

Designing Mobile Games for Engagement and Learning

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Abstract--Game based mobile learning is becoming increasingly popular, now that mobile devices provide support for multimedia content, location awareness, augmented reality and connectivity. However just having technical features does not make a game either engaging or pedagogical. The challenge for designers of games for mobile learning is to embed both effective gaming experiences and worthwhile learning outcomes into the same application. The game described and discussed in this paper was designed as an augmented reality game for two players. The narrative action follows a classic linear fiction model, whereby the game's phases move through teaser, elaboration, conflict escalation, climax and resolution. This narrative path is reflected by a physical path as players navigate the location and investigate the problem they have to solve.

Index Terms—Mobile computing, mobile game design, mobile learning, serious games, augmented reality.

I. INTRODUCTION

International research results indicate that educational video games and simulations can be used to promote critical thinking and problem solving from multiple perspectives [1, pp. 6-7]. Recent advances in computing and specifically in mobile computing have made it possible to create immersive gaming environments that may also support conceptual and higher level cognition. According to Prensky [2] contemporary learners may have already developed video gaming playing skills; therefore 'serious' (educational) mobile games using immersion may provide an attractive form of learning to young adult students, as also asserted by [3].

Prior research in the area of game based learning was recently reviewed in [4]. The author finds that a key challenge for any educational game is to maintain learner engagement and motivation while linking the game experience to clearly formulated learning outcomes. Factors such as sense of challenge, realistic game design, and emphasis on exploration

and discovery can have a powerful positive impact on player motivation. It is suggested that new forms of gaming such as augmented reality gaming that extend learning beyond the confines of the classroom may be particularly suited for designing serious educational games for adult learners.

Augmented reality is created when the natural scene of the game is enhanced by adding digital objects. An augmented reality game played on a mobile device can make players change location frequently thus offering opportunities for exploration, problem solving, and collaboration. A serious augmented reality mobile game will support student centered learning by providing learners with engaging experiences that are both enjoyable and educational and will assist them in developing meta-cognitive skills [5],[6].

The design challenge for an augmented reality game is to try to maintain a state of flow experience in the players. To achieve this, much of our initial investigation was focused on finding out how games were designed to be enjoyable, what elements attracted players to games and what encouraged them to continue playing. Two groups of general factors were identified and considered when designing the characteristics of our mobile learning game.

First, prior research results suggests that mobile games can be made more attractive by ensuring that the player is feeling really immersed in the game, at the same time being able to interact not only with the game but with other participants, in competition or in collaboration [7]; the user interface design also needs to support the continuing sense of immersion [8]. While communication with others can make the game more enjoyable, players must have a reason to engage in interaction while playing, for example they may need to mutually decide on their next move [9].

Second, providing a clearly articulated overarching final goal and related sub-goals, or challenges during the course of the game, creates a feeling of involvement and can motivate the player to continue participation [10]. Keeping the design relatively simple leaves the player enough decision making freedom (i.e. by providing options, or choices) which also contributes to the sense of enjoyment [11].

An outdoor mobile game that includes elements of physical motion, active enquiry and collaboration can be used to support cognitive learning (e.g., problem-solving), and also social learning (e.g., collaboration) [12]. This paper describes and discusses the development of an augmented reality mobile learning game that is played outdoors and involves navigation across the game site. It aims to teach higher level skills (analysis, synthesis, critical thinking) in the context of a simulated business consulting project. Players have to gather,

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analyze and reflect on various (and sometimes conflicting) pieces of information about a mobile phone manufacturing company that is having some public relations problems. In the game, players are equipped with a location aware mobile device and led through a physical environment that is overlaid by both physical and virtual resources, triggered by reaching locations that represent parts of the company. These resources unfold a series of problems that the players must identify and try to resolve by the end of the game.

The rest of the paper is organized as follows: We first discuss some general game characteristics, then present the concept of narrative flow and describe in detail the design of the game. In the last two sections we focus on how the game design may support both engagement and learning, and provide directions for further work.

II. GAME CHARACTERISTICS

Features that are common to all games include representation, interaction, conflict and safety [13]. Representation refers to games being about something else. In our game, representation is an important concept. Being a virtual reality pervasive game, the core idea is that one physical environment (such as a university campus) stands in for the virtual environment in the game (i.e., the various departments in a manufacturing organization).

Interaction occurs when the player is able to influence the world of the game and get meaningful responses to actions, to feel engaged with the game. To some extent this is a feature that is not embedded in the game itself, but is acquired by playing the game. Whilst the game process does not adapt to player actions, the intention is that the game gives the players the opportunity to outline how they would act to influence the virtual organization represented in the game, to overcome its various problems.

Conflict means that a game has a goal that is blocked by obstacles. The obstacles in our game are intellectual ones. They are problems of perspective and bias that have to be understood and analyzed.

Safety means that conflicts in a game do not carry the same consequences as those same conflicts in the real world. The idea in our game is that the participants act as consultants to the virtual company. Unlike real world consulting, there would be no negative consequences from misunderstanding the issues or giving the wrong advice. The worst possible outcome is not getting a very good grade, if the game was used as part of an assessment.

Hunicke, Leblanc, and Zubeck, cited in [14] list the elements that attract us to games (p. 39). A subset of these elements also represents the important features of our business game, namely narrative (game as drama), challenge (game as obstacle), fellowship (game as social framework), discovery (game as uncharted territory) and expression (game as self-discovery). Other features are less relevant to serious games such as this one. We do not have a particular emphasis on sensation (game as sense-pleasure), fantasy (game as

make-believe) or submission (game as pastime). Aspects of these may encourage game participation but are not the main aim of a learning game.

Finally the game discussed here can be characterized as a two-person, non-zero-sum game, in which there are two players and the strategies chosen by each player determine the outcome of the game [15, p. 64]. Associated with each possible outcome of the game is some kind of a payoff. The important aspect of a non-zero-sum game is that one player does not win at the expense of the other. In fact the ideal outcome is that both players 'win' together.

III. GAME NARRATIVE FLOW

A game that provides an educational simulation is by its nature open ended, and does not apply a strict set of rules, since it is intended to encourage exploration and critical thinking. Rather, it needs to be based on a loose set of rules where mutual understanding of general play would be expected by the players. Free form play does have rules, but these are implicit and flexible and may not even be spoken, yet they function as guidelines nevertheless [14, p. 27]. These implicit rules shape the entire experience of being in the game with others. In summary the game does have a rule system but is an open ended environment.

It is important that games have some kind of narrative flow that leads the player through the game in a way that unfolds over time. The core narrative that we have adopted in our game is taken from Larsen's model of standard linear fiction as described in [16]. This model draws the reader (in fiction) or the player (in a game) through a series of game stages: teaser, elaboration, conflict escalation, climax and resolution (Fig. 1). "Such a structuring of events may even...be a standard model of human perception ...From a position of ignorance the interactor is taken through a learning process that ends in a climax." [16].

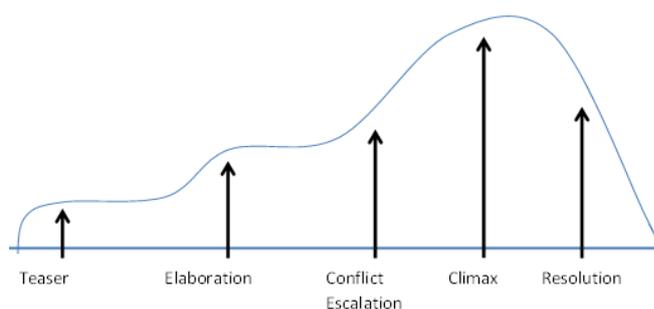


Fig. 1. Model of standard linear fiction.

Taking Larsen's model of narrative fiction as our narrative framework and considering Castronova's advice to minimize what the game attempts to do, and then polish it as much as possible [17, p. 114], the current narrative of the game contains the minimum number of activities to implement the framework. The concept of conflict escalation in the context of a two player game is introduced by having branching game paths.

The diagrammatic representation of a sequential-move game

is referred to as an extensive-form game, or, more popularly, a game tree [18]. Fig. 2 shows a simple tree representing the stages in the business game.

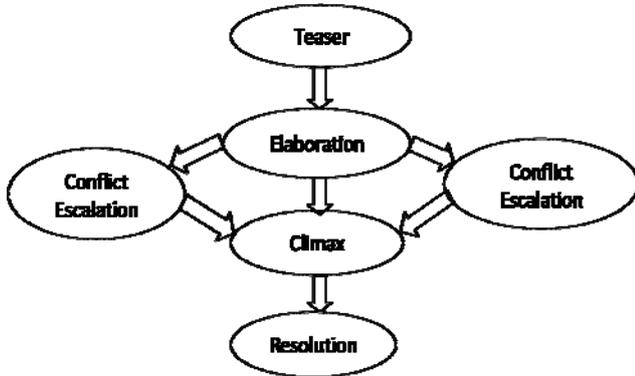


Fig. 2. Game tree for the business game.

The teaser lays out the initial problem to the players and leads them to the elaboration. After this stage the two players are sent to different ‘departments’ in the company and are given conflicting information. The climax gives them the final piece of the jigsaw that should help them to the point of resolution.

At the resolution stage the players provide feedback about the issues they have identified as causing the problem under investigation. All player responses are scored for correctness, the final score is announced to the players, and the game ends.

IV. PLAYING THE GAME

In this section we briefly outline what happens in each of the stages of the narrative. The first step is the teaser (Fig. 3).



Fig. 3. ‘Teaser’ - newspaper article.

This teaser consists of a video interview with the CEO (Chief Executive Officer) of a mobile phone manufacturing company called Kiwi Mobile. His main complaint is about “...the bad press I have been getting from the daily rag.” The CEO directs the players to a physical artifact, which is a copy of a newspaper article about a cell phone battery exploding, as shown in Fig. 3. To maintain a sense of realism this was adapted from a genuine newspaper article about mobile phone battery explosions [19]. It is worth noting at this point that in the first iteration of the game, all artifacts were virtual, and were provided on the mobile device. However early user testing made it clear that in many cases this was not the best medium for conveying the information, and several of the resources were converted to physical artifacts. As well as making them more readable, this also increased the player’s interaction with the physical world around them, linking the game more directly to its context, and the virtual resources to the physical ones. For example a character in a video interview will refer to a physical artifact in the player’s location.

The elaboration stage provides more information about the company’s products, and the potential issues. An interview with the Chief Operating Officer about issues with a fragmented product range includes a comment about “moaning developers ... keep talking about fragmentation this and fragmentation that.”

The artefact that is available at this stage is the product range flyer shown in Fig. 4. The point of this artefact is that it provides different concerns to those raised by the CEO, relating not to the story in the press to the nature of the company’s products, their fragmentation, and the relationship between the company and third party software developers. Again, to keep the artifact realistic, the material is based on Nokia’s product range and real world issues about market fragmentation and complex platforms.



Fig. 4. ‘Elaboration’ - product range flyer.

The purpose of the conflict escalation in the game is to further exercise the learners' analysis, synthesis and critical thinking skills by leading the two players to different departments in the company. These departments are in conflict, as shown by the contents of the interviews and the artifacts gathered. Players are given differing viewpoints from different personalities in the company; when the players get together again for the climax, they will have been given views and resources embodying a conflict, which the players must resolve.

One player is sent to the marketing department where they are told "So what if some of our products get returned or malfunction, look how many of them are released that are okay"! The artefact shown to the player is the sales figures chart shown in Fig. 5, which shows good sales for Kiwi Mobile. The marketing department blames the Research and Development (R&D) department for all the problems: "A potato is still a potato any way you dress it up, Samantha over at R&D has a lot to answer for"!

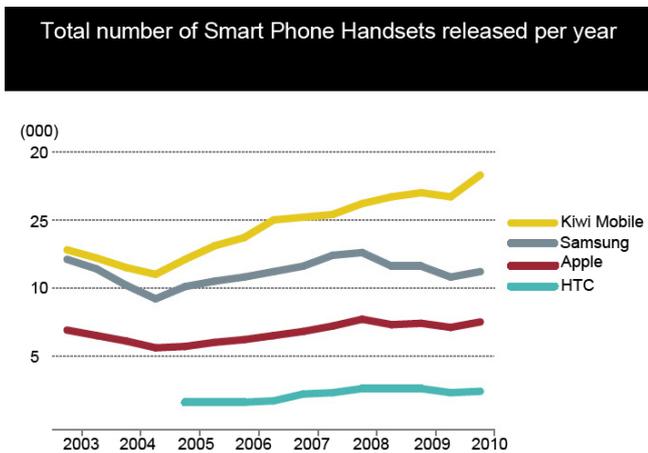


Fig. 5. 'Conflict escalation' - sales data.

The other player is sent to the R&D department and gets a different story from 'Samantha'. In this interview she claims that "I was pushed out by Martin ... I leave phone messages and emails constantly but he never gets back to me...the man is impossible." The essence of her argument is that Marketing are not communicating with R&D, and are storing up problems for the future. Therefore the high sales currently being recorded cannot be sustained without organizational change. The artifact provided as evidence is an email log that reveals that Marketing does not pay any attention to R&D's requests (Fig. 6).

The final interview and the artefact at the climax point, where both players rejoin, returns to the issue of the exploding batteries. It appears that "Jimmy dropped a pallet of batteries..." due to the poor layout of the assembly floor. Fig. 7 shows the artefact for this stage of the game: a blueprint of the factory floor showing that inadequate layout has led to batteries being dropped (damaged batteries are liable to explode).

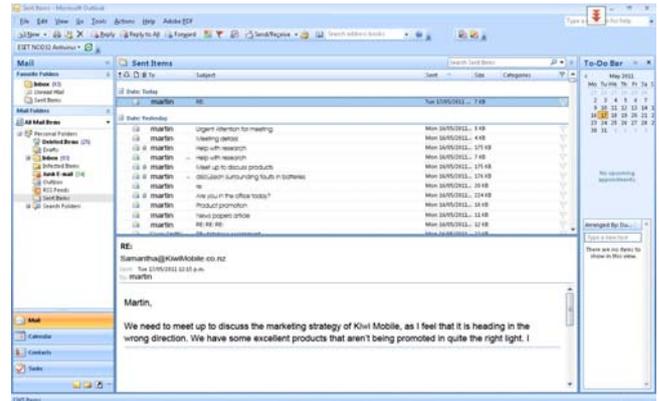


Fig. 6. 'Conflict Escalation' - email log.



Fig. 7. 'Climax' - factory floor blueprint.

At the resolution stage, the players revisit the CEO, who says to them "you two have already taken up enough time ... What issues have you found with the business and how do you think I can get this place back on top"? At this stage the players must present back their findings and recommendations.

Interaction with the game is achieved in several ways. First, players need to navigate to the correct point of the route in order to invoke playing the relevant video clip. Second, players interact with the game as they progress from stage to stage. At each interview players have to 'ask' an interview question in order to better understand the situation at the respective company department.

For example, at the R&D department a player may choose to ask "Does the lack of communication with marketing department effect this business in a negative way? If so how?" The response they will get is: "Of course, something needs to be done about this soon. There is no way we will be able to get this company out of this rut if something isn't done soon about communication through all departments but especially marketing and R and D."

At the end of the game players provide recommendations for the CEO: the interface provides a set of statements describing possible ways to solve the company's problems, from which each player needs to select the ones that they find relevant to the findings. Finally, players interact with each other as well: they conduct some of the investigation together, then separate but

meet again and have the opportunity to discuss and consolidate their findings. At the meeting they can replay all interviews and review all interview questions/answers in order to clarify some points or to resolve contradictions.

The individually provided recommendations (i.e., the statements selected at the resolution stage) demonstrate how well the players have understood the business and its problems, and what issues they have uncovered. Based on the selection and also on the type of question chosen to be asked after each interview, each player obtains a final score reflecting the quality of their investigation and analysis.

V. DISCUSSION

The first prototype of this game, described in [20], focused on the software implementation of a game that combined geo tagged resources with an overall game goal based on understanding the problems of an organization. Continuing from the original development the emphasis of the current work on the game has shifted towards the fostering of player engagement through enjoyment.

In the second prototype the basic concepts of enjoyment and how enjoyment relates to game play identified earlier in the literature review (refer section I) were applied to our game. First, the interactive mode of playing the game supports its immersive nature as players need to respond in order to continue playing. Second, players need to collaborate, i.e., to interact with each other. Third, in the course of the game players need to make a number of decisions with each one affecting the final decision (conflict resolution). Finally, locating and interpreting the physical artifacts contributes to the continuing feeling of being engaged with the game.

The game is not designed specifically to teach skills at the lower levels of Bloom's taxonomy, such as knowledge acquisition, comprehension and application. Although these skills are an important foundation, the key intent of the game is to provide a learning environment in which higher level skills - analysis, synthesis and critical thinking - can be fostered.

The core context for analysis in the game is for participants to be encouraged to ask the question 'What does this tell me?' The material in the game does not necessarily deliver factual information. Sometimes the players are given facts but sometimes they are given opinions. Of course the facts themselves are also open to interpretation.

In terms of synthesis, participants need to address the question 'How do these different sources relate to one another'? They need to be able to contextualize different types of information from different sources and put them into an overall framework of understanding. Participants reflect on their findings, identify potential problems, and recommend solutions - a process which according to [21] is one of the distinguishing characteristics of serious mobile games.

Part of this process includes critical thinking. Participants have to ask themselves 'Why am I getting different stories from different people?' It is necessary for them to understand different personal and political agendas, as well as figure out

what the factual data means and how they may be interpreted by different people.

VI. CONCLUSION

Game based mobile learning is becoming increasingly popular now that mobile devices provide support for multimedia content, location awareness, augmented reality and connectivity. The paper presents and discusses the design of a mobile business game played in augmented reality by a team of two players.

By applying a simple linear fiction model to the narrative flow and by mirroring the narrative and the physical path, the game design embeds both effective gaming experiences and worthwhile learning outcomes into the same application. This work in progress contributes to the body of knowledge in the area of designing and implementing mobile educational games by demonstrating how the game design principles elaborated on earlier allow creating an engaging immersive environment that motivates learning.

The game described in the previous sections is part of an ongoing project which aims to provide a customizable game that can be used in multiple contexts. Rather than addressing course or domain specific knowledge, it attempts to support the development of more generic, higher level skills that can benefit students from many different discipline areas. That said, it simulates aspects of a business consulting exercise, so it is most appropriate for students studying in business or information systems areas.

At the time of writing of this paper we are completing the evaluation of the current prototype and are gathering empirical data on player experiences involving participants at two different university campuses; the outcomes of the data analysis may allow us to gauge the extent to which the game design successfully embeds enjoyable experiences and meaningful learning outcomes.

The results thus far are encouraging. In an initial sample of 14 players of the game, responses to the statement 'I found the game provided an enjoyable way to learn' averaged 6.04 on a Likert scale where '7' was 'strongly agree'. Responses to the statement 'I felt engaged in the activity of playing the game' averaged 5.57. Many of the responses recorded in semi-structured interviews with the participants reinforced this positive attitude, for example "...good game ...playing it was awesome... The idea was wonderful...", and, from another respondent, "...I liked it because it was a different way to go about solving problems."

Further research directions include developing the game software for other platforms and adding a self-configuration feature that can be used to customize the application, piloting an implementation, and evaluating the next prototype from the perspectives of both learners and instructors.

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