quality of Life points", the virtual currency of Utrecht2040. The Quality of Life points indicate which team has made the most uploads and received the most "likes" from other teams. It is a built-in feedback system and quality control for the future of Utrecht. Players can earn points by adding initiatives or rating other teams' initiatives on the map, and in the end can win prizes that are handed out in the awards ceremony during the closing lecture.

The closing lecture is the final act of the game, after the players have finished playing the game outside. For this debriefing session, the teams regroup in a lecture hall, where the complete map of 'seeds' is presented on the screen. This allows for highlighting best practices and for the teams to reflect on their own uploads and on what others did. The focus of Utrecht2040 is on active and creative participation. Participants experience the learning objectives by coming up with small-scale" solutions". A transfer is needed for the players to be able to subsequently generalize and apply the futures game experience to situations outside the game. This transfer requires reflection as well (Renger & Hoogendoorn, 2019). The communal setting of the closing lecture thus allows for a debriefing, which is vital in a process like this, and a collective reflection on the initiatives and the change in profiles that emerged from the game

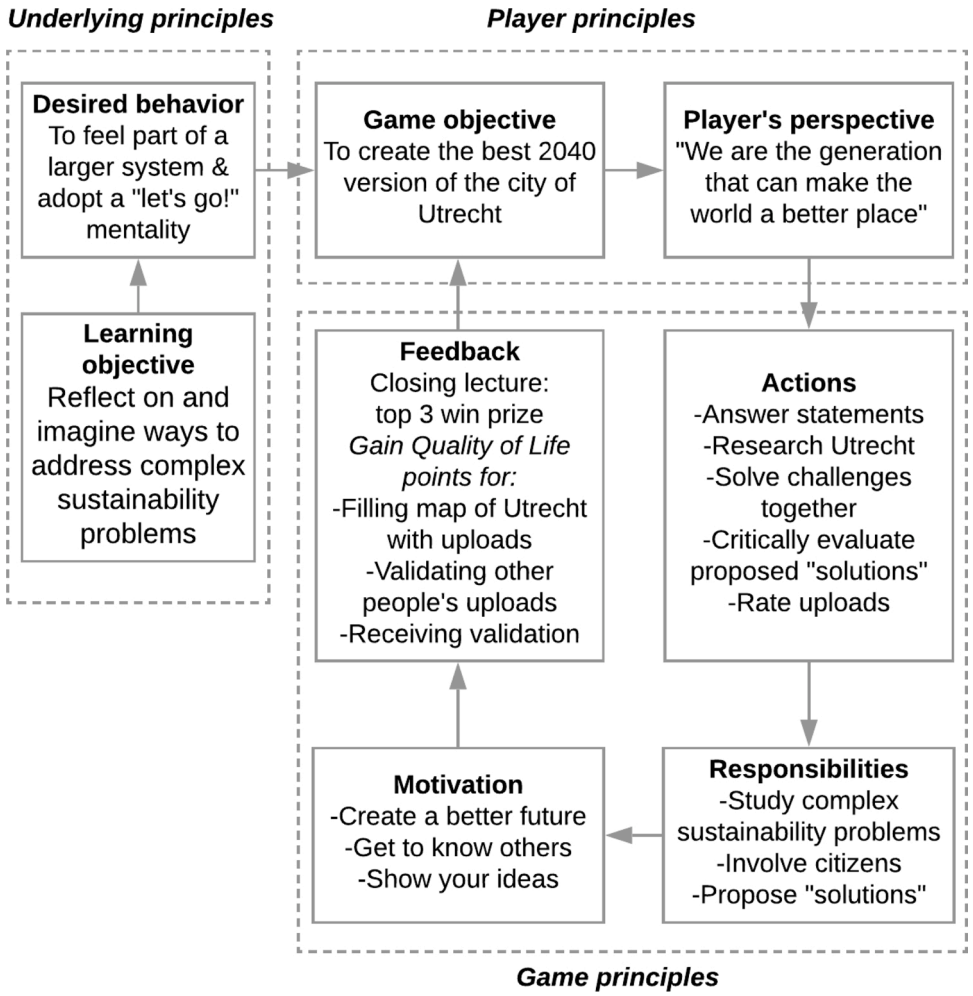

Fig. 2. Utrecht 2040 Play Design.

(Crookall, 2010). In the debriefing session, the players see how their "solutions" are actually 'seeds' in a larger, dynamic picture of a sustainable future Utrecht.

Fig. 2 shows the outline of the Utrecht 2040 game concept. The flowchart is structured according to the various game elements, from the learning aim to the player's own game perspective. The model is based on the "playful design canvas" by Renger & Hrehovcsik (in Renger & Hoogendoorn, 2019).

5. Methodology

5.1. Participants

In our case study, we played Utrecht2040 with four groups of Utrecht University students. The BSc students that played the game are enrolled in Global Sustainability Science (GSS), Human Geography and Planning (HGPL), and Politics, Philosophy, and Economics (PPE). For the groups of students enrolled in GSS and PPE, the game play took place in their university introduction week. The game teams were the teams in which they participated in this introduction. They had multiple days between the start of the game and the closing lecture to play. For the HGPL students, the game was part of a tutorial, and they played for four hours. The game was also played with slightly more advanced students enrolled in the master's program in Green Media and Civic Engagement (GM). These students played the game as part of a lecture and played for four hours.

5.2. Data collection

We collect data in a mixed-methods approach to capture this process empirically in a representative way (Bauer & Aarts, 2000). This comprises surveying the participants before and after the intervention, analyzing player engagement with the intervention in the

Table 2
Survey questions.

Pre-game questions	**Outcome (# in Table 1)**
1. How familiar are you with the UN's Sustainable Development Goals (SDGs)?	Knowledge of sustainability (1a)
2. How would you characterize your view on the future of the planet?	Attitude to future (2a)
3. Please indicate your agreement or disagreement with the following statements:	a: Knowledge of sustainability (1a)
a. I would describe myself as environmentally conscious.	b: Individual outcome efficacy (3a)
b. My personal actions can make the world a better place.	c: Collective outcome efficacy (3b)
c. By acting collectively, people are capable of making the world a better place.	d. New ideas for solutions (1b)
d. I have ideas for solutions that can make Utrecht a better place.	
Post-game questions	
1. How familiar are you with the UN's Sustainable Development Goals (SDGs)?	Knowledge of sustainability (1a)
2. How would you characterize your view on the future of the planet?	Attitude to future (2a)
3. Please indicate your agreement or disagreement with the following statements:	a: Knowledge of sustainability (1a)
a. I would describe myself as environmentally conscious.	b: Individual outcome efficacy (3a)
b. My personal actions can make the world a better place.	c: Collective outcome efficacy (3b)
c. By acting collectively, people are capable of making the world a better place.	d. New ideas for solutions (1b)
d. I have ideas for solutions that can make Utrecht a better place.	
4. To what extent did you gain new insights from playing the game?	d. New ideas for solutions (1b)

form of game data, and analyzing the futures output in the form of images. To analyze which futures were salient in the game, it is necessary to extract certain data from the game itself. We analyze which problems and challenges were chosen the most and the least; how many uploads the players made; and how many likes they gave and received. This entails making an inventory of all images generated by the players, and categorizing their choice of subject and solution (Penn, 2000). After coding the inventory, patterns and salient future components can be discerned from the game output.

The survey was built into the Utrecht2040 smartphone app. After login, the survey screen opened and the players were given some time to fill out the pre-test survey. After the closing lecture, the post-test survey opened up in the app and players were able to fill it out. Due to the fact that the final survey was the last step in the game, the response was lower than that of the first survey. Adding to the uploads generated in the game, Table 2 contains a set of survey questions to track the players' experience. Koletsou and Mancy (2011) provide a framework and operationalization for both individual and collective outcome efficacy. It should be operationalized via statements that measure perceptions of the extent to which the outcomes of individual behaviors contribute to achieving collective goals (Koletsou & Mancy, 2011). Individual actions can be independent of one another in social dilemma situations. Furthermore, the decision to cooperate may depend on the decisions of others, especially when the benefit is only attained if a threshold of cooperation is achieved. All questions are rated on a 5-point Likert scale where 1 is the most negative answer and 5 is the most positive answer. This data is categorical, and thus requires a non-parametric test. Since we collect paired pre- and post-intervention data from the same set of participants, the analysis requires a paired difference test. The variables consist of ordinal data, which is why the Wilcoxon paired signed-rank test is the appropriate option (Meek, Ozgur, & Dunning, 2007). The post-game questions contain one extra question on the extent to which players gained new insights, which is analyzed by calculating mean scores and comparing groups.

To collect more detailed information on the topics of players' knowledge, desired futures, and sustainable attitudes, the questionnaires are supplemented by a group feedback discussion with each group of players. In these focus groups it is possible to gain in-depth insights into the desirable futures as conceptualized in the game. The group feedback discussions took between 15 and 30 min. In every group, the semi-structured discussion was based around four main questions:

- What was your general experience playing the game? (opening question; ice-breaker)
- Did you learn new things from the game? (general)
- Did you encounter new solutions for sustainability problems in the game? Which ones stood out to you? (specific)
- How was the experience of playing in the city of Utrecht?

The participants were free to elaborate in depth on any of the questions, or contribute other experiences they found significant. The audio recordings of the sessions were later transcribed. The sessions were always conducted in pairs, with an observer present to register non-verbal feedback.

6. Results

6.1. Participants

A total number of 284 participants participated in both the pre- and post-tests. Appendix 1 contains the number of students in each group. It should be noted that our sample of university students is not representative of a larger demographic. In the pre-survey, the players indicated their prior knowledge of the UN SDGs, as well as their perceived level of optimism, individual outcome efficacy, and collective outcome efficacy. For some questions, certain groups had prior knowledge that was significantly higher compared to others (e.g., GSS students' prior knowledge of the SDGs significantly exceeded that of other groups). For other questions, such as individual efficacy, the differences were not significant. A perhaps surprising trend is that participants who indicate that they have a high

Table 3
Uploads per topic and study program.

Topic	GSS	PPE	HGPL	GM
1. Inclusive cities	37	78	786	410
2. Eat like you say it	34	12	398	264
3. Preserving oceans	30	29	175	154

knowledge of the SDGs and consider themselves environmentally conscious (GSS and GM), also report low levels of optimism and individual outcome efficacy. A second result that stands out is the score for collective outcome efficacy: this is very high both before and after playing, with an average score of between 4 and 5 for every group.

Table 3 displays the number of uploads per topic per group. GSS received all nano-lectures at once, and they show an even distribution in uploads. The other groups show a majority of uploads for "Inclusive cities". The "Inclusive cities" nano-lecture was accessible for the longest period of time, followed by "Eat like you say it", and finally "Preserving oceans", so an even distribution is not necessarily expected. Notably, the students who played in the context of a course (HGPL and GM) submitted many more uploads, even though GM only had one afternoon of playtime. These groups also had significantly more students than PPE and GSS.

6.2. Game content

This paragraph reports the results of the survey, game output and feedback discussions per criterion. Appendix 1 (descriptive statistics and pre-post comparison) and 2 (between-group comparison) contain the complete tables with all survey outcomes sorted by question as provided in Table 2.

6.2.1. Knowledge of sustainability

Between the pre- and post-game surveys, the players reported a positive effect on their knowledge of the SDGS, with the mean score increasing significantly across all groups from 2.69 to 3.55 on average (Appendix 1 Table 1A & Table 1B). About 50 % of the game uploads featured some type of knowledge exchange. This was depicted in the upload as an exchange between group members, from the group to the map (e.g., by sharing a favorite sustainable practice), or between the group and other people in the city, like children, passers-by, or family members. In the group feedback discussions, a PPE student mentioned that his main learning point *"was getting involved with the SDGs from the United Nations, and also to see actually in real life what perhaps we don't really do or things like plastic […], that are already surrounding us and tied up with what is happening in the oceans"*. Similarly, in other groups, students reported having gained knowledge from seeing the complex sustainability problems posed by the nano-lectures. On the other hand, students in the HGLP and GM groups mentioned that they felt that a more information-dense, rather than open, game would have taught them more about sustainability.

6.2.2. Uploads

The uploads submitted by the players were closely related to the futures approaches or relevant visions for everyday life that they encountered while playing. In the PPE focus group, one participant mentioned that he was positively surprised by the number of sustainable 'seeds' already implemented or supported by Utrecht's government, while another player mentioned experiencing plastic pollution when he went looking for a piece of trash for a photo. Other players mentioned that playing in a group and interacting with Utrecht citizens on the street also gave them new insights, for example about children's dreams for the future (GSS) or buying vintage clothing (PPE).

6.3. Reflection

6.3.1. Attitude toward the future

GSS, HGPL, and GM reported a significant positive change in their attitude toward the future (Appendix 1 Table 1A & Table 1C), although the average score was quite low overall: an average increase from 2.6 to 2.93 on the 5-point scale for each group (Appendix 1 Table 1A & Table 1B).

6.3.2. Re-interpretation of the present to generate futures

The uploads were coded and sorted by topic. Waste, (food) consumption, and individual behavior were the most frequently recurring topics. About 25 % of uploads were quick snapshots or jokes. About 25 % of the uploads featured the group or engagement with people in the city. These uploads generated the most likes. Across the uploads, the 'seeds' varied from creative to pragmatic. Existing sustainability interventions in the city of Utrecht – such as green roofs at bus stops and electric public transport – were featured in uploads quite a lot: about 20 % of the uploads across groups featured these. In the feedback discussions, both relevant future visions for the personal as well as the larger scale were mentioned. Two examples from the PPE group illustrate both cases. At the individual

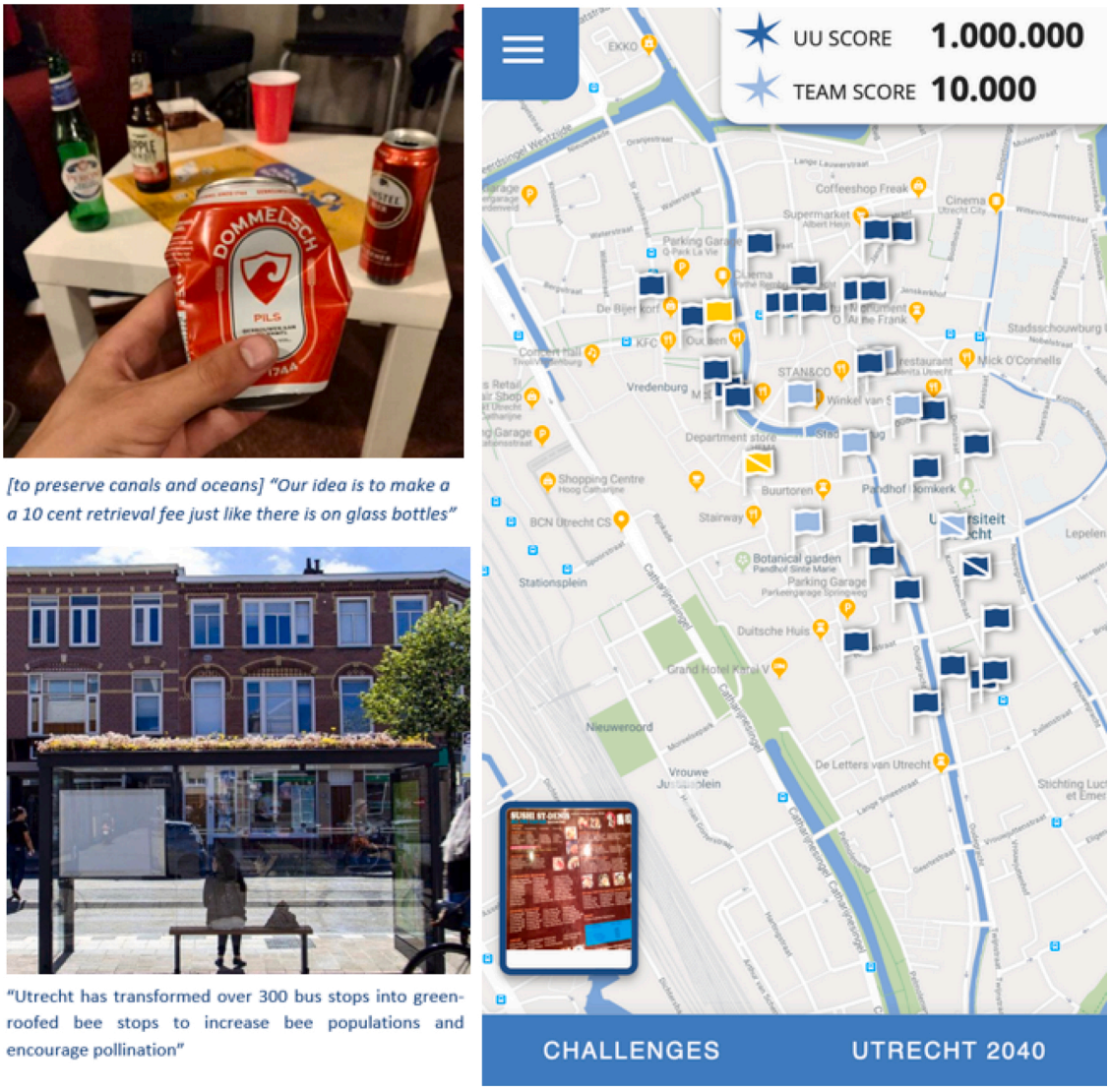

Fig. 3. L: two uploads: picture and description; R: Map of a sustainable Utrecht in 2040.

level, one student mentioned a shift in perspective inspired by a group member: *"one of our group members, he told that he got most of his clothing from secondhand stores, and that inspired me to do the same because his clothes look really cool and I didn't realize that you could get such a cool outfit at a secondhand store"*. At a macro level, another student mentioned: *"I noticed that Utrecht is already quite sustainable somehow and has a lot of greenspace and especially for example parking, bus stations, and a lot of water because it is all somehow linked to the climate in the city, and that inspired me"*.

The number of ideas to improve the city of Utrecht that students reported changed significantly after playing the game: players reported 2.55 on average on the five-point scale before playing, and 3.16 on average after playing (Appendix 1 Table 1A & Table 1B). The HGPL and GSS groups especially reported feeling positive about the amount of imagination and fun they experienced during the quite open assignments. In the PPE group, a student also credited the quality of the app with increasing the "futuristic feeling" of the intervention: *"I liked that we were walking around with our actual phones, because I think that is so common nowadays, and we had to take pictures and talk with strangers and get new ideas, but already future-oriented somehow while we were doing it"*. Moreover, in the feedback discussion groups, students reported that the interaction with the socio-material environment of Utrecht gave them many new insights. In every group, at least one participant brought this up without prompting. The students mentioned how searching the city for 'seeds' gave them a deeper sense of both the good and bad in the city, and what issues needed change. In the HGPL group, a student described

the game as *"a new lens through which to see Utrecht*". As for uploads, about 20 % expressed an explicit goal for the future, for example a photo of a student shaking hands with the manager of organic supermarket chain Ekoplaza, which in the future *"hopes to be larger than [current supermarket market leader] Albert Heijn"*. Perhaps more importantly, each session of the game also generated a map for Utrecht2040 featuring all of the individual uploads, together creating a future pathway out of existing routines and structures (Fig. 3).

6.4. Motivation to act

6.4.1. Individual outcome efficacy

For individual outcome efficacy, in the separate groups of players the change was only significant for HGPL and again the average score was rather low: it changed from 3.14 to 3.34. The entire sample of players increased significantly from 3.45 on average to 3.60 (Appendix 1 Tables 1A–1C). In the feedback discussions, some students expressed feelings of motivation to act. One PPE student summarized his view on the relevance of local 'seeds' versus large abstract problems: *"I actually got inspired to think more about practical solutions in the city, whereas a lot of times you talk about sustainability and things and stuff but actually like, what is going on there in the place where you actually are, there you yourself can change things. That gave me new ideas."*

6.4.2. Collective outcome efficacy

In contrast with individual outcome efficacy, collective outcome efficacy scored very high before and after the game sessions (above 4 on the 5-point scale for all groups, with a median of 5 among all groups). The average score decreased slightly but not significantly, from 4.52 to 4.49 on average (Appendix 1 Table 1A & Table 1B). The high score is an indicator of a strong belief among the participants that humans do have the capacity to effect transformative change as a collective.

7. Discussion

This paper investigates how large-scale location-based futures games can help addresses the need to stimulate urban imaginations through experimental futures. The challenge is to develop and implement approaches that engage diverse actors involved in or affected by urban sustainability transformations meaningfully in urban futures, allowing them to experiment and take action in shaping the cities of the future. Our empirical work can be understood as an answer to the call for futures engagement at scale, and for clearer links between futures and action (Mangnus et al., 2019).

We analyzed the urban futures game Utrecht2040 according to three sets of criteria for an effective experimental game: game content, reflection, and motivation to act. Utrecht2040 aims to stimulate players to collectively imagine actionable futures based on what they encountered in their present-day environments. The game depends on the input of players to create new futures all over the city, populating a city map, and thereby collectively imagining a future city. This visualization of a map and the associated photography by the students, both rooted in the present, generated a range of different ingredients for sustainable urban futures. This section discusses the novel futures and motivations for action that game and its results offer.

7.1. Gaming futures

Wiek and Iwaniec (2014) formulate ten quality criteria for future visions: these should be visionary, sustainable, systemic, coherent, plausible, tangible, relevant, nuanced, motivational, and shared. These criteria provide a useful lens through which to judge the visions of Utrecht in 2040 produced in the game. Firstly, when we consider the various images of Utrecht in 2040 resulting from the game, we can argue that the visions are "sustainable" in terms of the sustainability knowledge communicated through the game, and more importantly, the knowledge exchange around more sustainable ways of living in the city that forms a core game mechanic. The roots of the images in the present-day city of Utrecht lead to "glimpses" into systemic, coherent, plausible, tangible, and relevant futures (Ryan et al., 2016). Lastly, the collective, large-scale experience made the futures represented in the game motivational and shared. Overall, the way that Utrecht2040 brought imagination into the urban environment already serves to a promising extent as a way *"to explore and create possible, performable, livable, and viable worlds"* (Ezrahi, 2012).

At the start of the game, players were encouraged to adopt a futures-oriented mindset by means of an opening lecture, and debriefed by reflecting on their sustainable futures map in a closing lecture. Despite this staging and positive feedback from the players with regards to the futuristic layer that the game placed over the urban environment, we note that the strong connection to the present due to the constant physical boundaries of the "now" in the urban environment arguably takes away from the visionary and radical aspect of these futures. On the other hand, the game realized a number of the opportunities and challenges brought forward in previous literature on experimental futures. Firstly, the game engaging 284 players in the same futures exercise addresses the challenge of designing this type of futures interventions at scale (Mangnus et al., 2019; Kuzmanovic & Gaffney, 2017). Secondly, the relatively large number of players and the methodology developed to analyze their data provides empirical insights into experimental futures (Mangnus et al., 2019; Kuzmanovic & Gaffney, 2017). By engaging the socio-material environment as a stage for futuring, in which players can experiment with the ingredients of their daily lives, the game is a starting point for addressing the challenge formulated by Garduño García and Gaziulusoy (2021): it shows one way in which interactive mass media such as large-scale games could open up

futures to a wider public.

Finally, the game opened up a new, location-based avenue for engagement with the collection of 'seed' initiatives and ideas, contributing to a new strain of 'seeds'-based futuring that is emerging but that has so far not been embedded in the exploration of real locations (Vervoort, 2019; Bennett et al., 2016; Pereira et al., 2018; Raudsepp-Hearne et al., 2020).

7.2. Motivation for individual and collective action

The second aim of Utrecht2040 was to provide players with motivation to act toward a more sustainable future. In addition to encountering sustainable "seeds", feelings of both individual and collective outcome efficacy are crucial. A lack of motivation to act, or perceived individual and collective outcome efficacy, in the face of complex and wicked problems is arguably one of the greatest barriers to transformations toward sustainability at this moment. It lies at the heart of the value-action and knowledge-action gaps, and of the "crisis of the imagination" – when people feel no agency over their situation, even if they find that situation undesirable, and see no alternatives (Bendor, 2018). Interestingly, in the Utrecht2040 survey results the players reported very high levels of perceived collective efficacy both before and after game play: above 4 on the 5-point scale on average and never lower than 4. However, reported individual outcome efficacy was lower in comparison. For the HGPL players this increased significantly after playing the game, but not for the other groups. This indicates that the game's focus on generating action does not directly translate to the overall experience of all students. The gap between feelings of collective and individual efficacy shows the outlines of a collective action problem. There is consensus about the importance of the common goal and belief in the ability of the collective to solve the issue, but perceived costs of participation or other issues stand in the way of individuals coming together as a collective (Rasch, 2019).

Another important element in terms of impact on players was the development of new insights into complex sustainability problems and possible ways to address them. In the group feedback sessions after the game, without prompting, players reported that the act of surveying the socio-material environment for "seeds" gave them a much more profound understanding of environmental problems. The collective element also received many positive responses: players mentioned that their points of view were altered both through their teammates' input as well as the uploads of other teams on the game map. These insights led to reported feelings of optimism and motivation. By collectively bringing more futures into the realm of the possible, it appears that the players' attitudes to the future were changed and expanded.

7.3. Reflection and future research

Concluding that the game has a minor impact on collective and individual perceived self-efficacy, and may be a way to open up new imaginaries among its players, leads us to a number of directions for further design and analysis. First of all, developing an explicit link between the collective imagination processes of the game play and actual urban governance processes could arguably increase the impact of the game intervention in many ways. It means that whatever new futures are generated by player groups and collectively are much more likely to be actually useful for the urban governance context. It also means that the player experience is likely to change: if players know that their efforts have a good chance of impacting the city, effects on perceived individual and collective efficacy can be hypothesized to increase substantially. Bridging the gap between perceived collective and individual efficacy by providing concrete steps or plans to organize the collective or utilize the large number of players could further increase a player's motivation to take action. Furthermore, more integration with urban governance actors and processes will most likely open up far greater possibilities for knowledge sharing. In the case of Utrecht, there is already strong interest from the City Council in this kind of game play. Creating player groups that consist of a mix of students, researchers, policy makers, civil society actors, businesses, citizens, and others could further increase such positive effects. There are myriad concrete ways in which the game could be integrated with urban governance – for instance, by using it to collect input for city planning cycles, as a way to inform the city's broader efforts at communication with citizens, or by integrating present-day initiatives by businesses and civil society actors more comprehensively into the game and game locations.

Due to time constraints, the participants could not be followed over a longer period of time. We therefore tracked the expressed intentions of the players rather than the actual change in their study and life choices. We also chose to compare various groups, but developing a version of this intervention with a control group would strengthen the analysis further. It would be instructive to divide the participants in terms of their level of activity in the game and compare results. The survey conducted at the beginning and end of the game sessions may also have interfered with the futuristic experience. Although we received no negative feedback on the survey and had a large number of respondents, many fewer participants filled out the survey at the end, which may indicate that it was an obstacle of some sorts in the process. Interesting avenues for future research are firstly more longitudinal studies of this intervention, possibly also in other countries or contexts. Variations of the game can be played by a wide range of urban actors. These include local governance actors, who can engage in the game as a policy simulator or to use the game outcomes. Actors from local businesses or academia can also benefit from playing the game, both to gain a new perspective on their city as well as on local possibilities for urban sustainability transformations. While the game focuses on the urban level and in this case is specific to Utrecht, the format can easily be adapted to other cities.

Finally, integration with existing 'seeds' databases might open up new avenues for the use and collection of 'seeds' using such futures games. Arguably, this would also improve the quality of the 'seeds'. In Utrecht2040, the uploads made by the players could be anything they considered an existing good practice. As a result, the 'seeds' in the game ranged from existing initiatives that fit Bennett et al. (2016)'s definition, but also uploads that would perhaps be better classified as 'proto-seeds': snapshots of sustainable ideas that are not tied to a larger practice or initiative. Such 'proto-seeds' run the risk of inadvertently feeding into a "solutionist" tendency of the game. Bendor (2018) describes how a focus on achievable, practical alternatives, especially technological "fixes", may increase experienced self-efficacy, but tame or even hinder the development of more radical futures. "Solutionist" tendencies may also lead to consideration of very extreme measures without consideration of alternatives, out of a fear for looming environmental disasters. Experimentation, or open-ended learning that takes both successes and failures into account, is considered an antidote to the "solutionist paradigm" (Asayama, Sugiyama, Ishii, & Kosugi, 2019). Future iterations of Utrecht2040 could benefit from leaning further into its experimental characteristics, by using existing 'seeds', allowing for reflection on both failures and good practices, and moving away from overly simplistic, solutionist 'proto-seeds'.

7.4. Looking ahead: combining the experimental and the experiential turns

Utrecht2040 was built mainly on principles from the "experimental turn" in futures studies. However, there is also a growing body of work that suggests that there is merit in engaging with futures as more complete experiences, which has brought about the "experiential turn" in futures studies. This turn consists of a surge in futures interventions that design environments where participants move beyond a cognitive mode and into a visceral mode of understanding futures, inching closer to *"life as it is apprehended, felt, embedded and embodied in the present and on the ground"* (Candy & Dunagan, 2017, p. 137; Pelzer & Versteeg, 2019). While they arguably address similar concerns with regards to more traditional futures approaches, experiential and experimental futures differ in character and execution. Experiential futures are generally more speculative and imaginative, conducted by designers, artists, and academics with a background in humanities disciplines. Experimental futures have a more pragmatic component, which manifests in experiments in the urban context like the one at the center of this paper (Bulkeley & Castán Broto, 2013; Meijer & Rodriguez Bolivar, 2016).

Combining analytical and experiential futures tools leads to a demonstrable increase in engagement with and understanding of different futures (Vervoort et al., 2010). It may also allow for a more speculative approach to futures, that works against the trappings of the "solutionist paradigm" (Asayama et al., 2019). For this paper, we have already used some notions from the experiential futures literature, for example in the experiential learning component of Utrecht2040 (Garduño García & Gaziulusoy, 2021). We believe that the game is an interesting first exercise with a game of this kind, that can be further extended into other domains, for example by building on its potential to be developed into an experiential futures intervention. Hajer and Pelzer (2018) describe how experiential futures aim to build worlds in which people can immerse themselves and temporarily suspend their disbelief about possible, sometimes radically different, future worlds and events. However, designing circumstances or situations in which the collective imagination of a group of people can emerge is a challenge in itself (Candy & Dunagan, 2017). Thus far, experiential futures research still faces the dual challenge of 1) conducting interventions at scale, and 2) connecting imagined futures to present action (Mangnus et al., 2019) – there is a lack of knowledge on the concrete effects of these interventions.

In future research, combining approaches from the experiential and experimental turns in futures studies can address the aforementioned knowledge gaps, and the two are a natural fit in a number of other ways. There have been explicit calls in experiential futures literature to engage more with experimental futures methods (Kuzmanovic & Gaffney, 2017), as well as developments in experimental futures literature that would encourage increasing the experiential character of experiments (Ryan et al., 2016). A combination of the two may allow for a *"lab approach to everyday futures"*, as Kuzmanovic & Gaffney describe it, which would enable the *"prototyping [of] speculative scenarios in the present"* (2017, p. 115–116). This would allow for experimental data to be generated in an experiential setting. For Utrecht2040 specifically, this would mean adding a more immersive futures layer through for example role play or improvisational theatre. This could take the visions of the future generated through the collection of 'seeds' to a more radical and creative level, and amplify the effects we observed with regards to knowledge, reflection and efficacy.

8. Conclusion

There is a need for large-scale urban futures approaches that connect imagined futures to action in the present. Location-based games offer unique possibilities in this regard. We documented and analyzed the effects of the large-scale, location-based game Utrecht 2040 on the ability of its players to reflect on and imagine ways to address to complex sustainability problems. We used evaluation criteria focused on game content, reflection, and motivation to act. We found that this kind of experimental game can contribute to learning, generates many relevant ingredients of sustainable urban futures rooted in the present and can increase feelings of efficacy for some players and groups. We conclude that large-scale location-based gaming has strong potential for reconceptualizing sustainable cities of the future in inclusive and mobilizing ways. The digital infrastructure and large number of players also provided new opportunities for documenting and measuring the outcomes.

Declaration of Competing Interest

None.

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Appendix 1

Table 1A
Mean and median scores per variable pre- and post-intervention.

Variable	Study program	N	Mean before	Mean after	Median before	Median after
1a. Knowledge (SDGs)	GSS	54	3.20	3.78	3.00	4.00
	HGPL	122	2.70	3.43	3.00	4.00
	PPE	22	2.64	3.73	2.50	4.00
	GM	86	2.37	3.51	2.00	4.00
	All	**284**	**2.69**	**3.55**	**3.00**	**4.00**
1b. Solutions for a better future	GSS	54	2.85	3.26	3.00	3.00
	HGPL	122	2.45	2.98	2.00	3.00
	PPE	22	2.77	3.18	3.00	3.00
	GM	86	2.44	3.35	2.00	3.00
	All	**284**	**2.55**	**3.16**	**2.00**	**3.00**
2a. Attitude (to the future)	GSS	54	2.56	2.91	2.50	3.00
	HGPL	122	2.66	2.99	3.00	3.00
	PPE	22	2.82	3.05	3.00	3.00
	GM	86	2.49	2.81	3.00	3.00
	All	**284**	**2.60**	**2.93**	**3.00**	**3.00**
3a. Individual outcome efficacy	GSS	54	3.81	4.04	4.00	4.00
	HGPL	122	3.14	3.34	3.00	3.00
	PPE	22	3.68	3.73	4.00	4.00
	GM	86	3.60	3.76	4.00	4.00
	All	**284**	**3.45**	**3.60**	**4.00**	**4.00**
3b. Collective outcome efficacy	GSS	54	4.78	4.67	5.00	5.00
	HGPL	122	4.44	4.37	5.00	4.00
	PPE	22	4.64	4.77	5.00	5.00
	GM	86	4.44	4.48	5.00	5.00
	All	**284**	**4.52**	**4.49**	**5.00**	**5.00**

Appendix 2

*2. A Differences** between groups (pre-intervention)*

Table 1B
Difference between pre- and post-intervention.

Variable	p-value	Z-value
1a. Knowledge (SDGs)	.000*	−11.433
1b. Solutions for a better future	.000*	−8.951
2a. Attitude (to the future)	.000*	−6.454
3a. Individual outcome efficacy	.000*	−3.650
3b. Collective outcome efficacy	.429	−0.791

* significant at $p < 0.05$.

Table 1C
Differences within groups between pre- and post-intervention.

Variable	Study program	p-value	Z-value
1a. Knowledge (SDGs)	GSS	0.000*	−4.589
	HGPL	0.000*	−7.531
	PPE	0.000*	−3.739
	GM	0.000*	−6.477
1b. Solutions for a better future	GSS	0.006*	−2.773
	HGPL	0.000*	−5.477
	PPE	0.080	−1.748
	GM	0.000*	−6.424
2. Attitude (to the future)	GSS	0.001*	−3.189
	HGPL	0.000*	−4.436
	PPE	0.096	−1.667
	GM	0.002*	−3.149
3a. Individual outcome efficacy	GSS	0.083	−1.733
	HGPL	0.004*	−2.864
	PPE	0.822	−0.225
	GM	0.070	−1.812
3b. Collective outcome efficacy	GSS	0.109	−1.604
	HGPL	0.246	−1.159
	PPE	0.180	−1.342
	GM	0.575	−0.560

** (-) or (+): program a (left of table) has a higher (+) or lower (-) median response than program b (top of table).
* significant at $p < 0.05$.

Variable	Program	GSS	HGPL	PPE	GM
1a. Knowledge (SDGs)	GSS				
	HGPL	0.003* (-)			
	PPE	0.048* (-)	0.538 (-)		
	GM	0.000* (-)	0.004* (-)	0.350 (-)	
1b. Solutions for a better future	GSS				
	HGPL	0.010* (-)			
	PPE	0.878 (-)	0.077 (+)		
	GM	0.019* (-)	0.887 (+)	0.097 (-)	
2a. Attitude (to the future)	GSS				
	HGPL	0.296 (+)			
	PPE	0.159 (+)	0.420 (+)		
	GM	0.868 (-)	0.195 (-)	0.141 (-)	
3a. Individual outcome efficacy	GSS				
	HGPL	0.000* (-)			
	PPE	0.392 (-)	0.020* (+)		
	GM	0.156 (-)	0.001* (+)	0.838 (-)	
3b. Collective outcome efficacy	GSS				
	HGPL	0.001* (+)			
	PPE	0.191 (+)	0.233 (+)		
	GM	0.011* (-)	0.455 (+)	0.515 (-)	

* significant at $p < 0.05$
** (-) or (+): program a (left of table) has a higher (+) or lower (-) median response than program b (top of table)

*2. B Differences** between groups (post-intervention)*

Variable	Study program	GSS	HGPL	PPE	GM
1a. Knowledge (SDGs)	GSS				
	HGPL	0.021* (-)			
	PPE	0.865 (-)	0.169 (+)		
	GM	0.174 (-)	0.439 (+)	0.428 (-)	
1b. Solutions for better future	GSS				
	HGPL	0.063 (-)			
	PPE	0.702 (-)	0.285 (+)		
	GM	0.336 (+)	0.002* (+)	0.252 (+)	
2a. Attitude (to the future)	GSS				
	HGPL	0.440 (+)			
	PPE	0.419 (+)	0.108 (+)		
	GM	0.518 (-)	0.149 (-)	0.257 (-)	
3a. Individual outcome efficacy	GSS				
	HGPL	0.000* (-)			
	PPE	0.091 (-)	0.020* (+)		
	GM	0.050 (-)	0.003* (+)	0.781 (+)	
3b. Collective outcome efficacy	GSS				
	HGPL	0.002* (-)			
	PPE	0.527 (+)	0.005* (+)		
	GM	0.216 (-)	0.061 (+)	0.136 (-)	

* significant at $p < 0.05$

** (-) or (+): program a (left of table) has a higher (+) or lower (-) median response thanprogram b (top of table)

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