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Towards an Efficient Mobile Learning Games Design Model

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Abstract: Classrooms are increasingly equipped with information and communication technology and especially interactive mobile devices. However, the latest studies show that their use by teachers is still very limited because of a lack of resources and applications adapted to an educational use. Indeed, there seems to be a shortage of mobile learning practitioners due to the time required for these tools' apprehension. Likewise, studies show real needs to expand the variety of applications, resources and activities available on these mobile devices, in order to make them more suited to the teachers' pedagogic objectives.

Concurrently, new ways of using mobile devices for education are arising. Among those directions of use, research conducted on Mobile Learning Games (MLGs) seems particularly promising.

In this paper, we propose to identify several MLGs, from the most referenced scientific assessments, that have been carried out in educational context, in order to determine their common features and impact on learners, and to identify challenges in terms of design, storyboarding and student monitoring. Thus, we can discuss how far research on MLGs has gone in terms of pedagogical effectiveness and whether there are still challenges that teachers will be facing regarding the design and execution of MLGs. At this level, we try to define the main characteristics of the analysed MLGs, and identify the recurring problems that occur when teachers use them. First, this will allow us to establish several guidelines for designing MLGs. Secondly, in order to diminish the constraints of use, we discuss new ways of implementing MLGs. Furthermore, we propose a global MLGs model, capable of capitalizing the identified main characteristics and overcoming the recurring problems at the same time. Finally, we discuss the possibility of implementing this model through an authoring environment.

Keywords: game-based learning, mobility, location-based learning, teacher, pedagogic objective

1. Introduction

Today, mobile devices such as smartphones and tablets are widespread among teenagers. Indeed, in 2013, 53% of Europeans between 9 and 16 years old possess a smartphone, and 28% of them daily use tablets ((Mascheroni et al., 2013).

This increasing use of mobile devices has recently been followed by the awareness of their potential for learning inside and outside the classroom (Johnson et al., 2013). Hence, many European countries have established digital integration programs in their schools over the last years, such as the *MoLeNET* project in the UK, that can be considered as the world's largest implementation of mobile learning, involving 20,000 learners in 115 colleges and 29 schools (Attewell, 2009). In France, national directives are also encouraging educational institutions to experiment tablets in classrooms. The "*Académie de Nantes*" project for example integrates tablets into schools and reports their affordances for learning and provides detailed findings on their use by pupils¹. Furthermore, in the USA, 43% of teachers and/or their students use e-readers and tablets in classrooms (Purcell et al., 2013).

However, among all these ongoing programs, the *New Media Consortium (NMC) Horizon Report* (Johnson et al., 2014) shows that there are needs to expand the resources and activities available on these mobile devices in order to make them more suited to teachers' pedagogic objectives.

On the other hand, the concept of learning games is gaining support among educators who recognise that games can increase engagement, creativity, and authentic learning (Papastergiou, 2009)(Johnson et al., 2014)(Aceto et al., 2014).

In addition, now that tablets and smartphones are commonplace, game play is becoming a mobile activity. Hence, mobile games new abilities such as location-based activities (Schlieder et al., 2006) and collaboration (Sánchez & Olivares, 2011) motivated recent work on integrating learning games on mobile devices. In fact, we believe that mobile gaming will fit very well with the behaviour of teens, who are already used to playing games on their smartphones and other hand-held devices such as Nintendo DS² and PSP³.

¹ http://www.pedagogie.ac-nantes.fr/1369731934531/0/fiche___article/&RH=1162654424937

² https://en.wikipedia.org/wiki/Nintendo_DS

³ https://en.wikipedia.org/wiki/List_of_PlayStation_Portable_games

Although mobile game-based learning is still in its nascent stages, we propose in this paper, to look more closely at certain existing examples of Mobile Learning Games (MLGs).

Through a critical lens, we discuss how far research on MLGs has gone in terms of pedagogical effectiveness and whether there are still challenges that teachers will be facing regarding the design and execution of MLGs.

To answer these questions, we propose to identify five MLGs, from the most referenced scientific assessments, that have been carried out in educational context. We analyse these MLGs in order to highlight their common features and identify the recurring problems of use. This will allow us to establish several guidelines for designing MLGs. Then, we discuss the possibility of creating a MLG design model that integrates those common features and overcomes the identified problems.

2. Bibliographic research of Mobile Learning Games

In this section, we first present our method to identify MLGs having notable success in the research field. Then we describe the procedure for selecting the ones we analyse in this paper.

2.1 Identifying successful Mobile Learning Games

In order to outline our screening set, we decided to focus only on MLGs, which have already been assessed in an educational context. We used the following keywords to search for scientific articles: "evaluation" + "mobile" + "learning game". Then, in order to cover all terminologies used in the field, we replaced the term "mobile" by the following terms: "location-based", "pervasive" and "contextual".

Our research method consists in selecting the MLGs that appear among the first results obtained with the above keywords, on four major scientific search engines: *IEEEExplore*, *ACM Digital Library*, *Science Direct* and *Springer*. In addition, to reach a wider scope, we decided to expand our literature search on the meta-search engine *Google Scholar*.

At this point, we chose to retain only the articles evaluating MLGs with executable prototype and described according to the evaluation heuristics defined by Zaibon and Shiratuddin (2010) in terms of game usability, mobility, gameplay and educational content.

Due to the large number of results, we retained only the first ten MLGs appearing on each engine, in accordance with our search criteria and sorted by relevance. Although the algorithm that determines the degree of relevance varies from a search engine to another, it always takes into account the presence of keywords in the full text of the article, the name of the author and the publication in which the article appeared.

Table 1 contains the 50 MLGs obtained with this research method (5 engines x 10 results). There are actually 39 distinct MLGs because some of them figured on several engines (in bold in Table 2). Note that we only mentioned each MLG once per engine, even if it was cited by several articles.

Table 1: The first 10 MLGs found for each search engine

<i>IEEEExplore</i>	<i>ACM DL</i>	<i>Science Direct</i>	<i>Springer</i>	<i>Google Scholar</i>
<i>Skillville</i>	<i>On the Edge</i>	<i>Bauboss</i>	<i>HeartRun</i>	<i>The MobileGame</i>
<i>Lecture Quiz</i>	<i>Chinese-PP game</i>	<i>HeartRun</i>	<i>ToneWars</i>	<i>Explore!</i>
<i>Skattjakt</i>	<i>Parrot Game</i>	<i>QuesTInSitu</i>	<i>Power Agent</i>	<i>Frequency1550</i>
<i>Bagamoyo Caravan</i>	<i>Frogger&Floored</i>	<i>Frequentie1550</i>	<i>MobileMath</i>	<i>Skattjakt</i>
<i>FreshUp</i>	<i>Power Agent</i>	<i>EarlyBird</i>	<i>Explore!</i>	<i>Parrot Game</i>
<i>Cardinal direction</i>	<i>Kurio</i>	<i>Furio's</i>	<i>Detective Alavi</i>	<i>Frogger&Floored</i>
<i>Tower of London</i>	<i>Power Explorer</i>	<i>MSGs</i>	<i>Preserving Famosa fortress</i>	<i>Power agent</i>
<i>The Amazing City</i>	<i>iFitQuest</i>	<i>Reenactment</i>	<i>Mindergie</i>	<i>Lecture Quiz</i>
<i>CatchBob!</i>	<i>Explore!</i>	<i>BoomRoom</i>	<i>Language Learning Game</i>	<i>MuseumScrabble</i>
<i>The MobileGame</i>	<i>TimeWarp</i>	<i>EasyLexia</i>	<i>Nat. Palace Museum Adventure</i>	<i>Mentira</i>

2.2 Selection method

In order to identify the MLGs to be analyzed, we decided to sort them by total number of citations (sum of citations of all articles evaluating the same MLG). Table 2 lists the MLGs shortlisted in Section 2.1, sorted by total citations on *Google Scholar*.⁴

Table 2: Order by total number of citations of preselected MLGs.

MLG	Reference / publishing year	Citations	Total Citations
<i>Frequency1550</i>	(Huizenga et al., 2009)	146	313
	(Akkerman et al., 2009)	75	
	(Admiraal et al., 2011)	69	
	(Admiraal et al., 2007)	12	
	(Huizenga et al., 2007)	11	
<i>The MobileGame</i>	(Schwabe & Göth, 2005)	212	240
	(Schwabe & Göth, 2005)	28	
<i>Explore!</i>	(Costabile et al., 2008)	104	179
	(Ardito et al., 2008)	35	
	(Ardito et al., 2009)	18	
	(Ardito & Lanzilotti, 2008)	11	
	(Ardito et al., 2012)	10	
<i>Power Agent</i>	(Gustafsson et al., 2010)	49	88
	(Bang et al., 2007)	39	
<i>Skattjakt</i>	(D. Spikol & Milrad, 2008)	39	79
	(Daniel Spikol & Milrad, 2008)	34	
	(Spikol, 2007)	3	
	(Spikol, 2009)	3	

3. Description and analysis of MLGs

Now that we have identified the five most referenced MLGs, we will describe their educational purpose and scenario. We also provide the context and the results of their latest and most complete assessment.

3.1 Frequency1550

3.1.1 Educational purpose

Frequency1550 is a MLG about medieval Amsterdam to be played during a single school day.

3.1.2 Scenario description

In this game, pupils are assigned the identities of foreign workers in medieval Amsterdam who would like to obtain citizenship.

Each group of 4 to 5 pupils is divided into a City Team (CT), who will walk through the city, and a Head Quarter Team (HQT), operating from behind a computer in the *Waag* building⁵. After the lunch break, the teams switch places so that every pupil tries the role of both teams. The CT can only view a map of medieval Amsterdam on their smartphones, while the HQT can use two maps, one with medieval Amsterdam and another one with present Amsterdam, and can digitally follow the route of the CT by means of GPS, so they can guide them towards the required learning tasks using internet resources and media information received from the CT. At the end of the day, pupils gather at the *Waag* building for a debriefing session where each group presents their collected media to the other groups and to the teaching staff.

3.1.3 Assessment context

The game was tested on 458 pupils aged from 12 to 16: 232 played the *Frequency1550* game and 226 followed formal lessons on the same learning content (Admiraal et al., 2011).

⁴ The complete list of MLGs sorted by total citation is available on: http://perso.univ-lemans.fr/~akaroui/table_mlgs.html

⁵ http://en.wikipedia.org/wiki/Waag,_Amsterdam

3.1.4 Assessment results

Frequency1550 players scored higher at knowledge test than those who received formal lessons. According to the authors, the players were able to gain more knowledge through their direct presence on historical sites. It even seems that when students failed at parts of the game, location-based experience enabled them to learn anyway.

In addition, the fact that the scenario was designed in such a way that teams needed to communicate in order to accomplish game tasks (CT sent historical information and pictures found on sites to HQT so that they could find out more about them on the internet), led to a successful collaboration between the teams.

The HQT members were more motivated than the CT members because they felt a sense of control when guiding the CT and because of the diversity of their tasks (internet research, orientation and giving orders).

On the other hand, the authors noticed that some players were distracted by external events such as accidents in the street, and sometimes lost sight of the overall structure of the game. The CT members generally experienced a lack of control and vision of the game. According to some players' interviews, it is also possible that playing the game for a single day is not enough to reach the maximum level of immersion.

3.2 The MobilGame

3.2.1 Educational purpose

The MobileGame is a MLG designed to help new students get familiar with the building and the services on their university campus

3.2.2 Scenario description

The game consist in guiding participants along a map and through several missions to discover places in the university such as the library, the cafeteria or laboratories. Contextual tasks are included in the assignments such as finding a book in the library or a person in a department. Players can play individually or in groups of two, three or four people. Tasks are accomplished through mobile devices and are divided into cooperative and competitive missions. The competitive mission are based on hunting rules: each group tries to catch another group and, is itself hunted by a third group. The handheld device shows the location of the hunter and the prey. The cooperative missions force groups to meet with each other and with teachers in order to exchange information. Again, they are supported with location-based information on their mobile screens.

3.2.3 Assessment context

The evaluation was conducted with 22 students from 19 to 25 years at the University of Koblenz in Germany (Schwabe & Göth, 2005).

3.2.4 Assessment results

The majority of players (17 of 22), said they would like to play the game again, and 21 thought the electronic support increased the excitement of the game.

Regarding the gameplay, half the participants saw a considerable added value in comparison with a traditional guided tour. Moreover, 8 participants selected "the opportunity to individually explore the university" as one of the three most important positive aspects of the game.

According to the survey, map-navigation activities (moving through the digital map) and '*Hiding and hunting*' activities (chasing prey groups and avoiding hunters) obtained the highest score in terms of immersion and distraction.

3.3 Gaius' Day in Egnathia

3.3.1 Educational purpose

Gaius' Day in Egnathia is a MLG designed to learn about the archaeological park of *Egnathia* in southern Italy.

3.3.2 Scenario description

Players are divided into groups of 3 or 5. Each group impersonates a Roman citizen (Gaius), who settle down in Egnathia with his family. Group members play different roles: the *reader*; who reads the challenge, *the petitioner*; who consults the glossary, *the navigator*; who carries the map and marks the identified places, the *scouts* who go on ahead to find the places that are the targets of the mission.

The game exists in two versions. The first one is a paper-based version. Therewith, players are equipped with booklets containing the map and the challenges. The second version is implemented by the *Explore!* the mobile learning system. This time, the game information and assignments are displayed on cellphones. Sound effects indicating the beginning and the end of assignments and 3D representations of what places looked like at the time are included in the *Explore!* version.

In both versions, the game is supervised by a game master, whose main tasks are to check that the rules are observed correctly, encourage the players if they run into difficulties, and push them in the right direction by giving them suitable hints. Finally, a debriefing session take place in order to discuss the acquired information. The whole game lasts about three hours.

3.3.3 Assessment context

The article we report describes two studies of playing *Gaius' Day in Egnathia* on mobile phones (*Explore!* version), aiming to compare behavior, engagement and learning with the original paper-based version.

The first study involved a class of 24 students, from 11 to 13 years old, playing the paper-based game. The second study involved a total of 42 twelve years old students; 19 of them played the paper-based version and 23 played the *Explore!* version.

3.3.4 Assessment results

The results indicated a positive reaction to *Explore!* version. 74% of the students explicitly reported having preferred *Explore!*, only 13% preferred the original game and 13% did not express any preference. The 3D reconstructions on mobile screens during the gameplay and the debriefing, were the primary reason for preferring *Explore!*

However, results showed more right answers in the game assignments for the paper version. The authors explain this difference by the fact that the *Explore!* version showed only relevant information corresponding to the exact GPS position of students while in the paper version, students always had access to all the data. Additionally, the *Explore!* version required students to respond to the questions in a certain order while in the paper version, they could choose the order of their answers and even return to some of them later in the game.

Motivation was very high in both versions of the game but even more so for the *Explore!* version. The motivation factors were related to the used artifacts (such as the sound and augmented reality effects) for the *Explore!* version, while for the paper version, they were related to the archaeological park.

3.4 Power Agent

3.4.1 Educational purpose

Power Agent is a MLG designed to educate players about energies and teach them good consumption habits.

3.4.2 Scenario description.

Players take the role of a special agent whose mission is to save energy at home. To achieve this goal, the agents act under the supervision of their director "Mr. Q". Each agent is equipped with a mobile phone connected directly to the electric power meter in their home and must cooperate with the members of his family to reduce consumption between 5PM and 10PM. Then, his efforts are combined with other agents in the same city. The team of special agents is in competition with another team in another city. The winning team is the one that decreases its energy consumption the most over a defined time period.

3.4.3 Assessment context

Two teams of three agents, along with their family members, participated in the game for 10 days in two different cities in Sweden during the spring of 2008. Coincidentally, the first team consisted of three boys and the second team consisted of three girls.

3.4.4 Assessment results

Players were highly motivated and committed to the game and accepted a lower daily comfort level than the standard. According to the authors, the configuration of the two teams (girls' team and boys' team) improved the competitive aspect of the game. Thus, they recorded several outstanding initiatives among agents such as replacing light bulbs with energy saving ones or using candles.

Collaboration aspect within families was considerable and an important immersive factor. Indeed, parents were quite involved in the game and even communicated with "Mr.Q" through their children. The educational

objective was also achieved in most cases: players learned new methods to reduce consumption through the strategies exchanged on the game's web platform, by applying these strategies and discussing with their family and team members.

The MLG led to considerable changes in behavior during the 10 days period of the game but the assessment did not allow to measure the long-term effects.

3.5 Skattjakt (treasure hunt)

3.5.1 Educational purpose

Skattjakt is a MLG designed to promote physical activity and collaborative problem-solving while learning about history.

3.5.2 Scenario description

The game takes place in a castle. The main assignment is to help the ghost of *Anna Koskull* (former lady of the manor), to solve the mystery of her missing husband, who actually built the castle. While exploring the map displayed on their smartphones, players receive text and audio based clues to find landmarks. Therewith, they have to solve puzzles, spell out codes and collaboratively unscramble clues directing them to other landmarks. Moreover, they lose time each time they give wrong answers.

3.5.3 Assessment context

The study that we report, was firstly carried out on 12 pupils between 12 and 15 years old during the winter in 2007, and secondly, on 26 girls aged between 13 and 15 years old, during the summer of the same year.

3.5.4 Assessment results

For the first experiment, 58% of players said the game was very entertaining and 73% for the second one. This could be partly related to the weather conditions in which the game took place (Swedish winter vs summer). The gameplay also increased motivation to learn. Indeed, 100% of the players appreciated learning local history through the game in the second experiment and 75% gave the same feedback after the first experiment. Furthermore, even collaboration improved during the second experiment. The results indicate that 92% of the players in the second experiment (who were only girls) were able to collaborate all the time against only 58% in the first experiment.

4. Discussion

All the analyzed MLGs obtained good results in terms of learning effectiveness and high results in terms of gameplay satisfaction. So, we will firstly identify the common features which contributed to these games' success. Secondly, we will discuss the problems faced by players during the games assessments in order to analyze them from a design point of view (teacher's position).

4.1 Common features

4.1.1 Location-based learning

Location-based activity is a common feature to all the analyzed MLGs. It is obviously a pedagogic choice to use location-based activities as a learning mechanism. When games use this feature, they are called Geogames, according to (Schlieder et al., 2006). At this level, we can say that our analysis set consist of five Learning Geogames.

Given some of the assessments results, we conclude that the location-based experience is an effective way for learners to acquire information because of their direct presence on the learning spots, the possibility of observing and therefor better memorizing places, names and functions. Indeed, *Frequency1550* players have scored higher in the knowledge test, than those who had received formal lessons. Furthermore, pedagogical information in this game was sometimes acquired indirectly: players didn't always succeeded the game's assignments but always learned something from the context around.

Location-based learning also helped both teams that played *Power Agent* to learn about the required consumption habits in a practical way. Truly, we believe that it is more efficient to directly practice the learned methods in a realistic situation rather than just receive them in a theoretical form.

4.1.2 Learning autonomy

One of the most important elements characterizing Geogames is the moving ability. This feature fits ideally with the autonomous learning method. Actually, many studies recommend autonomy in learning because it is closely linked to motivation. Indeed, personal involvement in decision making leads to more effective learning (Dickinson, 1995)(Knowles, 1975). Autonomy is also valued by the players. Indeed, the majority of *The MobileGame* participants selected the possibility to individually explore the university as one of the most positive points of the game. In addition, the players of *Gaius' Day* who could freely answer the questions, scored higher than those who were constrained to answer in the implied order. Moreover, CT members in *Frequency1550*, who had less autonomy than the HQT, expressed less satisfaction for the gameplay.

Hence, we recommend more autonomy of movement and decision when designing MLGs scenarios. Indeed, we believe that enabling students to find items, explore sites, and choose strategies increases personal involvement and hence, leads to more effective learning.

4.1.3 Role-playing pedagogy

Role-playing was common to four of the five analyzed games. Indeed, in *Frequency1550*, players had to play the role of foreign workers in medieval Amsterdam, roman citizen in *Gaius' Day*, special agents in *Power Agent* and investigators of a fictional research group at the university in *Skattjakt*.

Role-play has been often used in education as a learning mechanism. (Heuser, 1999) for example used role-play to cultivate college students' understanding of poverty and homelessness in the United States. It has also been used with high school students in South Africa as part of a repertoire of activities for "multimodal exploration of texts" (Stein, 1998). In addition, since it requires students to embody characters and perspectives that may be quite different from their own, role-playing activities can be cognitively challenging (Shapiro & Leopold, 2012). Thus, we believe it can be a valuable addition to the gameplay experience and we recommend to integrate it in MLGs scenarios if there are suitable conditions.

4.1.4 Collaborative learning

Setting up collaborative activities between players is recognized as one of the mechanisms that enhances games. This is due to the social interactions and the extra challenge of team decision making (Marfisi-Schottman et al., 2014). Indeed, cognition is better when it becomes a result of a distributed process across members of a group (Hollan et al., 2000).

All the analyzed MLGs in this paper include collaborative learning methods since all the studied scenarios were based on group problem-solving. Hence, social interactions were promoted. For example, the involvement of the whole family in *Power Agent* improved the immersion of agents and made the game more challenging for them. Moreover, the authors reported that the randomly composition of teams by a girls' and a boys' team improved competitiveness. In addition, collaboration has been more successful among the girls teams compared to the mixed team in *Skattjakt*. This leaves us to say that, in some cases, it is possible to draw profit of the competitiveness aspects between the sexes to promote engagement.

Social and epistemic factors, such as age and relationship between players, can advantageously be taken into account to facilitate the design of such competitive activities (Hamalainen, 2008).

4.1.5 Innovative digital tools

Innovative digital tools makes the learning process more attractive. Indeed, according to the games observations, motivation was always higher when it integrated new digital tools. The experimentation of *Frequency1550*, for example, showed that players were more attentive and reactive when teachers explain how to use the mobile devices than during the explanation of the game's history. The augmented reality (AR) features also seemed to motivate *Gaius' Day* players and the 3D representations provided by *Explore!* allowed richer after-game discussions and a longer debriefing phase than the paper version. We therefore preconize combining AR techniques like QR/Flash codes and sound effects as well as including multimedia content to enhance MLGs attractiveness.

4.2 The problems of use

In this part, we will analyze the problems encountered by players during the gameplay and interpret them through the teacher's lens in order to determine possible solutions.

4.2.1 In terms of gameplay

Some players of *Frequency1550* lose sight during the assignments time and were distracted by external events. To overcome this kind of circumstances and to avoid distractions in general, a game master should always be

planned in MLGs scenarios. The teacher can advantageously incarnate this role. Indeed, we believe that the monitoring progress is particularly well suited for the teachers so they can help players in difficulty. Therefore, providing MLGs with tracking tools so that teachers can supervise the players' progress in the game could be very useful. Providing alternative paths in the game scenario and additional activities would also be an efficient solution to manage the different levels of player's.

4.2.2 In terms of design

Skattjakt players regretted that it was impossible to play the same game on other topics than history. Similarly, the authors of *Gaius' Day* (tested on *Explore!*) expressed their needs to make their authoring tool more generic to other topics besides archeological parks.

Currently, there are several authoring tools allowing to design and execute Learning Games such as *e-adventure*⁶ and *Storytec*⁷. However, these authoring tools do not provide the means to design located-based activities or using innovative digital tools which are essential to MLGs.

Consequently, we believe that a generic model and tool for designing and executing Learning Games on mobile devices would be very advantageous. Therefore, our future work will be focused on establishing such a generic model. We will concentrate on integrating the previously identified MLGs features in our system's database in order to guide designers to create MLGs in the most efficient way. Nevertheless, possibilities of reification of this model are multiple since we can take advantage of the existing authoring tools cited above.

Thereafter, (Figure 1) illustrates the process that we will set up for our authoring environment in order to assist the designers to create their custom MLG.

5. Towards an Efficient Mobile Learning Games Design Model

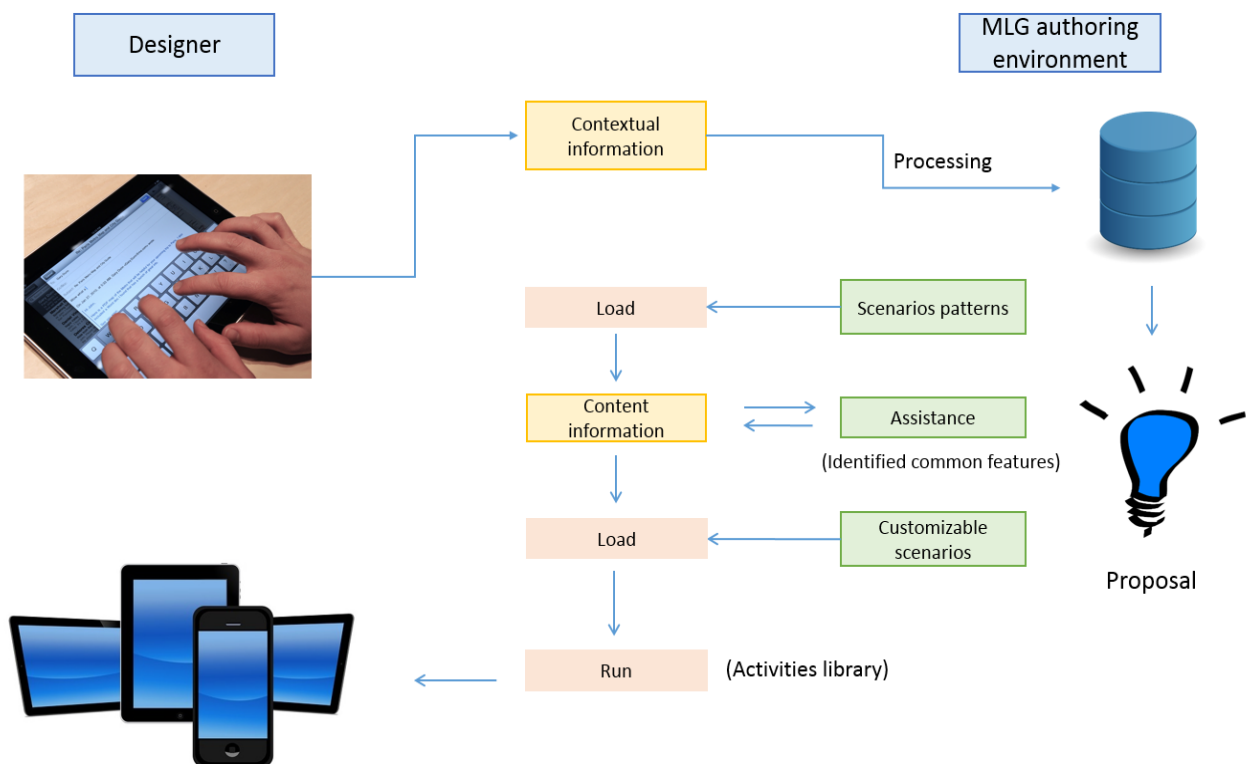


Figure 1: The MLG authoring environment process

The process takes place primarily between the designer and the authoring tool system. The idea of the operating method is that designer inserts information about context and content of his MLG and that the system gradually propose components (e.g. scenario patterns) and support (e.g. findings of this review) based on the provided information.

⁶ <http://e-adventure.e-ucm.es/>

⁷ <http://www.storytec.de/index.php?id=2&L=1>

6. Conclusion

In this paper, we sought to identify the principal common features that contributed to five MLGs success. On the one hand, we found that location-based autonomous learning, role-playing pedagogy and collaborative learning were the main features of the analyzed five MLGs. On the other hand, we exposed particular design and gameplay problems to which we have proposed possible solutions; such as the risk of distraction especially when playing outside and the question of managing different players' progress in the MLG.

Although we have identified interesting MLGs, our research method leaves out recent MLGs whose articles have not yet been much cited, but who potentially implement several mechanisms found in the last part of this article. For example, *Power Explorer* is a MLG that enhances the learning process found in *Power Agent* in order to achieve long-term changes in consumer habits.

The next step of our work is to define a generic authoring environment for non-computer scientist such as teachers, museum curators and park managers, so that they can design their own games and deploy them on mobile devices.

References

- Aceto, S., Borotis, S., Devine, J., Fischer, T., Kampylis, P., Punie, Y. & Institute for Prospective Technological Studies (2014) *Mapping and analysing prospective technologies for learning results from a consultation with European stakeholders and roadmaps for policy action*. Luxembourg, Publications Office.
- Admiraal, W., Huizenga, J., Akkerman, S. & Dam, G. ten (2011) The concept of flow in collaborative game-based learning. *Computers in Human Behavior*, 27 (3), pp.1185–1194.
- Admiraal, W., Raessens, J. & Van Zeijts, H. (2007) Technology enhanced learning through mobile technology in secondary education. *Expanding the knowledge economy. Issues, applications, case studies (Part 2)*, pp.1241–1248.
- Akkerman, S., Admiraal, W. & Huizenga, J. (2009) Storification in History education: A mobile game in and about medieval Amsterdam. *Computers & Education*, 52 (2), pp.449–459.
- Ardito, C., Buono, P., Costabile, M.F., Lanzilotti, R., Pederson, T. & Piccinno, A. (2008) Experiencing the Past through the Senses: An M-Learning Game at Archaeological Parks. *IEEE MultiMedia*, 15 (4), pp.76–81.
- Ardito, C., Buono, P., Costabile, M.F., Lanzilotti, R. & Piccinno, A. (2009) Enabling Interactive Exploration of Cultural Heritage: An Experience of Designing Systems for Mobile Devices. *Knowledge, Technology & Policy*, 22 (1), pp.79–86.
- Ardito, C., Costabile, M.F., De Angeli, A. & Lanzilotti, R. (2012) Enriching Archaeological Parks with Contextual Sounds and Mobile Technology. *Computer-Human Interactions*, 19 (4), pp.1–30.
- Ardito, C. & Lanzilotti, R. (2008) 'Isn'T This Archaeological Site Exciting!': A Mobile System Enhancing School Trips. In: *Proceedings of the Working Conference on Advanced Visual Interfaces*. AVI '08. New York, NY, USA, ACM, pp.488–489.
- Attewell, J. (2009) *The impact of mobile learning examining what it means for teaching and learning*. London, LSN.
- Bang, M., Gustafsson, A. & Katzeff, C. (2007) Promoting New Patterns in Household Energy Consumption with Pervasive Learning Games. In: Y. de Kort, W. IJsselsteijn, C. Midden, B. Eggen, & B. J. Fogg eds. *Persuasive Technology*. Lecture Notes in Computer Science. Springer Berlin Heidelberg, pp.55–63.

- Costabile, M.F., De Angeli, A., Lanzilotti, R., Ardito, C., Buono, P. & Pederson, T. (2008) Explore! Possibilities and Challenges of Mobile Learning. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '08. New York, NY, USA, ACM, pp.145–154.
- Dickinson, L. (1995) Autonomy and motivation a literature review. *System*, 23 (2), pp.165–174.
- Gustafsson, A., Katzeff, C. & Bang, M. (2010) Evaluation of a Pervasive Game for Domestic Energy Engagement Among Teenagers. *Computer Entertainment*, 7 (4), pp.54:1–54:19.
- Hamalainen, R. (2008) Designing and evaluating collaboration in a virtual game environment for vocational learning. *Computers & Education*, 50 (1), pp.98–109.
- Heuser, L. (1999) Service-Learning as a Pedagogy to Promote the Content, Cross-Cultural, and Language-Learning of ESL Students. *TESL Canada Journal*, 17 (1), pp.54–71.
- Hollan, J., Hutchins, E. & Kirsh, D. (2000) Distributed Cognition: Toward a New Foundation for Human-computer Interaction Research. *ACM Transactions on Computer-Human-Interactions*, 7 (2), pp.174–196.
- Huizenga, J., Admiraal, W., Akkerman, S. & Dam, G. ten (2009) Mobile game-based learning in secondary education: engagement, motivation and learning in a mobile city game. *Journal of Computer Assisted Learning*, 25 (4), pp.332–344.
- Huizenga, J., Admiraal, W., Akkerman, S. & Ten Dam, G. (2007) Learning history by playing a mobile city game. In: *Proceedings of the 1st European conference on game-based learning (ECGBL) October*. pp.127–134.
- Johnson, L., Adams Becker, S., Estrada, V., Freeman, A., Kamylyis, P., Vuorikari, R. & Punie, Y. (2014) Horizon Report Europe: 2014 Schools Edition. *Luxembourg: Publications Office of the European Union, & Austin, Texas: The New Media Consortium*.
- Johnson, L., Adams, S., Cummins, M., Estrada, V., Freeman, A., Ludgate, H., Johnson, L., Adams, S., Cummins, M., Estrada, V., Freeman, A. & Ludgate, H. (2013) The NMC Horizon Report: 2013 Higher Education Edition. , pp.1–40.
- Knowles, M.S. (1975) *Self-directed learning: a guide for learners and teachers*.
- Marfisi-Schottman, I., George, S. & others (2014) Supporting Teachers to Design and Use Mobile Collaborative Learning Games. In: *Proceedings of the International Conference on Mobile Learning*. pp.3–10.
- Mascheroni, G., Ólafsson, K., Cuman, A., Dinh, T., Haddon, L., Jørgensen, H., Livingstone, S., O'Neill, B., Ponte, C., Stald, G. & others (2013) *Mobile internet access and use among European children: initial findings of the Net Children Go Mobile project*. Educatt.
- Papastergiou, M. (2009) Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation. *Computers & Education*, 52 (1), pp.1–12.
- Purcell, K., Heaps, A., Buchanan, J. & Friedrich, L. (2013) How teachers are using technology at home and in their classrooms. *Washington, DC: Pew Research Center's Internet & American Life Project*.
- Sánchez, J. & Olivares, R. (2011) Problem solving and collaboration using mobile serious games. *Computers & Education*, 57 (3), pp.1943–1952.
- Schlieder, C., Kiefer, P. & Matyas, S. (2006) Geogames: Designing location-based games from classic board games. *Intelligent Systems, IEEE*, 21 (5), pp.40–46.

- Schwabe, G. & Göth, C. (2005) Mobile learning with a mobile game: design and motivational effects. *Journal of computer assisted learning*, 21 (3), pp.204–216.
- Shapiro, S. & Leopold, L. (2012) A critical role for role-playing pedagogy. *TESL Canada Journal*, 29 (2), p.120.
- Spikol, D. (2007) Designing Mobile Games that Explore Novel Learning Practices with Co-Design. , pp.41–47.
- Spikol, D. (2009) Exploring Novel Learning Practices Through Co-Designing Mobile Games. In: Peter Lang.
- Spikol, D. & Milrad, M. (2008) Combining Physical Activities and Mobile Games to Promote Novel Learning Practices. In: *Fifth IEEE International Conference on Wireless, Mobile, and Ubiquitous Technology in Education, 2008. WMUTE 2008*. pp.31–38.
- Spikol, D. & Milrad, M. (2008) Physical activities and playful learning using Mobile Games. , 03 (03), pp.275–295.
- Stein, P. (1998) Reconfiguring the Past and the Present: Performing Literacy Histories in a Johannesburg Classroom. *TESOL Quarterly*, 32 (3), pp.517–528.
- Zaibon, S.B. & Shiratuddin, N. (2010) Heuristics Evaluation Strategy for Mobile Game-Based Learning. In: *2010 6th IEEE International Conference on Wireless, Mobile and Ubiquitous Technologies in Education (WMUTE)*. pp.127–131.