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LOCATION BASED MOBILE GAMES FOR LEARNING AND DECISION MAKING

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ABSTRACT

The use of computer games as a tool for supporting learning about management and the appreciation of natural disasters is of great interest to many involved in supporting emergency services. Through the use of computer gameplay those involved in 'front line' disaster or emergency management can experience scenarios through simulated situations.

CODE RED: MOBILE is a game developed and designed with 7Scenes (7scenes.com) a free mobile game and editor for iPhone and iPad. Participants in the game learn about bushfires using visualisations created in modified (modded) Crysis Wars (Crytek.com) a computer game with a game editor. This paper outlines the development of CODE RED: MOBILE and discusses the results of the design of assessment of learning with the game using context based visualisations.

KEY WORDS: location based games, emergency management, training

INTRODUCTION

This paper applies the notion of personal cognitive maps (Brown et al 2010) to an assessment of a pilot mobile learning package about bushfires in S.E. Australia called CODE RED: MOBILE. The pilot game is played on iPhone (see Fig.1) and iPad using the 7scenes application (7scenes.com).

Figure 1. Screenshot of CODE RED: MOBILE in 7Scenes on iPhone

Visualisations delivered as vital elements in a location based game may induce a personal cognitive map rather than a simpler less emotive cognitive map from another person's ideas and experiences. The latter can be termed a fictional cognitive map (Brown et al, 2010). The authors of this paper are interested in developing a package that binds real world locations with visualisations made in a modified (modded)

Crysis Wars (Crytek.com). It is envisaged that this will produce a more comprehensive and effective package for learning about emergency management situations like bushfires. As a fire fighter in bushfire disasters such as Ash Wednesday in 1983, and more recently experiencing locally the threat of Black Saturday 2009, the first author is of the belief that learning about bushfires needs to be more concrete and less abstract, more vivid and much more grounded in the learner's local area. This grounding may promote a personal cognitive map.

In the first section location based games (LBS) are introduced as a subset of pervasive games. In the next section navigation through real locations and spaces egocentrically to make an allocentric memory of a place is examined. Cognitive science is used, in particular to show how personal cognitive maps may be distinguished from fictional ones. Next aspects of the CODE RED: MOBILE games are outlined, followed by further details on assessment. Finally conclusions are presented.

Pervasive and Location Based Games

A Pervasive game is defined by Montola (2005, p. 3) as: "a game that has one or more salient features that expand the contractual magic circle of play socially, spatially or temporally".

The game may require little in the way of, Information Technology or electronic devices.

On Location-based Games Fetter et al (2007, p.1) wrote:

"Location-based Games are one of the many areas where the concepts of pervasive gaming come to life. Thereby single players or teams perform tasks in specified scenarios using mobile computers like laptops, personal digital assistants or mobile phones in combination with wireless communication and location-sensing technologies, having the real world as their game board".

Capra et al. (2005), summarised in Raper et al (2007), defined location based games as mobile public interactions at locations that integrate elements of the real world with digital devices and programs. We argue that games although often for entertainment are useful for learning.

Learning in Games

Cartwright (2006, p. 33) stated:

"We have a need to produce artefacts that provide the stimulus for humans to create a mental map or a synthetic world.'

…and development of applications influenced 'by the need for creating accurate representations of the world… (by) gaming strategies… (and) more intuitive methods for interacting with and moving through cartographic representations of the world."

Cartwright (2006) found in a study of a prototype application that users preferred using the interactive multimedia with some aspects of a gameplayer interface to a paper map. The cognitive load was lower when using the 3D interface and naïve users preferred using game controls for accessing information.

This gameplayer interface applies to 3D computer games on a desktop computer and by extension also mobile games whether on a laptop or netbook, a tablet such as an iPad, an inexpensive low end mobile or a smart phone such as an iPhone. In the 2004 report 'Literature Review in Games and Learning', Kirriemuir and McFarlane pointed to a suite of valuable skills developed through game play that include: strategic thinking, planning, communication, application of numbers, negotiating skills, group decision making and data handling.

Marguerite L. Koole (2009) has proposed in A Model for Framing Mobile Learning some advantages for mobile learning. In this publication she states that mobile learning operates wirelessly providing access to information whilst at any location. It can find information about other locations with the device or via the device virtually. This access can occur at any time. Learning in a context provides authentic local based information making memorisation easier. This lowers cognitive load and together with new patterns of presentation can further assist learners to remember and transfer new knowledge.

Quinn and Cartwright described how a location based game incorporating visualisations about bushfires may be designed for a mobile device (2009). Information was delivered to the device when the player entered a GPS defined location. This is a form of location based service.

Location based services provide 'at-location' information that can be used in computer-assisted learning packages.

Location Based Learning

Edwardes et al (2005) reported on the WebPark project. They researched the development of location based services (LBS) delivered by a mobile information system for geo enabled knowledge transfer. LBS have two contexts: the user and pertinent phenomena. These LBS are differentiated in MacEachren's terms (1994 p 59-60) cited in Edwardes et al (2005) as discrete and abrupt, such as a point of interest (POI) or real time events, and discrete and smooth, such as deer observations. They may also be continuous phenomena, such as the density of vegetation types or animal distributions. The nearby or relevant data needs to be delivered for a user's location and spatial context. This data thus must be abstracted from a park wide body of data and is termed remodelling which affords the geo-enabling of the data. The database for Webpark links locations to multimedia content classified by location and by ontological relationship to other content.

Visitor use of WebPark in the Texel Dunes National Park (the Netherlands) and the Swiss National Park in eastern Switzerland have been reported by Dias (2007). He describes the application as a context-aware, location-based service (LBS). Dias argues that the results of their study show that the main advantage of the system is the delivery of multimedia at a location for a visitor to the park. The application also improves visitors' knowledge of the park rules and advisories, supporting management of the park.

Location based games for learning

In order to appreciate the use of location based games for learning, we next provide information about the use and affordances of location based games used in education.

Admiraal et al (2009) reported that "…mobile games... are excellent ways to combine situated, active and constructive learning with fun" (p 302). 216 students played the game. They reported that the game was designed with history teachers coordinated by the Waag Society (www.waag.org). The game players were students from local schools: pre-vocational, upper secondary and pre- university. Students played merchants or beggars that try to gain citizenship of the city in 1550. Upon entering certain areas of the city defined by general function they received a video and text items on their mobile phone. They also carried a game phone with GPS. They had to complete three assignments one which oriented them, another assigned a creative, imaginative exercise and thirdly a symbolic assignment, for example what is the meaning symbolised by a church steeple (students found this difficult). The 'Headquarter Team' (HQT) students found information on the Internet which they relayed to the City Team (CT). CT students had to act and record video performances or send photos or text in response to set tasks relating to locations in the city of Amsterdam. At the end of the game these media were presented to all the students involved in the game.

Data collected included school background on the individual students and information about their motivation and attitude to learning collaboratively. During the game researchers made observational notes, coaches for the CT and HQT kept notes and made an evaluation of the process and a video was made of the group presentations. After the game recorded files were collected and recorded GPS trails of the participants archived. A week after the game students answered a questionnaire on motivation and did a test and wrote an essay on medieval Amsterdam.

Results showed that the students were very enthusiastic. They did not engage much in the competitive elements and concentrated rather more on the assessed tasks.

Technical problems involved: failure of the GPS to adequately track students, video phone connection was sometimes lost, transmission of photo and video back to the server took a long time during which time the students could not proceed with the game. The assignments suited the pre- university group but the pre vocational needed much more assistance on the assignments and with the technology. The small screen and sun glare made the reading task difficult.

Students received information through videos delivering the narrative or story. The students barely glanced at the video or text information scrolling down quickly to the set work. They thus did not have a grasp of the historical background of the game and did not show much interest in the notion of gaining citizenship. Searching for information on the internet was difficult for those teams who did not know the key words to use. Communication between CT and HQT was mostly about navigation and not about the assignments.

Findings on learning showed that students who played the game had retained more factual knowledge about medieval Amsterdam than students in ordinary classrooms. Students with low ability in history learned as much as the other groups. Pre- university students learned more by the game than pre-vocational students.

This may demonstrate that knowledge needs to be 'scaffolded', whereby abstract concepts are broken down to make that knowledge available to a broad audience. Motivation may be a factor rather than low ability in history. Games such as this are valuable for learning history in its geographic context. Information such as provided by visualisations needs to be delivered, such that it must be carefully construed for success in the game. Otherwise the learning elements can be avoided.

Brown et al (2010) described the design of Route Mate, a mobile location based route finding application for people with intellectual and sensory disabilities. The application encourages learning of important routes and seeks to develop independent navigation and travelling skills. They developed the application for Android based mobile phones. A fundamental consideration was that learning in the real world and time context will compensate for lack of memory skills as well as the prevalence of concrete thinking. Brown et al, citing Gow et al (1990) reported that concrete thinking can be defined as context dependent, generally rule following and where learning is often not readily transferred to new contexts.

Mobile devices can provide access to images, maps, sounds and text related to a location "Systems for new route learning using location based services can be appropriately structured to heavily scaffold the planning of new routes and the first instances of travelling these new routes" (NESTA Futurelab Series 2004, p15).

Brown et al summarise that mobile devices can reduce cognitive load. However too much support leads to a lack of learning and personal cognitive maps are not then constructed by the participant. A game based approach may lead to the development of personal cognitive maps. Use of the mobile phone with map and GPS allows the person, with help, to plan a route, then rehearse it and finally find their way independently. Photos can be taken along the route and saved to the mapped location on the phone to aid navigation and memory. The in- built compass aids direction finding.

They concluded that because the game concentrates on learning a new route rather than just following a guidance system, the participants may be more empowered and benefit in general cognitive skills. Testing involves participants planning a route, doing a practice run and then undertaking an independent run through the game.

Ideas from Admiraal et al and Brown et al lead to some guidelines for researching, designing, assessing and making a location based game for learning.

Cognitive Science

Hegarty (2004, p. 280) in a literature review, related how people infer and mentally model how mechanisms work and explained that the literature described the meaning of a mental model in two ways: one was a model of the brain's processes and anatomy involved in understanding reasoning about and predicting a physical system's behaviour and the second as "running a 'mental model of a mechanical system."Tolman (1948), studied rats learning to navigate mazes, he concluded that in the process of discovering a new place rats must form a mental model or representation of their environment. This model he termed the cognitive map. O'Keefe (1976) discovered place cells in the hippocampus of the rat brain. Place cells in the hippocampus record short term memories of where they have been and the process produces an egocentric map (Hermer et al 1994; Hermer and Spelke 1996). The egocentric map is created using the place cells that record the direction of each straight lined segment (or vector) that a rat walks in the experimental space.

The egocentric maps in the hippocampus are recorded by the parahippocampus into long term memory (LTM) with the addition of memories of the iconic objects or important features of an event in a context, to create an allocentric map. The allocentric map is not centred on the rat or human but shows the context of the environment it is in, with boundaries, barriers, spaces and objects. These memories of objects or entities are linked in the mind to associated physical and affective memories (Hartley et al 2006). In addition place cells in rats and presumably humans, record slope being traversed and thus vertical movement is mapped (Jeffery et al 2006). The egocentric and allocentric maps are thus in 3D.

An allocentric map is sometimes referred to as a 'God-like' view of a scene or event, much like a map. However it is more a multidimensional mapping, perhaps like the database that runs a 3D computer game. The allocentric map can also be regarded as a cognitive map, mental model, situation model or event model. It also can preserve the context, content and layers of meaning of a conversation. A conversation can be non verbal communication.

Event Models

Radvansky, Copeland and Zwaan (2005) compared memories of events or situations that were either personal stories of experimental subjects or fictional narratives that they had memorised. The context of the memories was established in the mind according to the authors as a mental or situation model. A situation model in a single spatio- temporal framework was described as an event model. Connected event models are episode models. The links between event models, in an episode are time, causality and intentionality or goals (Zwaan et al 1995). This is their 'Event Indexing Model'. The links are generally based on time and thus are in sequence. Intention is derived from a character's motivations and causal links are causes and effects which change the state of the world. (See http://en.wikibooks.org/wiki/Cognitive_Psychology_and_Cognitive_Neuroscience/Situation_Models_and_Inferencing).

Brown et al (2010) advocate that participants acquire personal cognitive maps of the route they need to learn. Personal narratives or stories and autobiographic memory of Radvansky et al (2005) are personal cognitive maps.

A fictional narrative is a transformation of an event or idea into a communicable form. This cognitive artefact can be a story, play, movie and for describing physical systems, perhaps a mechanical or electronic device. This used to understand an event or idea, without the trouble of independently determining causes and sequence. The second type of cognitive map is created personally. Personal cognitive maps have personal context, retaining the rich sensual and emotional memories of a real experience. Cognitive maps learned with the help of cognitive artefacts are deficient in some sensual and emotional links and may well have errors in the temporal sequence and causal links.

Visualisations are more like fictional narratives than personal narratives. For fictional narratives Radvansky et al (2005) describe the temporal sequence as the framework for the memory of the story. Experimental subjects remembered events easiest in forward order rather than backwards. Where the causal connections were strong and clear the order was remembered more easily and was more important for recalling the context of the story rather than the details. In autobiographic or personal stories, event order was not as important and there was easier retrieval of the details that had strong causal connections. People tended to start with the important details first and then work out the order of events. However it tended to be that for autobiographical stories, recall was easier if the initial event was remembered first. Event importance and event structure seem related in that those more important events are later in the narrative in general i.e. the resolution of the story is at the end. In autobiographical memories of events generally cause and effect chains are often invisible. Illustrating events in a bushfire with a visualisation for learning should ensure that temporal sequence and causal links are clear and important events like a wind change stand out. The delivery of the visualisations at the real location of the fictional events adds real sensory and emotional aspects to the experience perhaps overcoming the deficits of a fictional narrative.

Assessing the ability of CODE RED MOBILE to induce personal cognitive maps

Hegarty (1992) asked subjects how they visualised a complex pulley system. She found that they viewed the system piecemeal, imagining the parts and their movements in causal order. Thus using a diagram of a pulley system to create a cognitive map would produce a fictional narrative form of a cognitive map with recall better in forward order but with difficulties in remembering backwards.Vrij et al (2007) suggest that truth tellers recall more of place and time (or contextual embedding) and remember conversations verbatim. They also recall more sensory memories and do not so much remember cognitive operations such as “I was thinking that”. Truthful recounts are spatial and temporal and the items, entities and events are in a detailed context. Vrij et al (2008) studied subjects lying. Whilst recalling an event in reverse order there was an increase in the cognitive load and the stress of this task revealed cues of deception, such as taking time to invent features by using errs and ums in speech. There is less contextual embedding and less sensory information. Vrij et al recommended using reverse storytelling to detect if people are lying. Retelling what you have learned from others, or learned from a visualization is a bit like inventing a lie in that, for both, it is difficult to give the order of events backwards. For lying this may be because creating a story from imagination or lying involves the difficult task of manufacturing a context from scratch. Entities’ behaviours have to be consistent with the story’s details and the complex causal chains. The emotional and sensual aspects do not have the primacy of contextualised real memories.

The aim of the location based learning package CODE RED: MOBILE is to demonstrate that the addition of real world sensations and emotions anchored to actual locations will assist learning. This is the combination to some extent of the fictional narrative of the visualisations with personal narrative cognitive maps created by the experiences in the game on location. To what extent this is achieved is measured by the ability of learners to answer questions that elicit responses about sequence and causes of events and the ability to recount details in reverse order.

CODE RED: MOBILE

CODE RED: MOBILE uses the iPhone or iPad operating the 7scenes game and the editor application on a PC (7scenes.com) (see Fig.2).

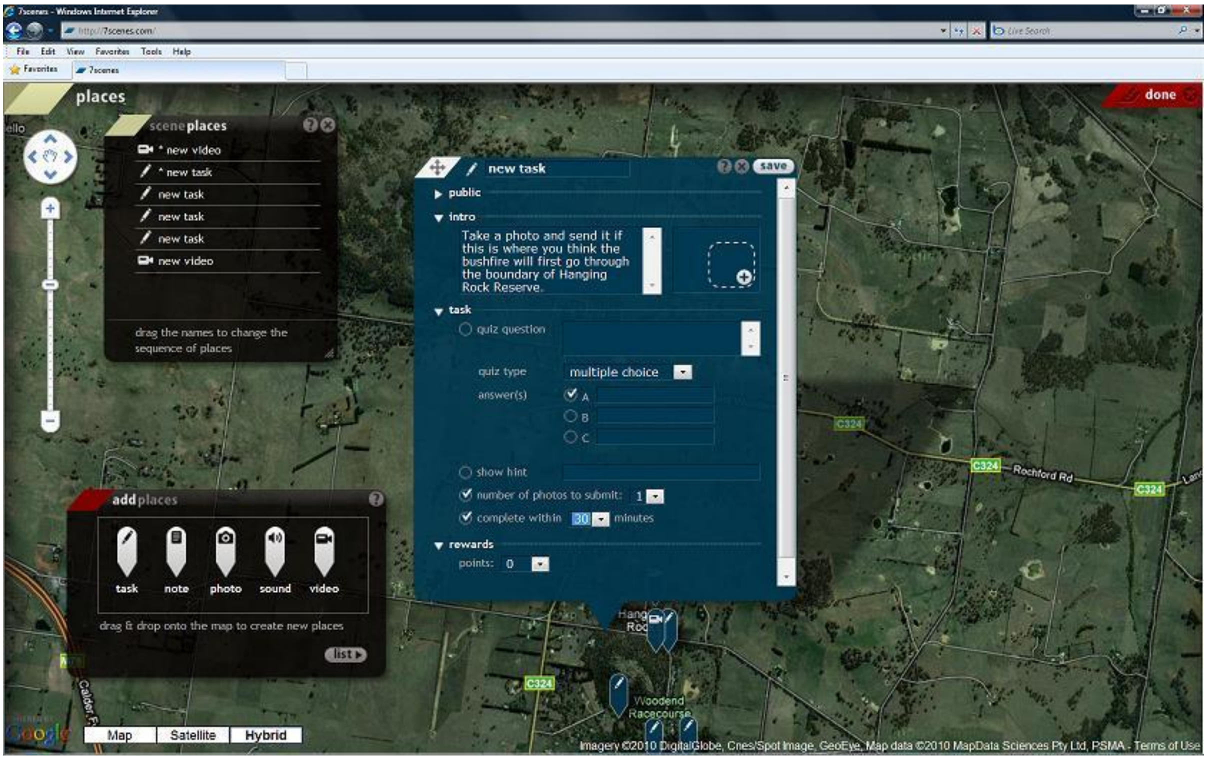

Figure 2. Editor at www.7scenes.com website.

Figure 3. Visualisation of a bushfire's point of origin near Hanging Rock. Created in CrysisWars Sandbox2 editor (crytek.com).

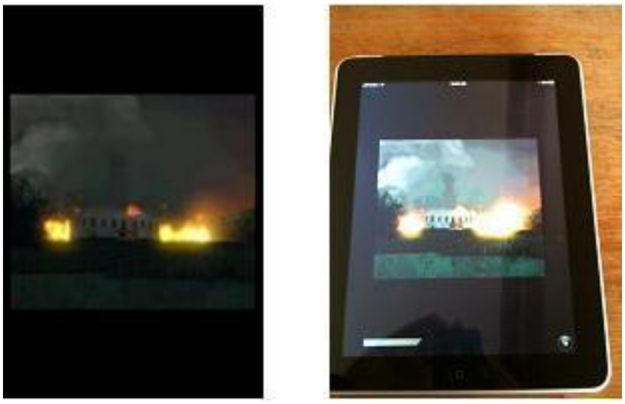

Figure 4. Viewing visualisations for CODE RED: MOBILE on iPhone on left (a screenshot) and iPad on right.

In CODE RED: MOBILE learning modules use visualisations created in a game editor (see Fig. 3) showing bushfire behaviour on mobile devices (see Fig. 4). Applying learning from the visualisations and game features can lead to a personal cognitive map of typical bushfire behaviour, and thus a greater understanding of how best to manage a bushfire in real-life situations. This will be evaluated in forthcoming research.

Evaluating the location based learning game

CODE RED: MOBILE is being developed to find ways that visualisations can best be designed and used for learning on mobile devices that are ‘context aware’ and ‘locationally aware’.

Participant’s tracks are recorded by the 7scenes server and can be viewed live or from archived tracks (see Fig. 5). Interactions with tasks, such as when visualisations set in the game ware watched or missed can also be detected. Questions are asked on the device and answers transmitted back to the server. Tasks appear on the screen when locations are reached. Scores are recorded at the server. Thus the participants details and performance are archived.

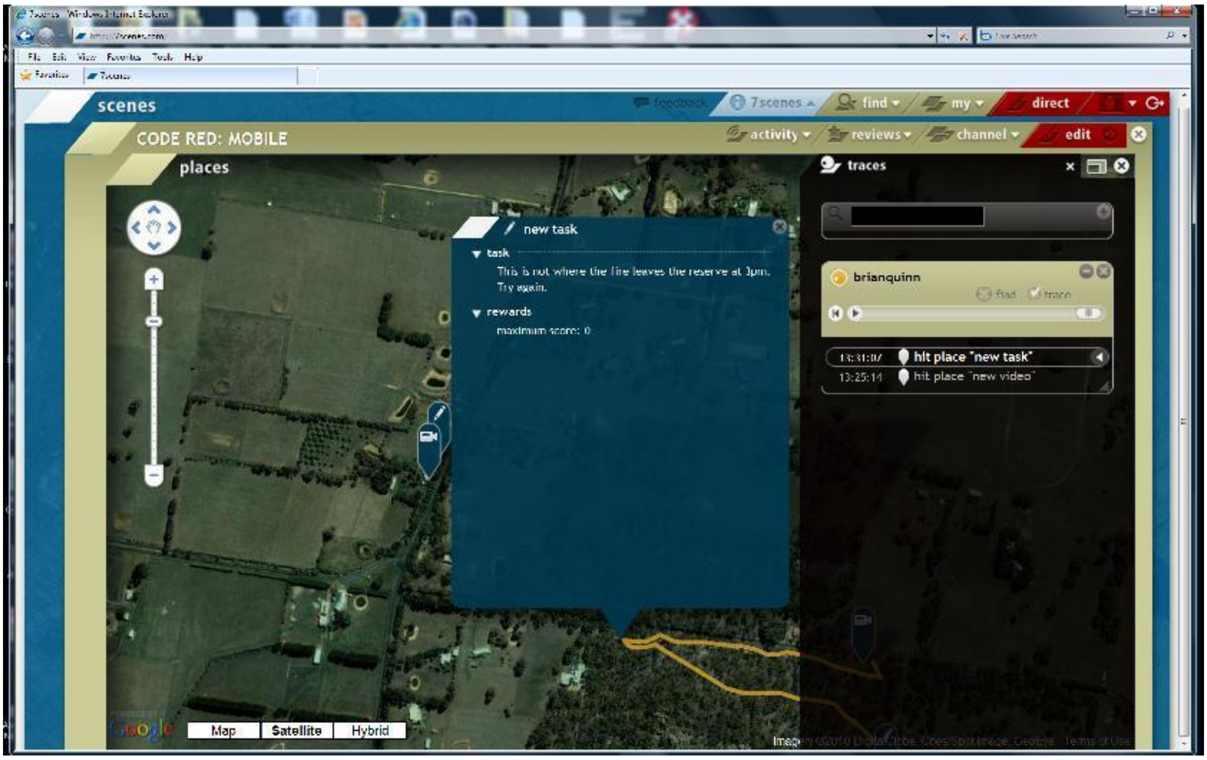

Figure 5. GPS track and record of task completion or error.

CONCLUSION

Viewing the visualisations at locations where the fictional bushfire occurs is proposed as a means of making a personal cognitive map of bushfire behaviour. Personal cognitive maps, should be more easily reported on in reverse order than cognitive maps acquired from others. If personal cognitive maps have been formed that would show CODE RED: MOBILE, it is proposed has induced learning suited to independent decision making.

CODE RED: MOBILE is being developed using 7scenes to provide a location based game that delivers visualisations of bushfires delivered at GPS controlled positions. If visualisations are delivered in the same setting that the game itself is set, then it may assist in the creation of a personal cognitive map of bushfires. The game and learning outcomes will be evaluated to ascertain the extent to which personal cognitive maps of bushfire behaviour are achieved by participants. These personal cognitive maps are likely useful for decision making in a bushfire.

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