‘Gamification’ in transport interventions

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Abstract

‘Gamification’ is transforming how behaviour change initiatives are delivered in health and physical activity, with interventions now appearing in the transport field. Gamification is defined as the “use of game design elements in non-game contexts” (Deterding et al., 2011a:1) and introduces competition and social activity into behavioural interventions. Gamification is often tied to new digital technologies, especially smart phone apps. Interventions that currently use gamification include road safety and travel demand management initiatives. This paper explores gamification in transport contexts, provides the underpinning theory as to why and how gamification may be most useful, and synthesizes current practice regarding the range of interventions offered thus far in public and active transport.

1. Introduction

Individual users and their behaviours are critical to transport system function. How can we better incentivise behaviour to achieve policy goals such as reduced road trauma, congestion relief and transport mode shift? Transport operators, planners and policy makers are looking for socially and politically acceptable approaches. Gamification is being used to improve engagement, increase motivation and encourage participation in specific programs and behaviours by applying gameful design. ‘Gamification’ is dramatically transforming how behaviour change initiatives are delivered in healthcare and physical activity, with interventions now appearing in the transport field. Gamification relies on competition and social engagement to influence behaviour. It increases public engagement in policy initiatives and can increase intervention efficacy. This innovative approach has been a central element of the successful gamified approaches underpinning many programs in transport field. Table 1 lists the samples of current and existing programs in the transport field.

Table 1 Examples of gamification (trial) programs in the transport field

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Year(s)</th>
<th>Department /Country</th>
<th>Field</th>
<th>Contents</th>
<th>Gamified design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy Active School Travel</td>
<td>2004-</td>
<td>Brisbane City</td>
<td>Active</td>
<td>A free, tailored program proven to</td>
<td>The competition between children,</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Scheme name</th>
<th>Start - End</th>
<th>Location</th>
<th>Category</th>
<th>Description</th>
<th>Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beat the street</td>
<td>2014-2015</td>
<td>Reading, UK</td>
<td>Travel</td>
<td>Encourages communities to undertake increased physical activity. Leading boards are compiled and reported at all competition levels. Low-cost rewards like stickers.</td>
<td>Organised into teams. Players and groups accrue points as they travel and head towards fun targets and low-cost or ephemeral rewards.</td>
</tr>
<tr>
<td>INSINC</td>
<td>2012-2013</td>
<td>Singapore</td>
<td>Public transport</td>
<td>An incentive scheme devised to shift demand from peak to off-peak shoulder times in Singapore’s public transit system.</td>
<td>(a) random (raffle-like) rewards, (b) social influence — the positive effects on a commuter of their friends in the INSINC platform, and (c) personalised offers.</td>
</tr>
<tr>
<td>GAMETUNED</td>
<td>2011</td>
<td>UK</td>
<td>Driver safety</td>
<td>A car insurance premium scheme to encourage drivers to have safer driving behaviour.</td>
<td>Based on an in-car installed GPS that tracks driving behaviour; excellent drivers get discounts of up to 11%; poor drivers pay up to an additional 20%.</td>
</tr>
</tbody>
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a Beat the Street was initially trialed in the City of Reading, UK and has been implemented across neighbourhood in London, UK; New York, USA; Shanghai, China; and Vancouver, Canada (Coombes and Jones, 2016).

b Pluntke and Prabhakar, 2013

Gamification uses both psychological- and design-oriented elements in combination. Baranowski, et al. (2008) and Miller et al. (2014) made clear statement that significant effort is required in the gameful design phase using such approaches as (1) leader boards that rank individual users and peer-group progress and achievements creating competition; (2) points and levelling systems to inform users of their level and to reward progress and continued engagement; (3) rewards, either real or virtual, achieved by reaching certain...
milestones or goals; (4) challenges and quests motivating users to continue engaging with the application; and (5) social connectedness through team challenges and the sharing of information via social media.

Gamification is often tied to and delivered via new digital technologies, especially smart phone apps. As an example, a current trial involving Moto Accident Insurance Commission (MAIC) and Queensland University Technology’s Centre for Accident Research and Road Safety (CARRS-Q) is using an app to try and influence road safety outcomes for a set of professional taxi drivers. Such apps can also work in public transport contexts where they can be linked to account-based transport payment systems, such as next-generation public transport ticketing (i.e. not the current ‘Go-card’ technology used in South East Queensland (SEQ) but what is planned for future roll-out in SEQ) and CityCycle. Apps may be particularly useful for the young learner driver cohort to incentivise safe driving behaviour but apps can also be used as a tool to incentivise other age groups, even if the impact is not as high.

Most prior studies are concerned with broader gamified design, concepts, and/or behavioural aspects (Deterding et al., 2011a). This paper explores the use of gamification in transport contexts. The next section briefly summarizes the literature on gamification, followed by a description of its implications for the transport field including public transport, road safety and active travel. The paper concludes with a discussion and suggestions for further research.

2. What is Gamification?

2.1 Game or Gamification?

Two different definitions for gamification are found in the literature. Deterding et al. (2011a) and Deterding (2011b) define gamification as "the use of game design elements in non-game contexts". Caillois' define a game as "an activity that is voluntary and enjoyable, separate from the real world, uncertain, unproductive in that the activity does not produce any goods of external value, and governed by rules" (Caillois, 2001; p.4). Caillois (2001) proposed a classification framework for gamification (see Figure 1), which distinguishes between paidia and ludus as two kinds of different activities. While paidia (playing) refers to free-form, expressive, and improvisational behaviours, ludus (gaming) characterizes rule-based playing under pre-determined goals.

CityCycle, Brisbane's public bike share scheme, is an active and sustainable type of public transport that encourages more people to cycle around the inner city.
The concept of gamification has brought together many disciplines and professionals, including game designers, psychologists, sociologists, computer engineers and others (Mora et al., 2015). Mora et al. (2015) further split current studies into three categories according to a three-dimension perspective: background (academic/non-academic); scope (complete gamification processes and focused only on a specific part or step), and approach (applicable to a wide spectrum of environments (generic) or designed for a specific business context) of interventions. In simple terms, gamification involves determining which games are preferable, how schemes may be organized, who should run them, and in what way.

Self-determination theory (SDT) (Deci and Ryan 1985) is a meta-theory for framing motivational studies. It views people as ‘active organisms’ with agency. The key constructs are ‘autonomy’, ‘competence’ and ‘relatedness’. Within such theory gamification is seen as assisting by creating intrinsic motivation – autonomous play for play’s sake; and by enhancing the internalisation of desired values or beliefs. Gamification does this by affecting an individual’s control orientation to focus on rewards and peer/system approval; and, by creating goals that meet basic needs.

Utility theory (Schoemaker, 1982) is also useful for understanding gamification. Games often rely on decision making under risk to help encourage specific behaviours (Kahneman and Tversky, 1979). When people make choices between risky prospects with a small number of outcomes, they tend to make decisions that violate the basic tenets of utility maximization (Schoemaker, 1982). That is, people are risk-averse over prospects involving gains and risk-seeking over prospects involving losses.

Prospect theory (Tversky and Kahneman, 1992) is relevant to gamification as it distinguishes two phases in a choice process: framing and valuation. In the framing phase, the decision maker analyses offered prospects, which often have a simpler description. In the second
valuation phase, the decision maker evaluates all the prospects in the framing phase and chooses the prospect with highest value. Carefully designed games can help people make behavioural choices with modest or no-cost rewards and shift perceptions in both framing and valuation phases.

The main interest for transport agencies is that gamified approaches can encourage behavioural change by harnessing the power of play, the design of reward structures and peer support and this can be achieved at potentially lower cost than alternative approaches such as cash rewards and discounts. Hamari et al. (2014) proposed a framework to evaluate the effects of gamification, examined the current research and indicated that gamification schemes generally provide positive effects that are greatly dependent on context and the way in which gamification is implemented, as well as users’ involvement.

2.2 Travel Demand Management or Gamification?

Incentives are providing for users to maintain certain behaviour or change users behaviour. Gamification is part of incentive schemes since is often used for pursuing similar goals. However, the gamification scheme is part of but different from a pure incentive scheme. In transport field, for example, incentives usually adopted as a travel demand management (TDM) instrument. It is important to understand the difference between a TDM instrument which offers a straightforward incentive and one which is designed with a gamification framework. Most incentive programs aim to offer financial rewards and economic benefit (redeemable by points) or concession which is known in advance. For example, a loyalty scheme provides a given number of points for a given purchase. Incentives can be variable in the sense that airlines, for example, give different numbers of points for a journey between A and B, depending on the class of booking. However, airlines are still, even with this differentiation, providing a pure incentive that is considering as extrinsic motivations. This has been demonstrated to be detrimental to intrinsic motivations, autonomy, and creativity (Deci et al., 1999; Hamari 2013). In the book "Punished by rewards", Kohn (1999) showed that for some incentive programs pleasure is not additive and rewards can backfire (Groh, 2012). Lepper et al. (1973) demonstrate the same results by understanding children’s intrinsic interests. Their work shows that if children are paid for drawing (incentive), they will draw more pictures with lesser quality. While this incentive is ceased, children did not like drawing as much as before. Lepper et al. (1973) verified this "Overjustification" effect where intrinsic motivation is shifted towards the extrinsic incentives.

The starting point for gamification is to amplify intrinsic value via suitable intrinsic motivation design that has three innate requirements: relatedness, competence, and autonomy (Deci et al., 1999; Hamari 2013). Take lottery-based gamification scheme as an example, it requires that the outcome is not known with certainty at the outset. This scheme that, for example, offered a fixed number of points for all journeys between A and B but with each booking gives an entry into a lottery to have the number of points increased by tenfold, would be employing a gamification framework. This lottery-based scheme harness the intrinsic motivation because it keeps participants who opt-in voluntarily (autonomy) play together
(relatedness) for a small amount of big prizes (competence) (Groh, 2012). Introducing gaming into the incentive market is useful for the entity paying the incentive since the outcome for them if certain even though it is not certain for the players. Gamification, in general, is a new strategy within transportation activities and TDM programs. Detail introduction about motivation theory can be found in section 3.1.

So far, there are lots of different definitions, categorizations and classifications for gamification and most of the previous studies agree that gamification introduces game design elements into non-game contexts. However, there are obvious gaps in the research. For example, based on the above definition, one might ask, what are game elements, how can they be defined, how would an individual be motivated by them and what are the scheme effects? In the next section we discuss gamification in relation to various theories in order to fill this research gap.

3. Case Studies

3.1 Public Transport

Peak hour traffic congestion and insufficient capacity on public transport are the twin most pressing issues for public transport agencies in Australian cities. The need for public transport investment to address congestion issues can be deferred if existing infrastructure is used more efficiently. For public transport, there are currently two main strategies for resolving this: increase peak hour supply of capacity by building infrastructure such as cross-river rail and bus/metro bridges and tunnels; or, using travel demand management strategies to shift peak hour demand to off-peak periods and defer such investment. Researchers have explored demand management strategies for utilizing existing infrastructure more efficiently (Palma and Lindesy, 2002; Merugu et al., 2009; Gomes et al., 2012). The predominant approach in Australia for shifting peak demand on public transport has been through providing a fare discount for off-peak travel. But are there more efficient and effective ways? Gamification schemes were recently introduced in Singapore’s INSINC program (https://insinc.sg/). INSINC is a gamified scheme to shift demand from peak to off-peak times on Singapore’s public transport system by incentivising commuters to travel during off-peak periods through random (raffle-like) rewards, social influence, and personalized offers. Figure 2 demonstrates the effects of the intervention on the commute start times of INSINC participants. The scheme successfully shifted 7.49% of peak demand for commuters involved in the six month research pilot in 2012. However, there is otherwise limited information on this scheme and the efficacy of key aspects of gamification in the public transport context largely remains unexplored.
3.2 Active Travel

Australia once led the world in travel behaviour change interventions using social marketing and in schools and workplaces, applied under broad heading of travel demand management (TDM) programs. This included the Queensland version of the TravelSmart initiatives and HAST programs. The TravelSmart program used social marketing to encourage voluntary travel behaviour change in the reduction of vehicle miles travelled (VKT). The Queensland HAST program is the long-running Brisbane City Council Active School Travel program\(^2\). This, and precursor programs in other local government areas, have proved very effective in changing school travel behaviour. Indeed, the numbers of children driven to school between 2007 and 2009 has declined by nearly ten per cent in SEQ Travel Survey data (Department of Transport and Main Roads, 2012) which suggests these programs have had strong system-wide efficacy in changing travel behaviours. Central to these school programs has been the embedding of low-tech gamified approaches.

Brisbane City Council’s program is a good example of the gamification involved. Around fifteen schools are recruited to participate in a multi-year program of interventions each year. Interventions are tailored to the unique environmental, social and transport context of each school. Each school establishes a specific reporting and measurement arrangement

whereby each child’s travel is recorded on specific days. This arrangement facilitates competition between children, classrooms, years, and schools. Leader boards are compiled and reported at all competition levels, in suitable ways. Peer encouragement is strong. Low-cost rewards like stickers encourage students to make positive changes in their travel behaviour or participate in events such as scooter safety skills sessions. Engagement remains strong throughout the year as each month a new focus and prize is offered. Examples include prizes for the ‘most children walking to school’ in March, to the ‘most children bike riding’ in April, to the ‘most children scootering’ in May. Schools also have competed repeatedly for a token prize – the ‘Golden Boot’ award – for the school judged to have best met a set of defined policy goals, with monthly and yearly prizes awarded. Principals and Parents & Citizens (P&C)3 members come to a civic reception with the Mayor where the prizes are awarded at the end of the year, further encouraging participation.

Similar approaches have also proven effective with adults. The Beat the Street initiatives4 began as a public health intervention in the UK to encourage communities to undertake increased physical activity. Over 150,000 participants were involved in 2015. Beat the Street uses Radio Frequency IDentification (RFID) card technology and readers similar to those in use in the SEQ ‘Go-card’ system. ‘Players’ are provided with cards via their school, workplace or in the mail. Readers are installed at locations across an urban area or town, creating an enormous “playing” field. Participants are encouraged to walk, run, bicycle, or scooter themselves from reader to reader, swiping their cards to record their travel. Organised into teams (again, class vs. class, school vs. school, workplace vs. workplace, etc.) players and groups accrue points as they travel and head towards fun targets and low-cost or ephemeral rewards. A website provides guidance and tracking of performance including leader boards. In the town of Reading mass participation turned the intervention into one of the UK’s largest ever place-based physical activity initiatives, where 49% of players were adults. Importantly, the intervention proved effective in both low- and high-socio economic neighborhoods.

4. Discussion and ways forward

Gamification is based on sound psychological and social theory and has seen success in the transport field. The INSINC program successfully shifted 7.49% peak demand to off-peak periods. The important questions confronting transport agencies are not if and how gamification works, but where it may be useful, and how to design a successful intervention. We know most about the approach’s efficacy in schools, and less about its efficacy with adults and in the transport context.

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3The P&C is a forum for parents, guardians and citizens to support and assist the government school system for the benefit of all students.
4http://www.beatthestreet.me/
There is ample scope to harness a gamification approach in Australia to achieve transport system-oriented goals. RFID card or app technology could be used to encourage better utilization of the new bicycle/pedestrian path infrastructure, or to undertake local area walking and cycling. The potential to combine games and rewards with public transport travel is significant, providing additional behaviour change rewards for off-peak travel (similar to *INSYNC*), encouraging walk instead of vehicle access to public transport, or to reward use of alternative public transport stops and avoid congested stations. Moreover, if the outcomes can be tied to business based travel plans where businesses can show improvements in their bottom lines from encouraging mode shift from car to public transport or active travel, some of the incentives may be underwritten through their savings.

Prior experiences lead to some important considerations. First, smart phone apps are an obvious pathway for gamified interventions, especially in contexts such as learner or professional drivers. But as both *Beat the Street* and *HAST* programs demonstrate, an app may not be needed or appropriate in certain transport contexts. Second, the private sector may or may not develop apps that support transport agency goals. For example *Strava* inadvertently encourages for some users unsafe cycling speeds on particular street networks through competition. In contrast, apps now exist that incorporate user information, e.g., Moovit which could be harnessed. However, it is more than likely that public agencies will need to invest in gamified approaches and programs that suit their needs. Third, trials and pilot schemes are the most sensible way forward. Low-cost trials can help identify which games are preferable, how schemes may be organized, who should run them, and in what way with the lessons learned being used to fine-tune the games for optimal results in a full scale implementation. Finally, the Australian market place has a significant cluster of app developers and technicians available in each of the capital cities to supply the necessary technology once the right transport objectives are identified.

**References**


