

Place based mobile Games and experiential learning in natural environments.

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Abstract. Place based mobile games have the potential to support experiential learning through enhancing a landscape with enticing media and encouraging interaction with the real world. When contextual awareness is combined with Augmented Reality (AR) and different forms of interaction, the potential for enjoyable and educational engagement with the physical world can be greatly enhanced. However, there can be issues with maintaining immersion, due to divided attention across virtual and physical environments, higher levels of difficulty, particularly during navigation tasks, and distractions that affect concentration.

This paper describes a contribution to a wider research investigation that considered how the play experience of outdoor place-based games can be optimised to encourage young people to engage with natural environments and learn about what they find. A central aim was to create a new framework based on flow theory, introduced by Mihaly Csikszentmihalyi that will categorise design guidelines that can support the development of an 'ideal experience' for place-based games.

A collaborative project between the University of Brighton, Friendly Fox Games and Forestry England specifically addressed features, particularly relating to game goals and narratives, that influenced levels of perceived control in games, an aspect of flow that is pivotal to success and motivation. A proposed new flow framework for PBMGs was subsequently adapted through the findings, alongside specific design guidelines that can help to overcome typical problems and challenges during play.

Children were included in an extensive co-design process, along with stakeholders, as part of a design-based research methodology. Prototype games were subsequently implemented and tested in forests in the UK, with positive feedback from both children and teachers.

Keywords: Location Based Games; Nature Trails; Flow Theory for Games; Outdoor digital games; Co-designing with Children; Place Based Mobile Games.

1. Introduction

Forestry England were interested in developing learning experiences for their woodlands that would support the UK school curriculum in natural science and concurrently communicate the benefits of their forest management methods. Encouraging young people (targeting 8 to 12 years of age) and their families to visit their locations was an important aspect of the project and therefore Placed Based Mobile Games (PBMGs), which are a form of Location Based Games situated at a particular site, provided a potential solution. Research had been carried out over a period at the University of Brighton and Sussex into the use of these games to connect young people with nature (Grundy, 2014). It was therefore a Friendly Fox Design have been working on digital experiences, including Nature Trails, to support facilities for children to play outdoors in nature locally, based on this research.

The benefits of location based mobile games for experiential learning have been widely explored. (Ardito, 2010; Benford, 2004; Brown, 2010; Chen *et al.*, 2004; Hsaio, 2010; Lonsdale, 2004; Moorhouse, tom Dieck and Jung, 2019). However, there are inherent challenges that can interfere with the experience of playing and learning with PBMGs. They present a relatively high level of cognitive demand, compared to other computer games, as the player negotiates both physical and virtual worlds (Ritchie, 2014). Creating a balance of attention can be problematic, with players often overly focussing on the screen and not on their surroundings (Frohberg, 2009; Eliasson, 2013; Schwabe and Goth, 2005). Such complexities can also interfere with a sense of

volition and motivation to compete the game goals (Rigby and Ryan 2011; Schwabe and Goth, 2005). Added to this, social and cultural challenges can constrain visits to natural environments for some children and make them appear less attractive as play spaces (Bond, 2012; Moss, 2012; O'Neill, 2019; O'Neill, 2020). It was therefore necessary to create games that are enjoyable and motivate players to overcome inherent challenges; in short, the games needed to represent the best experience possible.

Ideal game experiences have often been analysed in relation to Flow theory, originally introduced by Csikszentmihalyi (2002) and therefore models of flow were considered during this research as a framework to categorise design guidelines for developing PBMGs. In previous investigations, certain requirements for the game had already been established that would enable the interface to be usable, support navigation and agree suitable effort parameters for children, such as the length of play times and distances covered. Exploration of the balance of focus and how physical and virtual attributes draw attention was also carried out (Grundy, 2018). Design guidelines discovered during these investigations were subsequently implemented into game prototypes used during this project. The study described in this paper builds on previous research by targeting factors that influence feelings of 'control' for a game which are considered important for a flow state, also considering how a flow model for PBMGs might be influenced and interpreted through game goals and narratives.

Game success is also often also associated with ability to address key emotional needs of the player, with a role in motivating and engaging players (Freeman, 2003; Yee, 2007; McGonigal, 2011). In theory, if key emotional needs can be addressed in the design of PBMGs, a better play experience will be created, and games will be more successful in motivating children to learn. This study therefore involved participatory design activities with children to assess latent needs, in answer to the question:

What are the attributes of the game narrative that can increase feelings of control, enticing the player to overcome challenges, by targeting and addressing the emotional needs of the player?

Rigby and Ryan (2011) create a connection between key emotional needs and control through their PENS model, based on Self Determination Theory (SDT) which is used to study motivation (Deci, 2000).

- 'Competence' needs, in general, refer to an ability to *control* outcomes and experience or demonstrate mastery of a task or skill.
- 'Autonomy' needs refer to the urge to be *in control* of a situation and have choice of action.
- 'Relatedness' is also included in their model, which relates to feeling connected with other beings, however these influences were considered in a separate research study for PBMGs due to their complexity (Grundy, 2018)

The words control and power are often used synonymously. Power as defined by Google's Oxford Languages includes: 'the ability or capacity to do something or act in a particular way and 'the capacity or ability to direct or influence the behaviour of others or the course of events'. These definitions follow the SDT descriptions of 'competence' and 'autonomy', with an emphasis on ability and having agency through choice respectively. Further, psychologists have defined wanting to be 'in control' or acting upon such desires as the strategic or measurable aspects of gaining power, which is a considered as a human need REF. In the study therefore children's narratives were analysed keeping in mind that references to having power are likely to be expressions of the emotional need behind control as discussed in flow theory. Evidence suggests that children's need to feel powerful during play is particularly strong, because they have relatively little status or ability to choose in their real lives compared with adults (Del Vecchio, 1997; Barroody *et al.*, 2003; Hyson, 2003).

2. Using flow theory to model experiences

Murphy *et al.* (2013) suggested that the qualities defining flow for games are a sense of timelessness, being at one with the activity, experiencing exhilaration, focus and immediacy. However, the significance of flow models for this investigation lies in their potential to predict ideal game requirements, rather than describing their esoteric qualities (Chen, 2007; Murphy, 2013; Sweetser and Wyeth, 2005).

According to Csikszentmihalyi, flow for any activity can be split into the following attributes, illustrated in Figure 1.



Figure 1: Attributes of flow

- Achievable goals: we can do the activity or can hope to with time.
- Clear goals: the activity has tangible, well communicated goals.
- Affords concentration: the activity draws our attention, and we are able to concentrate on it.
- Feedback: the activity has direct and clear feedback.
- Control: we feel that we are in control of the activity, the choices we make and the outcomes.
- Worries disappear, other worldly concerns are secondary to the activity.
- Alters perceived time: subjective experience of time is altered.

Sweetser and Wyeth (2005) created the GameFlow model to show how flow corresponds to games, shown in Table 1. Their model is a general one, however and they invite others to create genre specific versions.

Table 1: Mapping flow to games (Sweetser, 2005)

Flow theory	Games design
An activity that can be completed.	The game goals can be completed (appropriate level of challenge)
An activity that has clear goals.	The game should have clearly communicated goals
The ability to concentrate on an activity.	The ability to concentrate during the game.
An activity that provides immediate feedback.	The game gives immediate feedback.
The ability to exercise a sense of control over actions.	Players should feel in control during the game.
A deep but effortless involvement; concern for self disappears; sense of time is altered.	A sense of Immersion.

Murphy et al. (2013) went on to categorise **prerequisites** for attaining the flow state and the **benefits** of being in a state of flow. Prerequisites included: an appropriate level of challenge; clear game goals and the provision of feedback, shown in blue in Figure 2. Benefits were defined as: feelings of control, being able to concentrate and immersion, shown in green (Murphy et al., 2013).

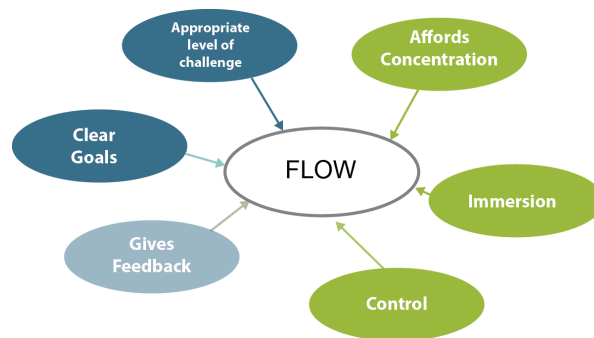


Figure 2 Flow categorised into prerequisites and benefits (Murphy et al., 2013)

Other evidence, however, pointed to the inclusion of requirements that enable feelings of control as prerequisite for flow rather than simply a benefit; with theorists noting the influence for design of both the core mechanics of a game (Yee, 2007) and the narrative (Freeman, 2003). In order to consider the relationship between control factors for flow and designed elements that would influence key emotional needs in this area, the PENS (Players Experience of Need Satisfaction) model, based on SDT was investigated through this study, which suggests the following are important:

- *'Competence' needs*, interpreted for games as 'a sense of achievement or feeling more masterful during play' and can refer to developing or using their abilities.
- *'Autonomy'* interpreted for games as 'allowing players self-expression through a sense of individual purpose, volition, or the freedom to make choices'.

This investigation therefore considered feelings of control by considering emotional needs as a potential prerequisite for flow and how control might be incorporated into the flow model and interpreted through design guidelines for supporting game design.

3. Approach

The methodology for the study can be described as design-based research, including design thinking methods that help to solve complex problems. It specifically followed a concept driven approach, whereby particular attributes of games can be isolated for study, keeping other variables constant. During this phase, co-design methods were used to work with young people to investigate preferred narratives and their relationship to control needs. The process was iterative, with findings incorporated into prototype games and AB tested with young people, retaining other parameters previously identified across versions, leading to further information about the requirements for the game.

Co-designing was a critical part of the work, but activities needed to be age appropriate and able to be 'triangulated' to get valid data. The work of Alison Druin (Druin, 1999) and others illustrates the significance of including children in a design process at all stages, through creative but comprehensible methods. However, this is not straightforward, as an adult it is almost impossible to second-guess the preferences of an 8-12 year old child (Naranjo-Bock, 2011). This led to the development of a process where the children designed characters and stories (CAS) to illustrate a scenario related to the game context. During this process, they discuss with the researcher their creations and their reasoning. This method proved to be popular and effective and helped to identify emotional needs, forming the subject of previous research papers (Grundy, 2013)

4. Co-design and test sessions with children

The first two sessions were held prior to working with Forestry England, however they also informed the results and informed conclusions about the significance of control factors for PBMGs.

4.1 Method: Session 1

Co-design events were undertaken in June 2013, over a 5-week period, with St Andrews primary school in Brighton, for pupils average age 9. Each pupil designed a character based on their favourite natural creature and created a story about their adventures using a template storyboard. Subsequently they made their own

outdoor game, the pupils worked in groups of three making animated videos of their drawings using an app called MORFO to create content and add to the game through a game engine. The pupils subsequently played their own game and a researcher videoed their progress. At the end of the final session pupils were asked to fill out a short questionnaire which asked them to rate their activities on simple Likert scales.

4.2 Method: session 2

In June 2014, a two-day workshop was conducted with 12 pupils from Fairlight primary school, also average age 9, repeating the character design activity and their own game content development as before.

On this occasion they were also asked to play two different games developed by researchers. Both games included parameters for usability and concentration that had already been identified and also included a range of activities in nature, introduced by wildlife experts.

The first game included gold coins as rewards for carrying out an activity, the second represented an adventure game style, including a mission 'to save the forest through helping creatures and getting superpowers as a reward'. These were both narratives that had arisen in the 2013 session with other children. The children were asked about preferences for the overall game goal and intermediate activities towards them through basic Likert scales.

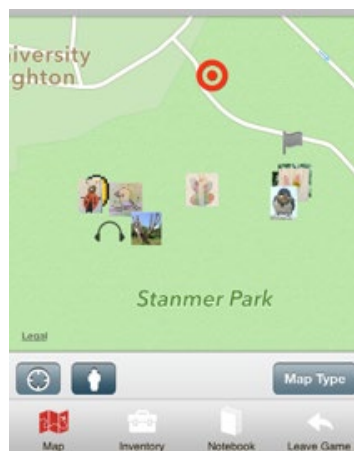


Fig 5: Screenshot of adventure game version

4.3 Method: session 3

After the project was initiated with Forestry England In April 2019 the CAS method was introduced again to a class of 30 pupils at St Andrews School in Hove, UK, with an average age of 10. The school is in a relatively urban setting. In this case, the children were also told about the forest management activities and their benefits and asked to include some of them in the stories they created.

4.4 Method: session 4

The same CAS process as in session 3 was repeated for a school, in Alfriston, Sussex, in May 2019, with a group of 20 children (who lived in a more rural setting).

The pupils were asked to play two different games and previously identified requirements were included. The content also referred to the benefits of forest management, through the commentary of animated creatures that introduced game activities. The difference in their overall game goal was as follows:

- Game 1: Get superpowers from natural objects found on the route to defeat an adversary
- Game 2: Explore and gather ingredients (treasure hunt) for a magic potion that would cure an animal.

The first placed more emphasis on competence needs, the second allowed more autonomy through choosing ingredients and allowing exploration, however it proved impossible to completely isolate these different needs and both games displayed aspects of both. The children were asked about preferences for the overall game goal and intermediate activities towards them through basic Likert scales as before.

They also were put out if they had to return to any point on their previous game, or to back track in the same game. It seems that much of the enjoyment is in moving forward into new terrain

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