THE IMPLEMENTATION OF MOBILE LOCATION BASED-GAMES AND QR CODES: THE CASE OF MOBIGEO

Liliana Vieira[1], Clara Coutinho[1], José I. Graça[2], João Graça[3]

[1]University of Minho (PORTUGAL)
[2] Municipality of Vila Verde (PORTUGAL)
[3] Agrupamento de Escolas de Vila Verde (PORTUGAL)

Abstract

Education is being revolutionized by the introduction, of mobile technologies in the teaching and learning process. However, studies that focus in the application of mobile technologies to informal learning environments is scarce and not systematized [1]. This is the reason for conducting a research project that involved a urban game MobiGeo, designed in to take better advantage of the flexibility and ubiquity offered by the Mobile Learning (ML) but also taking into account the importance of motivation and interaction to enhance students learning.

The definition of ML has been a complicated task for researchers, but there are assumptions that can not be neglected: the mobility, portability and ubiquity [2], these are features that will drive new learning spaces and thus motivate students. This idea is supported by [2] that introduces the concepts of "just in time", "just enough" and "just-for-me" and [4] that speaks of the triad "location independence", "independence time" and "meaningful content".

These principles of "anytime" and "anywhere" consolidated by mobile technologies came to renew the variety of educational activities available to teachers and in this context arises the concept of mobile location-based games. According to [5] "these games are played in physical space, but at the same time, they are supported by actions and events in an interconnected virtual space", which can be classified into three categories: ludic, pedagogic and hybrid. By being in direct contact with the contents to assimilate and move in a real context, students will have a more significant learning [6] and this will result in the mobilization of knowledge in different contexts. To make the connection between the physical and the virtual world, our research has made use of Qr codes as these devices provide information in real time and in a dynamically way.

For this research was idealized an urban game called "MobiGeo", that respect the principles suggested by [7] and that has as common thread the history of the European Union. To measure results the researchers developed a questionnaire that was adapted from a proposal of [8] which created a "Model to evaluate Educational Games", so our proposal was built taking into account the motivational model of Kirkpatrick (level1) and encompassing three major dimensions: Motivation/Interest, Interaction and Perceived Learning. To assess the Motivation/Interest was used the Model ARCS (Relevance, Confidence and Satisfaction) and items of Fun, Immersion and Challenge of "Game User Experience". On the other hand the interaction was evaluated by items of the Social Interaction dimension of the "Game of User Experience", the Learning Perceptions were evaluated by Bloom's Taxonomy (Knowledge category).

In this paper we present the design and implementation of the MobiGeo outdoor learning activity with a group of 173 students from the 7th grade of a basic school in the north of Portugal. Initial results show that this urban game with Qr codes was an adequate activity to use in informal learning environments that could engage students in gaming with high degrees of motivation and interaction in order to solve the tasks presented to them and so consolidate and acquired new knowledge about the European Union.

Keywords: Mobile Learning, Qr codes, urban games, informal learning.

1 INTRODUCTION

Advances in communication technology have create new interfaces that allow to develop and promote applications and a open wide range of possibilities for usability in educational contexts, as mentioned [9] "The evolution of the society gave to the mobile phone an importance that goes behind the typical communication between people. As expected this has spread and also came to school. It becomes

imperative to use this media to promote/increase new activities that are motivating and challenging for students.”

In this context, emerges a new educational paradigm, but there a lack of consensus among researchers ([2]; [10]; [11]; [12]) to define it, most of the definitions is based on the technology, in other words, learning happens to and through a mobile device, for example a mobile phone, a PDA or tablet [13]. However, this view to some authors ([14]; [10]) is reductive, so is necessary to frame the context shared by the device itself and the user/learner mobility. Thus, according to [10] ML occurs when the learner "is not fixed " and when you take advantage of the learning opportunities that mobile offers.

Based on these perspectives will adopt a more consensual set of variables that are essential to develop and implement ML, instead of trying to select a single definition. Corroborating this idea and according to the literature, the ML has to incorporate the following variables: time, space, learning environment, content, information technology, the mental abilities of the learner and the method [8].

This study is important to demonstrate the true concept of Mobile Learning (ML) because much of the discussion between authors is holding in the "use of mobile phones in the classroom”, however it is a reductive vision of the ML, because, as defended by [3], ML is suitable to support personalised, situated, authentic and informal learning.

This is the reason for conducting a research project that involved a urban game called MobiGeo, designed in to take better advantage of the flexibility and ubiquity offered by the ML but also taking into account the importance of motivation and interaction to enhance students learning.

1.1 Mobile Location-based Games

Bearing in mind the truly concept of ML there is a new wave of educational activities mediated by mobile technologies and based on contextual learning. Context accordingly to [16] “is a central construct of mobile learning, not as container through which we pass like a train in a tunnel, but as an artefact that is continually created by people in interaction with other people, with their surroundings and with everyday tools”, its exploration must be mobile (conceptual and physical) and the conversation its the bridge that unites learning contexts.

Is in this field that are developed games relate to the location/mobility of user raises and mediated by mobile phones, the "mobile location- based games " [5]. A typical example of these games are the "urban games" or "street games" that are a phenomenon of modern societies, in the literature there is a certain difficulty in defining them, but there are characteristics that must be taken into account: i) be performed in a public space, ii) its scale being large ("human scale"), and finally iii) aggregate communication technology (mobile phone, GPS, internet and digital cameras). According to [5] "these games are played in physical space, but at the same time, they are supported by actions and events in an interconnected virtual space", which can be classified into three categories: ludic, pedagogic and hybrid. By being in direct contact with the contents to assimilate and move in a real context, students will have a more significant learning [6] and this will result in the mobilization of knowledge in different contexts.

[17] also argues that "location-based mobile experiences" offer several advantages and a great educational potential, including:

a) Chance to learn in particular context, being able to choose where and when, for example, when students study questions related to the History of Art may access the thematic content when they are in front of a characteristic building;

b) Data collection *in situ*, i.e. allows students during fieldwork examine or submit data on a site for further interpretation;

c) Personalization of learning experiences, because the students can access content according to their own learning time, with no pressure from the collective.

1.2 Qr Codes in the education

To make the connection between the physical world and the virtual, our research has made use of Qr Codes as this provide information in real time and in a dynamically way. A Qr code ("Quick response") is a 2D bar created in Japan by Denso-Wave Corporation in 1994. Qr code incorporates information in the form of URL, text message, phone number, contacts and plain text, in a two-dimensional array. The information is stored either vertically or horizontally, and can be read from either direction since it

has recognition patterns in three corners of the positional code. After reading a Qr code, students can immediately see your content or store it.

[9] argues that QR codes applied to education fall within the principles of ML in that potentiate the "independence" given by "portability" [12] of technological devices. [4] speaks of the triad "location independence", "independent of time" and "meaningful content" and [3] uses the phrase "just in time" to characterize this new way of learning. The capacity of crosses information with space afforded by Qr codes can be an innovation concerning to information issued by local and objects.

Qr codes in educational settings have multiple applications, in our literature review we establish three major types of educational activities which Qr codes can make a difference: a) outdoor activities: what can be proven by the example presented by [18], [19] and [20] b) Treasurer Hunt/Trail Activities, like the works presented by [21], [22], [19] and [23]; and finally c) Classroom activities developed by [24], [25], [26], [27], [28], [19] and [29] e [30].

2 DESIGN OF MOBIGEO

The theoretical background for the proposed Urban Game is based on four pillars: Constructivism (the student takes an active role in the production/construction of knowledge), the Situated Learning (authentic context is a sponsor of knowledge); Connectivism (which puts mobile devices as a source of connections available for the acquisition of knowledge) and Conversation Theory, which according [31] is fundamental to understanding the processes of collaboration in M L activities.

For this research was idealized an urban game called “MobiGeo”, that had as main thread the history of the European Union and that was aimed for learning without forgetting the entertainment. . Its preparation respected the principles suggested by [7]: i) real world relevance: use ML in authentic contexts; ii) mobile contexts: use ML in contexts where learners are mobile; iii) explore: provide time for exploration of mobile technologies; iv) blended: blend mobile and non mobile technologies; v) whenever: use ML spontaneously, vi) wherever: use ML in non traditional learning spaces; vii) whomsoever: use ML both individually and collaboratively; viii) affordances: take advantage of the characteristics of mobile technologies; ix) personalise: planning the use of the devices owned by the learners themselves; x) mediation: using ML to mediate knowledge construction; xi) *produse*: using ML to simultaneously produce and consume/use knowledge.

The MobiGeo arose from a partnership between the Basic School (“Agrupamento de Escolas de Vila Verde”) and the Knowledge House of Vila Verde (Casa do Conhecimento de Vila Verde). In this Urban Game participated all classes of the 7th grade of the Basic School of Vila Verde, a total of 173 students (82 boys and 91 girls), with ages between 12 and 15 years. Each class was divided in four teams – GeoFronteiras, PDA, Support and Wallpaper – and the geographical area was bounded between the school and the Central Square of Vila Verde, since here we use the wireless Internet system implemented by the Knowledge House. Mobile phones were also available for each of the teams to be able to communicate with each other, receive instructions of the way to go (GPS) and the tasks associated with Qr codes. In the end the team that find all the points and perform all the tasks had to raise the European Union flag as a symbol of victory.

Figure 1: Students playing MobiGeo

3 METHOD

To measure results the researchers developed a questionnaire that was adapted from a proposal of [32] which created a "Model to evaluate Educational Games", so our proposal was built taking into account the motivational model of Kirkpatrick (level1) and encompassing three major dimensions: Motivation/Interest, Interaction and Perceived Learning. To assess the Motivation/Interest was used the Model ARCS (Relevance, Confidence and Satisfaction) and items of Fun, Immersion and Challenge of "Game User Experience". On the other hand the interaction was evaluated by items of the Social Interaction dimension of the "Game of User Experience", the Learning Perceptions were evaluated by Bloom's Taxonomy (Knowledge category).

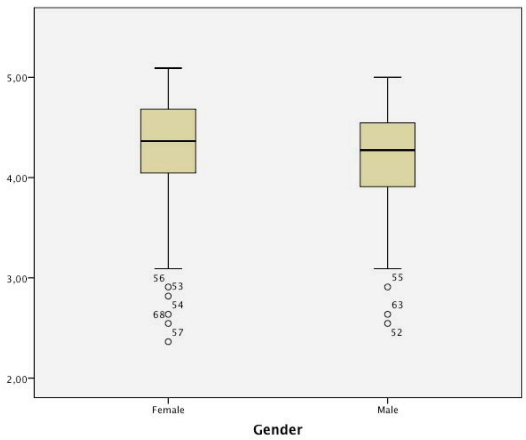
The questions were closed type with a *Likert* scale of 5 degrees of agreement (Completely Disagree, Disagree, Indifferent, Agree and Completely Agree). The questionnaire included 2 open-ended questions asking students. The analysis was undertaken using SPSS software for closed items and content analysis techniques were used to categorise and interpret the open-ended questions.

In order to verify if the different results between samples and if they had statistical significance we applied the nonparametric Mann-Whitney-U test for independent groups and assumed that the significance level for rejecting the null hypothesis was p<10%, a value accepted by educational researchers to support decisions based on probability [33].

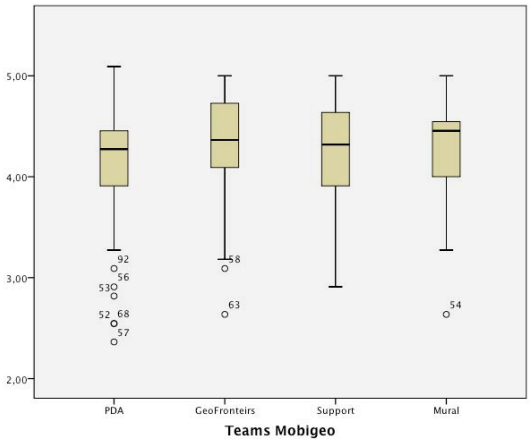
In the content analysis we create an emergent process of coding and categorization based on the answers provided by the students. Four categories were considered for the positive features of MobiGeo (use of technological devices, interaction, learning achievement and informal context of learning) and two for the suggestions to enhance MobiGeo (technological devices and activity organization).

4 RESULTS

The results of descriptive analysis showed that the mean value of *motivation* of the students was 4.21 and a standard deviation of 0.549. Exhibiting that the girls had higher values than the group of boys. In the content analysis we confirm this positive result when students pointed has positive aspects the use of mobile technologies ("the use of mobile phone motivated the efforts of the team.") or the context/local ("Be outside of the school became the activity different"). The boxplot graph revealed the existence of some outliers and a slight difference between groups based on gender (Graphic 1), so to verify that the observed differences had statistical significance was applied the nonparametric on-tailed Test of Mann-Whitney-U for independent groups having obtained the value of .072, which confirms gender differences in motivation, presenting girls higher values than boys. Looking at the teams (Graphic 2), the GeoFronteirs had a higher value of motivation/interest and the PDA team hat the lowest score of the four teams. As we noted in this last team the presence of outliers, we applied the Kruskal-Wallis test to assess the significance of differences between the four teams, however the values of significance obtained did not confirm the statistical relevance of differences observed.

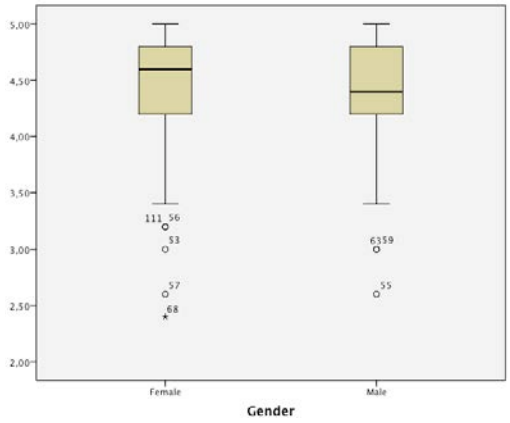


Graphic 1: Distribution of the mean values of *Motivation* by gender

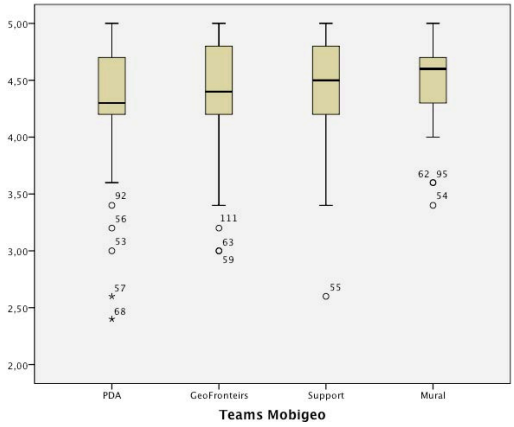


Graphic 2: Distribution of the mean values of *Motivation* by team

The results of the *interaction* variable had a mean value of 4.36 and a standard deviation of 0.526. Regarding to gender (Graphic 3) the mean values showed very slight differences, although the female group present values slightly higher than the male group. The preview of the boxplot graphic 3 reveals outliers, especially in the female group, although the patterns of distribution of the two groups in terms of central tendency and dispersion are very similar. In Graphic 4, we can visualised that the mean values are for the four teams are close, although we apply the Kruskal-Wallis test for independent groups to the teams and confirmed the absence of significant differences among groups. In the content analysis 39% of the students point as a positive aspect of MobiGeo the teamwork and communication among them, what demonstrate the importance of the interaction in this game (“The MobiGeo allow the cooperation among students”; “talk with colleagues”; “in MobiGeo we can avail to interact and learn with partners”).

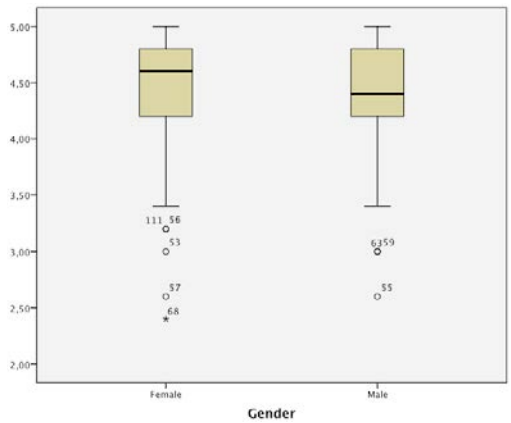


Graphic 3: Distribution of the mean values of *Interaction* by gender

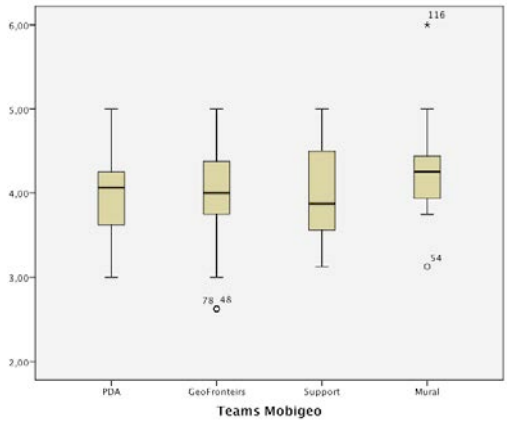


Graphic 4: Distribution of the mean values of *Interaction* by team

Finally, the sample has an average value of *learning perceived* of 4.03 and a standard deviation of 0.529. The mean by gender (Graphic 5) reveals that the female group has values slightly higher than the male group - 4.085 versus 3,911. The mean values by gender demonstrate that girls had slightly higher levels of perceived learning than boys. Therefore, to assess whether the observed differences had statistical significance was applied the nonparametric test Mann-Whitney-U for independent groups and the values confirmed that there are differences in the groups regarding gender, girls have a higher level of *perception of learning* than the boys at a significance level of p<.010. The team GeoFronteirs had a higher mean value and the lowest was the PDA team (Graphic 6). However, the application of the Kruskal-Wallis test to assess the significance of differences between the four teams reveals that the observed differences aren’t meaningful for the level of significance .010. The MobiGeo contribute to enhance and consolidate the contents of Geography, especially of the European Union, that’s what the students argue “"contributed to the knowledge of the European Union", "allowed a better learning content", "was an educational activity".



Graphic 5: Distribution of the mean values of *Perceive Learning* by gender



Graphic 6: Distribution of the mean values of *Perceive Learning* by team

5 FINAL REMARKS

Initial results show that this urban game with Qr codes was an adequate activity to use in informal learning environments that could engage students in gaming with high degrees of motivation and interaction in order to solve the tasks presented to them and so consolidate and acquired new knowledge about the European Union. The girls reveal higher results of motivation, interaction and perceived learning and the results of the analysis by team show that that there are slightly differences, however the GeoFrontiers team reveal more motivation that we associated to the use of Qr Codes in their trail, was it said [19] and [27] the students consider the activities with Qr codes interesting and they are very curious about this new approaches that are different from their daily classroom routine.

Unlike what happened with the study reported by [19] in which some students didn´t demonstrate motivation to perform an activity whose contents had already learned in the classroom, in the MobiGeo students revealed motivation and interest despite the fact that the content have been studied. We believe that the students were motived by the challenge to discover what was behind the GPS position and the use mobile phones for that propose. The curiosity allied to mobile technologies was a great impulse to the success of MobiGeo game.

With this study, we can conclude that mobile location-based games with Qr codes can improve the process of teaching by motivating the students to apply their knowledge, allow the interaction and cooperation and that will compromise positively the perceived learning.

REFERENCES

[1] Jones, A. C., Scanlon, E., & Clough, G. (2012). Mobile learning: Two case studies of supporting inquiry learning in informal and semiformal settings. *Computers & Education*, 61, 21-32.

[2] Coutinho, C. (2011). Mobile Web 2.0: New spaces for learning. In Lee Chao (Edt), *Open Source Mobile Learning: Mobile Linux Applications* (180-195). IGI Global: USA. DOI: 10.4018/978-1-60960-613-8.ch13.

[3] Traxler, J. (2007). Defining, discussing and evaluating mobile learning: The moving finger writes and having writ. *International Review of Research in Open and Distance Learning, 8* (2), 1-12.

[4] So, S. (2011, December). *Beyond the simple codes: Qr codes in education*. Communication presented at Ascilite 2011: Changing Demands, changing directions. Tasmania: Australia.

[5] Avouris N., Yiannoutsou, N., (2012). A review of mobile location-based games for learning across physical and virtual spaces, *Journal of Universal Computer Science*, vol 18,(15), 2120-2142.

[6] Silva, A. D. S., & Delacruz, G. C. (2006). Hybrid Reality Games Reframed Potential Uses in Educational Contexts. *Games and Culture*, *1*(3), 231-251.

[7] Herrington, J., Herrington, A., Mantei, J., Olney, I. & Ferry, B. (2009). *New technologies, new pedagogies: Mobile learning in higher education*. Faculty of Education, University of Wollongong. Retrivied from: http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1092&context=edupapers.

[8] Savi, R., von Wangenheim, C., Ulbricht, V., Vanzin, T. (2010). Proposta de um modelo de avaliação de jogos educacionais. *Novas tecnologias na educação, v.*8 (3). CINTED-UFRGS.

[9] Vieira, L. S. & Coutinho, C.P. (2013). Mobile Learning: perspectivando o potencial dos códigos QR na Educação. Actas da VII Conferência Internacional de TIC na Educação, Challenges 2013, (pp. 73-91). Centro de Competência TIC do IE-UM, Braga: Universidade do Minho.

[10] O'Malley, C., Vavoula, G., Glew, J.P, Taylor, J., Sharples, M., Lefrere, P., Lonsdale, P., Naismith, L. & Waycott, J. (2005). *WP4 – Pedagogical Methodologies and Paradigms. Guidelines for learning/teaching/tutoring*. Retrieved from: http://www.mobilearn.org/download/results/public_deliverables/MOBIlearn_D4.1_Final.pdf

[11] Moura, Adelina (2010). Apropriação do telemóvel como ferramenta de mediação em Mobile Learning: Estudos de caso em contexto educativo (Tese de Doutoramento). Universidade do Minho.

[12] Valentim, H. (2009). Para uma compreensão do Mobile Learning: Reflexão sobre a utilidade das tecnologias móveis na aprendizagem informal e para a construção de ambientes pessoais de aprendizagem (Tese de Mestrado). Universidade Nova de Lisboa.

[13] Quinn, C. (2000). *mLearning: Mobile, Wireless, In-Your-Pocket Learning*. Retrieved from: http://www.linezine.com/2.1/features/cqmmwiyp.htm

[14] Kukulska-Hulme, A. & Shield, L. (September, 2007). *An overview of Mobile Assisted Language Learning: Can mobile devices support collaborative pratice in speaking and listening?* Communication presented at EuroCall'07 Conference Virtual Strand. Ireland: Coleraine. Retrieved from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.84.1398&rep=rep1&type=pdf

[15] Laouris, Y. & Eteokleous, N. (2005). *We need an educationally relevant definition of mobile learning*. mLearn 2005 – 4thWorld Conference on m-Learning. South Africa: Cape town. Retrieved from: http://www.mlearn.org.za/CD/papers/Laouris%20%26%20Eteokleous.pdf

[16] Sharples, M., Sánchez, I. A.. Milrad, M. & Vavoula, G. (2009). Mobile Learning: Small devices, Big Issues. In Balacheff, N. (Ed.). *Technology-enhanced learning: Principles and products*. Springer. Retrieved from: http://www.uio.no/studier/emner/matnat/ifi/INF5790/v12/undervisningsmateriale/articles/KAL_Legacy_Mobile_Learning_(001143v1).pdf

[17] Benford, S. (2005). Future location-based experiences. *JISC: Technology & Standards Watch*. Retrieved from: http://www.jisc.ac.uk/uploaded_documents/jisctsw_05_01.pdf

[18] Liu, T-Y, Tan, T-H, Chu, Y-L (2007, July). *2D Barcode and Augmented Reality Supported English Learning System.* Communication presented at 6th IEEE/ACIS International Conference on Computer and Information Science. Melbourne: Australia.

[19] Rikala, J., Kankaanranta, M. (2012). *The use of quick response codes in the classroom*. Retrieved from: http://www.academia.edu/2494686/The_Use_of_Quick_Response_Codes_in_the_Classroom.

[20] Lai, H-C., Chang, C-Y., Li, W-S., Fan, Y-L., Wu, Y-T. (2013). The implementation of mobile learning in outdoor education: Application of Qr codes. *British Journal of Educational Technology*, Vol. 44, 2, E57-E62. DOI: 10.1111/j.1467-8535.2012.01343.x

[21] Ceipidor, U., Marsico, M., Romano, G. (2009, June). *A Museum Mobile Game for Children Using Qr-Codes*. Communication presented at 8th International Conference on Interaction Design and Children (IDC). Milan: Italy.

[22] Robinson, J. (2011). Case Studies from Math's and Science Classrooms – Case Study 13 (Chapter 2) In Liz Kolb (Ed.). *Cell Phones in the Classroom: A practical Guide for Educators,* International Society for Technology in Education (ISTE).

[23] Wells, V. (2012). Hunting for Qr Codes: Linking Students to the Music Collection. *Music Reference Services Quarterly*, 15:3, 137-148. DOI: 10.1080/10588167.2012.700831.

[24] Susono, H. & Shimomura, T. (2006). Using Mobile Phones and Qr Codes for Formative Class Assessment. In Méndez-Vilas, A et al (eds) *Current Developments in Technology-Assisted Education. Vol. II: Tecnnological Science Education, Collaborative Learning, Knowledge Management.* Formatex: Spain.

[25] Ramsden, A. (2008) The use of Qr codes in Education: A getting started guide for academics. Working paper (Unpublished). University of Bath.

[26] Chen, N-S., Teng, C-E, Lee, C-H. (Abril, 2010). *Augmenting Paper-based Reading Activities with Mobile Technology to Enhance Reading Comprehension*. Communication presented at 6th IEEE Conference on Wireless, Mobile and Ubiquitous Technologies in Education. Taiwan.

[27] Law, C. & So, S. (2010). Qr Codes in Education. *Journal of Educational Technology Development and Exchange, 3* (1), 85-100.

[28] Kegler, J. (2012). *Geografia e novos recurso para a aprendizagem: o uso do smarth phone na sala de aula.* (submitted for evaluation at 17/09/2012). UNIFRA: Brasil.

[29] Bonifácio, V. (2012a). Qr-Coded Audio Periodic Table of Elements: A Mobile-Learning Tool. *Journal of Chemical Education,* 89, 552-554.

[30] Bonifácio, V. (2012b). Ensinar Química com telemóveis inteligentes: a tabela periódica em Códigos Qr. *Química, Sociedade Portuguesa de Química,* 127, 71-72.

[31] Naismith, L., Lonsdale, P., Vavoula, G. & Sharples, M. (2004). Literature Review in Mobile Technologies and Learning. *FutureLab Report* 11. Retrieved from: http://www2.futurelab.org.uk/resources/documents/lit_reviews/Mobile_Review.pdf.

[32] Savi, R., von Wangenheim, C., Ulbricht, V., Vanzin, T. (2010). Proposta de um modelo de avaliação de jogos educacionais. *Novas tecnologias na educação, v.*8 (3). CINTED-UFRGS.

[33] Heiman, G. (1996). *Basic Statistics for behavorial Sciences.* Boston: Hougton Mifflin Company.