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Gamification design for motivating and measuring modal shift

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Abstract

Cities across the world attempt to minimise the negative environmental and wellbeing effects of increasing traffic volume and density. To this end, an increasing number of cities have taken to games and gamified applications to motivate mobility behaviours with less adverse effects. Being a novel approach predominantly deployed on online platforms, a major challenge of this approach is designing systems to generate valid in-the-wild mobility behaviour data to assess their effectiveness. Drawing on experiences from an on-going development project of a gamified application targeting tourist behaviour in York (UK) city centre, this paper discusses how a mobile gamified application driving sustainable behaviours can be designed to quantify its impact. It provides recommendations on how gamification design can allow for a measurable output on the levels of modal shift gained through in game promotion of alternative modes of transport.

Keywords:

Gamification, modal shift, integration, mobility behaviours, measurement

Introduction

Gamification describes the use of game design elements in non-game contexts, typically to improve user experience and motivate desired user behaviours [1]. Games are systems purpose-built to foster engagement and enjoyment; gamification attempts to transfer their 'active ingredients' and design principles to other systems to make these systems more engaging and enjoyable as well. Conceptually, this puts gamification between *serious games* – full-fledged games for non-entertainment purposes [2] –, and *persuasive technology* – computing systems designed to drive desired behaviours and attitudes [3]. Emerging around 2010 as a new information technology trend, gamification has seen massive growth in both industry and research [4], by one estimate poised to become a 2.8bn US$ industry in 2016 [5]. Implementations and research abound across sectors, from education, productivity, health and wellbeing to retail, marketing, and sustainability [6].

Mobility has been a particularly rich field of gamified applications, usually to improve health and wellbeing and reduce environmental impact by encouraging people to change their mobility behaviours and decisions. An early influential example is *Chromaroma* [7], a London-based game that

used people's Oyster card and Barclay's Cycle Hire data to encourage them to use public transport off-peak and get off early and walk or bike. Another group of early and common examples are in-car eco-dashboards that measure and reward energy-efficient driving, such as the Honda Ecological Drive Assist System [8] [9]. Another category of implementations centres on improving the in-transport user experience, such as the Volkswagen/Google *SmileDrive* app [10] [11]. Numerous gamified mobile applications have now been developed to offer a more engaging experience for pedestrian tourists traversing destinations [12].

Still, research on gamification in general and gamifying mobility behaviours in particular is in its infancy, with conflicting evidence as to its efficacy and a lack of well-designed evaluation studies [4]. A major promise of gamification is automatic and comprehensive user behaviour tracking enabling easy impact assessment and iterative, data-driven design [6]. However, this mainly holds for online environments like question-and-answer platforms where the targeted real-world user behaviour *coincides* with user input in the gamified software system. In the case of mobility behaviours, targeted real-world behaviours are rarely and not automatically in-application behaviours: changing travel routes, switching from car to bus or choosing train over car transport, etc. Hence, gamification designers are tasked to devise means to track and quantify these behaviours, be it by using the sensing capacities of the used technological infrastructure, be it by encouraging users to implicitly or explicitly self-report behaviour changes.

In response to this challenge, in this paper, we present design recommendations drawing on the case study of the on-going InnovateUK project 'GAMification for Better living in the cities by Influencing Tourist behaviour (GAMBIT)', which develops an application that motivates tourists in York city centre to change their mode of transportation. We will first provide background on the project itself, the city of York, its current mobility challenges, and the overall design of the application. We then outline how the application's design drives modal shifts and tracks behaviour. Finally, we will draw out design recommendations for future projects of a similar kind.

Case Study

The project presented here sits at the intersection of mobility gamification for enhancing the user experience and driving desired behaviours, particularly channelling tourist flows. In early 2015, InnovateUK put out the competition call 'Urban Living: Integrated Products and Services'. It called for start-up projects that would benefit cities and integrate products and intelligence from several sources. The consortium put forward the concept of a game, which answered the call by integrating 3D models, Open data and traffic data into the application. This offered users an innovative way to navigate through York city centre and allowed York organisations to promote themselves.

The project is targeted towards York's 6.7 million annual visitors to York City Centre, with younger

visitors as the target age range for the application. Within York, the Minster Quarter is the initial scope of the game, the area holds many of York's attractions such as the Minster and Stonegate, Figure 1. Whilst the initial target area is relatively small, it is particularly affected by adverse tourism effects like footfall congestion, and also serves as a test site, which if successful could be expanded to the whole of York, then transferred to other cities.

Figure 1 – York Minster Quarter Trial Map ©Visit York

The developed game would aim to promote behaviour change for users, with alternative walking routes, modes and attractions being promoted and incentivised through the game. The quantification would take place on the effect of the application and whether it had influenced modal shift or improved air quality in the area.

The City of York

The historic city of York has developed in size over the centuries due to its beneficial position for transport. Originally a river port for the Rivers Ouse and Foss in the Vale of York, it has been a significant rail hub since the introduction of railways to the city in 1839 it. Home to the National Rail Museum and boasting sub two hour train journeys to London, York has retained its railway heritage. Current transport developments in the City have seen the introduction of a Park and Ride system, which has expanded from one site in 1990 to now six sites around the city.

Due to its good transport links and wealth of attractions, York has developed into a major tourist

destination with over 6.7 million visitors per year, compared to only 200,000 permanent residents. Of those tourists visiting the city centre, 96% were based in the UK [13]. Tourists from the areas surrounding York, make up the majority of visitors, 27% of the total visitors coming from the Yorkshire and Humber region. Yorkshire, visitors have several modal choices for their journey. The large number of local visitors, results in the majority, 79%, of tourists being day-trippers to the city. Visitors travelling from further afield often have to stay overnight, with longer distance journeys often being limited in modal choice, with train and car being the only realistic options to accessing York City Centre.

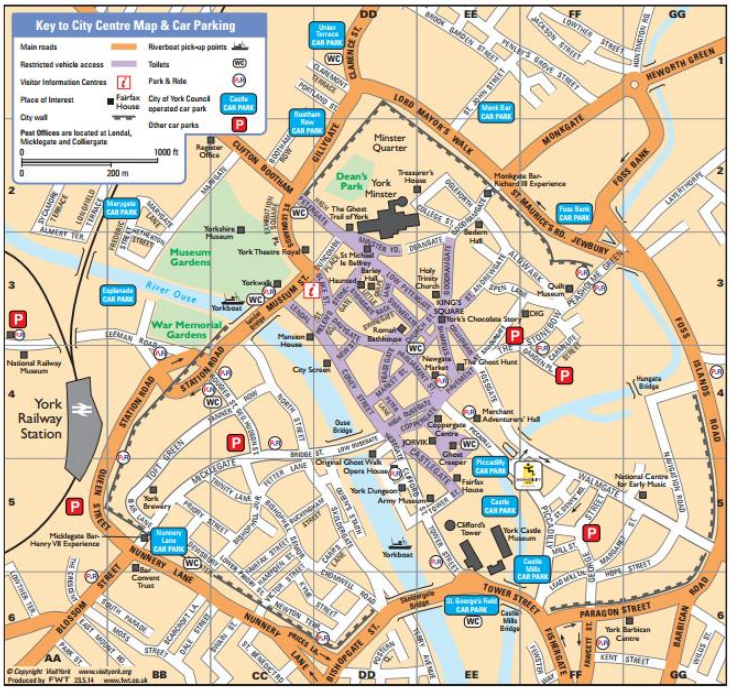

Figure 2 – Vehicle restrictions in York City Centre ©VisitYork

York suffers from similar transport problems as many other cities around the United Kingdom and Europe: high levels of congestion and poor air quality. The walled City Centre holds many narrow, cobbled streets which are pedestrianised between 10.30am and 5pm daily and also closed to cyclists in these hours, indicated purple in Figure 2. Despite these vehicle restrictions the City Centre still suffers from high footfall congestion, especially during peak tourist season. Particularly affected by footfall congestion is the Minster Quarter, a largely pedestrianised area holding main tourist attractions.

The gamified application

To reduce the burden of footfall congestion, improve air quality, but also to enhance the tourism experience and promote local retail and attractions not located on the main routes through the Minster Quarter, the Consortium decided to develop a gamified mobile application targeting younger visitors but with no targeted age group, the rationale being that this is that younger visitors to York are more likely to be engaged with a game than older visitors. While the detailed game design is still in

development, the overarching concept is to make use of York's rich historical heritage and set up ghost hunt scenario: through an in-application 3D map, using smartphone location tracking and camera capacities, players can track down, hunt, and encounter ghosts of the city's past and interact with their avatars overlayed onto the 3D city model and camera footage. Additional information about the city and its historical locations can also be accessed through the app, and particular tourist and retail destinations can be highlighted and connected to virtual rewards or discounts.

Motivating modal shift through game design

There are two major ways in which the application's design encourages model shifts in users' mobility behaviours. First, the application is designed to offer an engaging pedestrian experience: it cannot be properly played with in a car or bus. In comparison, the application makes the (still-short) pedestrian option more appealing by foregrounding interesting tourism destinations to adults and turning it into enjoyable gameplay for children. By promoting the application online and at the York train station, users are encouraged to download and open it before making the decision which mode of transport to use to access the Minster Quarter – and thus, become more likely to choose the comparatively more appealing pedestrian option.

Second, the application lays out ghosts and the trails along which they have to be chased through pedestrian city routes off the main route leading directly from York train station to the Minster, distributing footfall more equally across roads to reduce congestion and noise while also exposing tourists to tourism destinations they would not automatically discover if they follow the main route through the city.

In-game design to assist with tracking of modal shift

A series of methodologies can be adopted within the games design, to allow for it to be capable of quantifying sustainability and determining whether the application had influence over modal shift. The developed game will not have full market penetration, therefore the results that come from the game need to be considered a sample of the population.

Obtaining Origin-Destination Points

Through in-game determination of a user's game 'start point', by geolocation or survey, and the assumption that the City Centre is the end point of the journey; an Origin-Destination (OD) matrix can be compiled of the games users. The developed application can be used to determine the most populous routes taken through the game. Therefore by using measuring variation in a daily traffic count data, provided by Local Transport Authorities (LTA), on specific route, and comparing the traffic count to the journey times generated through the games outputs, the true influence can be quantified.

The determination of the 'game time', the time taken for a user to reach the city centre from origin, comparison can take place against route journey times known by the LTA. This comparison can be

used to determine the validity of the results with route anomaly's being highlighted at this stage. The data would be used to measure the differences of journey times of particular routes into the city, which can be used as an indicator of modal shift and congestion arterial roads to the city.

In-application surveys

On the game's start-up a stated choice survey would allow for the game to act as a survey module, with the pre-use preferences of users being compared to the actual movements undertaken by the user. Whilst acting in the form of a survey, the gamification principles would use the questions to tell the story of using the game. Questions such as: 'What mode did you travel into York the last time you visited?', and 'What mode are you planning to use today?' would enable quantification to take place on the games ability to promote modal shift.

After the game has been used a follow-up stated choice survey would reveal the influence of the game and allow a measure on modal shift through the game. Alternatively, this could be carried out through revealed-choice survey, or tracking the user's movements. This would therefore provide a measurable against the stated-choice survey results taken pre-use too see whether a modal shift has taken place based on the user's original opinions.

Incentivising travel options

The incentivisation of alternative travel modes can be used to influence behaviour and also allow for the sustainability and modal shift of the application to be determined. The incentives could involve reduced fares on an alternative mode of transport or reduced prices of goods/ admission within the city centre. The quantification would come through measuring the difference in usership of the public transport before and after the application. The game would determine activity on public transport through interaction with the mode, using technology such as QR codes. The data generated through the game would be used to determine patterns the usership levels and quantify whether the game had influence over the fluctuations in usership levels.

Recommendations

Defining modal shift

Providing a definition of modal shift in the context of the project is essential when planning on methods to measure it. The GAMBIT project, looked to measure sustainability with modal shift acting as an indicator. Therefore, promotion of 'green' alternatives was seen as a key policy for the games attempt to promote sustainability. It is also vital to identify who is being targeted by the modal shift, as the measures are unlikely, in the short-term to produce city wide results. For the GAMBIT project modal shift will be measured by the decrease in percentage of visitors using private vehicle to visit York city centre, but an increase in Park and Ride usage and a smaller increase in other forms of public transport.

To assess modal shift, pre-existing data on modal patterns is essential for measuring the impact of the measures introduced through the game. Journey to work census data, which is openly available, can provide an overview of the modal choices of citizens getting to a city. However, if the games targeted audience are not commuters, the data does not provide a realistic overview of the modal share situation. The GAMBIT project benefits from Visit York and their publication of tourist surveys that they undertake, this allow for a true baseline model of tourists behaviour to be developed. The acquisition of a reliable pre-game modal split dataset for the target audience is essential for the measurement to be undertaken.

Use of the cities resources

The nature of gamification applications is that they are not designed to be end to end journey planners, the high levels of graphics and download speed required mean that other products and applications are better suited to perform this function. To promote modal shift requires integration between the 'game' and the cities existing travel planners.

Early engagement with local authorities and organisations with an interest in promoting modal shift is essential for in game modal shift to be successful. Existing local policies promoting modal shift and more sustainable travel options should be introduced into the game. For GAMBIT, The York iTravel application offers route planning options to users, and its integration into the developed is vital for successful integration. The integration of this service within the game (and vice versa the game being advertised on the iTravel York's website) allows for existing transport planning applications to be utilised and allow the 'game' to focus on functionality previous not provided through journey planners.

Within York, the Park and Ride (P&R) facilities provide an ideal opportunity for the game to target a more sustainable approach to journeys into the city centre. By targeting the most popular parking sites it would allow for the games 'story' to start on the journey into York City Centre. The application could incentivise the P&R, the application could tell if the P&R was being used through QR codes or location. In other cities, where there is a prominent sustainable transport such as a bus rapid transit or metro, this could be used in similar fashion as York's P&R.

Competition

Promoting a level of competition within the game is an easy way for engaged users to strive to achieve greater results through the application. Intelligent Health have developed a card based game called 'Beat the Street' that uses gamification techniques to promote healthier activities such as walking, with citizens movements being tracked by card readers deployed around the game area. The competition element shows the distance walked by all of the users, with in game incentives for the winners. Intelligent Health have shown that in areas where the game has been deployed 48% of people use their car less [14]. This shows that through completion a shift away from motor vehicles can be achieved. The GAMBIT developed application will use in-game multiplayer competition to further engage users,

promoting users to visit certain destinations and travel modes.

Game entry points

Whilst the 'game' element of the application may only commence within the confines of the city centre, it is vital that the game starts outside of the city centre to allow for a modal shift to be encouraged. Game entry points can be seen to be either 'virtual' or 'real', with a combination required for successful games. Virtual entry points, are through external promotion of the game, such as a tourist board website and allow a user to engage with the game outside of the games boundaries. Real entry points, such as Park and Ride sites, start the games story for devices when entering the city. One of the key differences between a game and an app is that the 'game' can be played without travelling into the games area, through the 'virtual' entry points. These game plays outside the city centre would encourage alternative more sustainable modes of transport to be used when the journey to the city centre takes place.

In areas, such as York's Minster Quarter, where there are limited roads and which is largely pedestrianised, there is no ability to quantify modal shift simply by analysing the effects on footfall. Therefore, ensuring suitable 'real' entry points for the games users outside the city limits is vital. Marketing and promotion of the 'virtual' entry points, will allow for the early engagement with the game prior to making a modal decision.

Output data availability

The availability of data through the application is vital for quantification to take place. An application which does not capture a user's information allows for little information to be outputted, and therefore limits the quantification that can take place. In game tracking of a user's movements allows for a revealed preference survey to be carried out on a user's movements, and allows for a comparison against the stated preference answers provided in a start-up or end-game survey.

Output location data can also allow for analysis to be carried out on the effectiveness of the game's ability to influence behaviour. With the game providing alternate routes to adjust the user's behaviour, the effectiveness of altering the decision making process can be assessed. Within the York GAMBIT project, this is being undertaken through differing game scenarios with different proposed routes and destinations being proposed based on the users choices. Anonymous, time-stamped, location data from players using the game will be compared to similar data from volunteer tourists using a blank version of the app with no game interface. If behaviour change has been caused by the gamification of the app a significant difference in movement will be seen, providing evidence that the game has influenced tourist behaviour and can therefore be seen to promote modal shift.

Marketing

The promotion of the developed game used to promote modal shift is vital to ensure that enough

market penetration is achieved in order for a significant sample size of users is achieved for analysis. Marketing also allows for the 'virtual' game entry points to be discovered by users prior to beginning their journey to the games area. Marketing companies are increasing using gamification as a way to engage users, but the nature that the game is marketed will affect the overall effect and audience of the game. For the York based GAMBIT project, Science City York and Visit York are vital partners in the project in ensuring that the game is marketed well. Promotion of the game on tourist board's website will enable potential users to download and begin the game prior to arriving in York.

Expected outcomes

With the GAMBIT project still being its relevant infancy the outcomes of the project have yet to be determined, but expected outcomes can be proposed. With the alpha release of the developed game not due until late 2016. Due to the scale and the nature of the game developed in during the York based GAMBIT project all the recommendations set out within this document are unlikely to be met for methods for measuring and motivating modal shift through the application.

The game is expected to show, that on a small scale that the gamification techniques do have influence on the mobility of users. Therefore a modal shift is expected to be able to be determined for users of the application. The city wide effect of the application would not be clear through the application due to the levels of penetration, however, by using the games users as a sample of the cities population, the overall effect of the application could be assumed.

Conclusion

Gamification within certain aspects of mobility is not a new concept, however the influence that it can have on modal shift have yet to be fully determined. With the market growth of gamification set to reach $11.1 billion by 2020 [15], the growth is set to be exponential, therefore smarter mobility needs to adapt in order to harness this new way of behaviour modification. Working towards the European target 2020 [16] and the ambition for 20% reduced emissions, developing a populations engagement with in sustainability projects and promoting shift through gamification techniques could harness a new generation of mobility users to ensure an increase in more sustainable modes of transport.

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