mobile Game-Based Learning – Issues Emerging from Preliminary Research and Implications for Game Design

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Abstract

Mobile technologies are increasingly the technologies of choice for social and leisure activities, particularly among young people. Mobile games are among the most popular applications and we are beginning to see how these may be translated into effective learning technologies. The 3-year mobile Game-based Learning project (mGBL) is a practical response to the emerging opportunities, designing new learning game models for delivery via mobile devices. These are to further the development of skills and strategies for dealing with crisis situations, a priority concern of the European Commission, which supports the project. Our vision is for great games that are user-led, not technology-led, informed by theory and competence-based, for use in blended learning programmes. Can all this work, or are the aims too disparate? Now mid-way through the project we take stock, engaging with findings from the first round of field research and from the first User Trials.

Keywords: mobile, game-based, learning

1 Introduction

1.1 Background

With the increasing affordability, sophistication and capacity of mobile devices, linked to the continuing expansion of broadband wireless networks, new generation mobile phones are fast overtaking the desktop PC as a prioritised means of communication:
“The mobile revolution is finally here. Wherever one looks, the evidence of mobile penetration and adoption is irrefutable: cell phones, PDAs (personal digital assistants), MP3 players, portable game devices, handhelds, tablets, and laptops abound. No demographic is immune from this phenomenon.” (Wagner, 2005)

User-centred teaching means acknowledging this trend and widening the delivery options available to students. Hence a new paradigm for learning has been invented: now there’s m-learning, i.e. learning mediated through mobile technologies. Developments in m-learning are supported by market trends: mobile applications initially offered as expensive business solutions or as entertainment are increasingly included as ‘standard’ within mobile contract packages.

Mobile games are among the most popular applications (Wagner, *ibid*). The sector is expanding rapidly, with the convergence of mobile technologies and with mobile applications less constrained by device limitations. Not only are the latest mobile devices, with higher definition colour screens, enhanced memory and functionality, making mobile gaming more appealing – crucially, development costs are lower for mobile games than for games on ‘traditional’ platforms.

Now, as models of learning move from a focus on learning objectives towards personalised learning goals (Heppell, 2005), games delivered by ‘personal and portable technologies’ (Naismith *et al.*, 2004) such as mobile phones and Personal Digital Assistants (PDA’s), are increasingly seen (e.g. Ioannis *et al.*, 2003; Mitchell and Savill-Smith, 2004; de Freitas, 2006) as a potentially powerful combination in catering for needs and expectations of learners in the new millennium and are emerging as an important alternative or supplement to traditional teaching applications. Current trends even suggest that:

“…there is every reason to believe that educational gaming will provide mobile learning with its first big "win," in terms of adoption.” (Wagner, 2005)

### 1.2 The mGBL project

The mobile Game-Based Learning project (mGBL, [www.mg-bl.com](http://www.mg-bl.com)) is a 3-year pan-European project that began in October 2005 and is supported by the European Commission (EC) Information Society Technologies (IST) programme ([http://cordis.europa.eu/fp6/whatisfp6.htm](http://cordis.europa.eu/fp6/whatisfp6.htm)). A practical response to the opportunities outlined above, the project seeks to contribute new learning models to the mobile games market. Partner organizations forming the project consortium are drawn from Austria, Croatia, Italy, Slovenia and the UK. The project is coordinated by evolaris Privatstiftung, a research lab based in the city of Graz, Austria.

We are committed to designing real games that are fun to use and user-led, so that they can effectively engage target audiences: students and young adults aged 16 – 24, a priority age range for the EC. Game focus is on decision-making in crisis situations – an EC priority area of concern. Support for life-long learning is another EC priority; we set out therefore to design games that are standards-based, to suit a ‘blended learning’ approach (*i.e.* a mix of formal and informal learning). Our game implementations will be in the fields of e-health, e-commerce and
career guidance, areas where our consortium has particular strengths and where there is need for creative decision-making (e.g. de Bono, 1967; Senge, 1998) alongside recognition-primed decision-making (Klein, 1998). To provide users with the option of creating their own mobile learning games easily and efficiently, we are developing game authoring templates, ‘generic’ in design, to be useful in a wide range of sectors.

At the time of writing, we have reached mid-way stage in the project. Three game types have been designed; and template development and content development is underway. Our approach to game design is outlined below.

1.3 Theory informing our games design
Anglia Ruskin University leads the iterative design of the mGBL research framework and learning models. Essentially ours is a social-constructivist (Vygotsky, 1978) approach that is learner-centred and sees intrinsic learning through social interactions. Specific theories that inform mGBL game design include:

- Vygotsky’s (1978) theory of the ‘zone of proximal development’, which proposes that the level of development that learners achieve when they engage in social behaviour and enjoy the guidance of adults and/or the collaboration of peers is greater than what they can achieve by working alone;
- Kolb’s (1984) experiential learning theory, which we understand as learning via a direct participation in the events of life and reflection upon that experience;
- Lave’s (1990) situated learning theory, which sees the active learner graduating from ‘newcomer’ to ‘oldtimer’ within a learning community;
- Laurillard’s (1993) concept of a conversational framework: a ‘continually iterative dialogue between teacher and students to reach shared understanding’.

We find these concepts fit the benefits of m-learning, which lie not only in their potential for making learning opportunities available anywhere, anytime, but also in providing opportunities for social interaction (Naismith et al, 2004; Mitchell and Savill-Smith, 2004).

1.4 Scope of this paper
Within our collaborative project, challenges range from the purely educational to the technical, requiring a multidisciplinary approach to design. Our field research is valuable here, helping us to derive insights from practitioners and target audiences to inform pedagogical, functional and technical design. It complements our desk research in providing guidance and uncovering issues that we must resolve if we are to realise our project aims.

In this paper we show how we have begun to respond to these challenges. We first report key desk research findings and their implications for the games design. We go on to outline our field research activities and the lessons learned from these. We conclude with outline descriptions of the mGBL games we are developing and identify next steps.
2 Desk research

To inform the design of the mGBL game models we first turned to the literature. We used the findings of several in-depth literature reviews and reports concerning the potential of computer games for learning (e.g.: Mitchell and Savill-Smith, 2004, Kirriemuir and McFarlane, 2004, Ellis et al, 2006) and concerning mobile game-based learning (e.g. Naismith et al, 2004). We also consulted papers, articles and reports for pertinent findings concerning learning mediated via mobile games. The mobile games sector is fast moving and printed material is soon out of date, so for current information we also searched Internet sites.

2.1 Using digital games to encourage learning

We found plenty of acknowledgment of the pedagogical role of fun in learning and of the potential of digital games to support learning (e.g. Randel et al, 1992; Doolittle, 1995; Dempsey et al, 1996; Fabricatore, 2000; Prensky, 2001; Wu et al, 2004). The more complex recreational and educational computer games are observed (e.g. de Freitas, 2006) to encourage development of transferable skills. Those relevant to m-learning include metacognition, visualisation and imagination, improved strategic thinking and insight, development of analytical and iconic skills. However there were conflicting views on what the longer-term effects on learning might be, if the player were negatively affected by multiple goals and distracting components. For our games to be successful therefore, instructions will need to be clear, concise and game-oriented.

What very clearly emerges from the literature is that digital games – particularly the newer online games – do have the potential to engage young people in learning. Fun, intellectual curiosity, fantasy, persistence through levels of challenge, plus a sense of being in control are among the wide range of motivating factors. This is true of both males and females. Although girls may be put off by male stereotyping in action and adventure games, they too enjoy open-ended games, with opportunities for exercising communication skills, not pressured by time constraints. This aspect is of particular interest to us, as we are designing games for mobile phones, which are communication tools.

A key message from learning games ‘gurus’ Fabricatore (2001) and Prensky (2001) is that digital learning games should be modeled on the new generation of commercial games. These (ibid) immerse the player in a complete, interactive virtual playing experience, ambient information provided by sound and graphics maintaining the ‘flow’ state (Csikszenmtihalyi, 1990) in players. They offer various levels of challenge enabling good match to player’s current ability. Other perceived benefits are that the new games are fast and responsive, handle content well and are easily customisable by individual players, making the player part of the creative team.

2.2 The potential of mobile technologies to support games-based learning

As Wagner (2005) points out, learning mediated via mobile devices is not a new concept: graphic calculators were in classroom use a few decades ago and PDAs have been supporting instruction and on-the-job training for years in fields such as health, business, and journalism. Currently, use of laptops outnumber that of PCs
in Higher Education settings, with notebook computers valued as the most important hardware, mobile phones in second place.

Nonetheless, despite the continuing improvements in functionality, connectivity and interface, designers of m-learning methodologies and applications still have to contend with significant constraints of mobile phones. These include screen size limitations, which directly affect user behaviour (Ioannis et al., 2003). There is also the issue of screen quality – some screens are still difficult to use in daylight. Moreover the provision of rich experiences provided by sound and graphics (Fabricatore, 2001; Prensky, 2001) is difficult to implement with mobile technologies.

In addition there are factors that inhibit take-up of mobile games delivered online: “… problems with coverage and signal strength particularly in rural areas and that service providers can be reluctant to admit and address these problems. Bandwidth, and therefore response times, are not yet good enough to make on-line mobile learning comparable with e-learning and learners can become very frustrated.” (Attewell, 2004)

A solution here is to use a mixture of on-line and off-line learning (c.f. Attewell, ibid).

For us as social-constructivists, the central challenge in designing mobile games-based learning resides less in connectivity and phone quality (these will continue to improve) and more in the extent to which we can exploit the nature of the Web, supporting interactions and relationships between individuals (c.f. Seely-Brown, 1999 and Downes, 2005). We need to exploit the unique educational affordances of the latest mobile phones, usefully defined by Naismith et al (ibid) as: portability, social interactivity, context sensitivity, connectivity and individuality. We therefore searched the current literature base for examples of projects that have taken up these challenges. Projects that caught our attention were those where the player is mobile, has a high degree of control via use of the mobile device and/or collaborates in order to win the game. Three such projects are briefly described below.

### 2.3 Examples of mobile games-based learning

Students at the Future Applications Lab, Viktoria Institute, Sweden (www.viktoria.se/fal/projects/collgames/) were assigned the task of creating a game for handheld computers. The result was a ‘collaborative game’ model. The play area is distributed across shared screens and to progress in the game, players must move their avatar between displays. They need to collaborate with each other to manage the sharing of the displays. User trials with high school students at a local café suggested that the use of shared displays in mobile computer games has the potential to introduce new interaction models.

The Savannah mobile gaming and learning project engages primary school children in two related areas of activity (Morrison, 2006; Facer et al, 2004). First, on the school playing field, the children play the roles in a pride of lions. Here they use PDAs with headphones linked to a global positioning system that enables them to ‘experience’ the ambience of the Savannah as they move around, ‘hunting for food’. They use the mobile technologies to transmit data to a map of the
Savannah on an interactive whiteboard indoors. This activity encourages them to reflect on their performance and develop strategies for ‘survival as lions’ in the virtual Savannah. The project demonstrates the benefits when learners themselves become mobile: moving around helps them to remember ‘spatially organised information’, while the combination of play and planning supports exploration of knowledge:

“...from a number of different perspectives: through experience; through reflection on experience; and through research and discussion.”

Further it demonstrates that the motivating potential of mobile games lies in providing ‘appropriate and authentic challenges’, allowing learners to explore new environments with:

“... high degrees of control over how they manage their time and their information resources”.

A project at the University of Chile supporting the development of problem-solving skills based on interactive games for mobile devices was successfully trialled by in science classes for 8th graders (Sanchez et al., 2006). The students had a core problem to solve via the game:

“preserving and evolving different biological species from the animal kingdom, in an unknown and varying environment, by modifying some key factors for evolution of the species.”

The methodology consists of pre-classroom activities with the teacher (here it was a guided visit to a zoo observing animals directly), followed by classroom activities and a central activity using an interactive simulation game for PDA that takes place in the school during four weeks. Results were reported to show:

“highly motivated learners with a fast adoption of mobile devices, fully engaged in a learning task without external control.” (ibid)

3 mGBL User Requirements research

Whichever specific theories, technologies and techniques are deployed in the game models, common sense dictates that the models will need characteristics attractive to target audiences. Accordingly, alongside the desk research, we are also seeking insights and understandings from our research with potential teacher and student users.

3.1 Methodology and procedures

In order to define more closely our target audiences and to gain some insights into their needs and wishes, we first consulted the views of experts in five partner countries: Austria, Croatia, Italy, Slovenia and UK.

10 experts per country were drawn from organisations to which partners had access, in fields of relevance to mGBL:

- Technology, market-oriented view
- Learning and didactics
- e-Learning
- Sociology/Youth Culture
- New Media Journalism.

We recruited respondents via gatekeepers known to mGBL partners, for example Heads of Colleges or University Faculties. The recruitment process respected
ethical guidelines such as those laid down by Anglia Ruskin University. This was overt research (Burgess, 1993: 119): it was explained that the research was for an mGBL public Deliverable and intended to inform our prototype development. We emphasised the potential benefits of the project to mGBL target audiences, promising to make results of the research available on a website. We agreed to respect confidentiality and obtained permission to use verbatim comments unattributed. By using different researchers in different countries, we sought to minimise bias.

Tools for recruitment, data-gathering and analysis were collaboratively developed (c.f. Mitchell, 2006). Recruitment made use of a screening tool and our chosen methodology was to use semi-structured interviews, allowing us to follow up ideas and probe responses to strive for insights about the respondent's motives and feelings (c.f. Bell, 1991: 91). We made use of a Conversation Tool containing predetermined but open-ended questions to allow the emergence of important information. Use of such a tool ensures a rational, replicable process that is also documentable (Seidman, 1991: 9-15). The tool included pointers to thank respondents for their help at the beginning and end of the interview.

Interviews took place either face to face, or via skype. We began with 'ice-breakers', then explained interview purpose. Respondents then participated in an interview lasting approximately one hour. Where information was provided freely, prompts were not needed.

Interview focus was on the following areas:
- Mobile services and applications: user preferences.
- What we must do to make mGBL a success - key enablers in terms of pedagogy and technology.

The full results of this research are available at: www.mg-bl.com. Below are key findings:

Young adults’ preferred mobile technologies are mobile phones. Preferred use is as a phone and preferred application is SMS (short text messaging), largely for communication with friends. Mobile games are liked but main use is to pass the time ‘when their mates aren’t texting’. There is growing use of camera phones and MMS (multimedia messaging), however here cost is an issue. Use of these is mainly to impress friends, for example photos taken are often shared with people nearby. This corroborates the findings of the desk research of the social nature of m-learning.

Regarding the potential of mobile games-based learning, it was thought that knowledge-testing games would be useful, as would simulation games, where the mobile technologies would support flexible access to experiences otherwise difficult to achieve. Strong potential was seen for games that used a mix of technologies, to be playable on multiple devices and multiple platforms:

“Play on the phone on the bus on your way home, then carry on using the TV at home.”
“We could spend the day talking about mobile TV – how to teach maths in the playground – reduce it to 5 minute programmes …”

There was also thought to be a trend towards collaborative games, with good prognosis for networked games that used social software – “web2 stuff “. Respondents highlighted the social aspects of mobile games – the social value of online friendships was found similar to those in traditional environments:

“In the 20th century we built big things for people. Now we help people to help each other in that virile, viral, agile peer-to-peer way. People are at the centre rather than on the periphery.”

Correspondingly it was found that role-play games are giving way to real-life interactions:

“Alternate reality is a genre of game but it can be overrated – but with the spread of the ubiquity of the Internet it doesn’t mean anything anymore. Years ago to call myself a cybername was amazing – it shielded me, but was still exciting. Now it’s the most boring thing I can do … it’s better to speak to people with own real identity. I see big chances for this field.”

„Role play games are starting to lose their attraction, because speaking as your own self is so much more entertaining and powerful. That’s the problem the BBC have – abuse. It’s because role-play is not real.”

Such games would revolutionise learning:

“Of course they’ll be more ubiquitous – allow learning to take place across boundaries – the beginning of global learning is upon us.”

Key messages in terms of making mGBL games a success:

- Don’t port P.C. style games to mobile.
- Don’t focus on providing learning content.
- Do use generic processes and best practice:
  “Create collaborative, problem-solving activities that use the scientific method: observe, question, hypothesise, test.”
  “Reflect what learning has become: Peer to peer, agile, project based, collaborative, built around communication.”
- Do focus on lifelong learning.

Finally:

“It needn’t be an all-whizzy computer game – but it must be great fun - and relevant to their learning, they won’t bother.”

4  Using the lessons from the research

Findings from the first round of mGBL research guide us towards flexible and fun mobile learning game solutions where the game delivery vehicle is the mobile phone, as opposed to a PDA or mobile gaming device.

Taking on board that our learning games need to be games first and foremost, we are mapping learning content to game style, seeking to embed it naturally in the game. We are considering speed, level of difficulty, timing and feedback, striving for variety in both game context and complexity, and also novelty, surprise and humour (although this last aspect has its challenges). The constraints imposed by the technologies mean we are currently able to make only limited use of graphics to accommodate different learning styles (e.g. Honey and Mumford, 1992) and are
not yet using sound files, however we plan to incorporate multimedia clips into the games at a later stage.

Some learners do not like using games or not be very competent at playing certain types of game (de Freitas, 2006), so we are developing different types of game design that signpost to other learning materials and thereby facilitate integration of mGBL games within a blended learning environment as is indicated in Figure 1.

Figure 1: mGBL blended learning framework, Alice Mitchell, Ultralab 2006

4.1 mGBL game types

These are still in development, so there follows only an outline of the games design as they currently stand.

mGBL Game 1 is 'Ahead of the Game', a hybrid of a quiz and a type of linear simulation game that makes use of staged questions. The quiz format was selected because it supports recall. Our format uses instant feedback during the game with the option of longer feedback at the end. Players can choose whether or not to upload game results to the server. The quiz is used to prepare users for active participation in the follow-on simulation, intended to support integration of the learning content into cognitive structures and thereby retention over time (c.f. de Freitas, 2006). We are developing a simple format that we think can nevertheless be effective in supporting development of decision-making skills: the only feedback that players will receive are the short-term consequences of their
decisions and at the end players are given an opportunity to self-assess the effectiveness of their decision-making strategy.

mGBL Game 2 began as a type of board game, however it has been developed in modular format, enabling game-play in short sessions, each with feedback. This approach allows development of a potentially complex game that contains many surprises / red herrings and that can be replayed from different perspectives. In this game the fun and motivation will come from competing with:

- self (ipsative referencing, as player ‘characteristics’ are enhanced during game play);
- others, including the game system itself (criterion-based referencing).

During the game, the player will struggle to meet the challenges (c.f. Prensky, 2001) that are set, as s/he encounters the kinds of experiences necessary for learning about resolving complex and emotional issues. A variety of opportunities for developing problem-solving skills offer support for co-operation and collaboration (c.f. Small, 2000).

Both the above-mentioned mGBL games incorporate opportunities for reflection on decision-making processes and outcomes of decisions (Senge, 1998). Feedback takes various forms, both cognitive and affective (Garris et al., 2002). For example while the quiz component provides system feedback, in the board-type game an option to pause the game at strategic points allows players to consult peers and experts. Such consultation will be enabled for example via SMS, voice call or accessing online resources via internet phone.

Game 3, ‘Get real!’ builds around communication, collaboration, tacit and ambient learning (c.f. Wu et al, 2004), using the full functionality of the mobile phone. In line with findings from our field research, we want to use ‘world phones’ with multimedia functionality to bring learners together to solve real-world issues, for example players in different locations building / exchanging / trading information and ideas.

“No-one actually takes advantage of it all – I’m sure a game could – photos, video – heady mix of all those things coming together....”

(Respondent, User Requirements research)

4.2 Next steps

Challenges remain. For example there are ethical and legal issues involved in sending learners outside the classroom to use their camera phones. There are technology-related issues - restrictions in web-browsing via mobile devices - and accessing the internet comes at a cost each time. There are also considerable challenges in encouraging formal take-up of mobile games to support learning (de Freitas, 2006), so we will be developing support for teachers:

- Authoring tools that relate game content and objectives to ‘generic’ learning objectives (Bloom and Krathwohl, 1956).
- An interactive Classification of mobile games that can assist teacher users in defending their choice of learning tool and that can save them time in familiarising themselves with the different game types.

Finally, in developing our game content we will be seeking to apply ‘object-oriented engineering’ philosophy, i.e. giving the mGBL game objects computer-readable 'metatags', to enable their use in learning management systems.
References
All urls checked 05/03/2007


