

GGULIVRR: Touching Mobile and Contextual Learning

Authors

Hiram Bollaert, Artesis University College Antwerp, Belgium
hiram.bollaert@artesis.be

Justino Lorenzo, Instituto Superior Politécnico Gaya, Portugal
jml@ispgaya.pt

Philippe Possemiers, Artesis University College Antwerp, Belgium
philippe.possemiers@artesis.be

Said Trari, Artesis University College Antwerp, Belgium
said.trari@artesis.be

Tags

mobile gaming, contextual learning, social constructivism, 21st century skills

The quest of today's learning communities is to creatively uptake and embed the emerging technologies to maintain the pace of change, of learning content and platforms, while satisfying learners' needs and coping with limited resources. As information is delivered abundantly and change is constant, education focuses on driving 21st century fluency.

Project GGULIVRR, Generic Game for Ubiquitous Learning in Interactive Virtual and Real Realities, initiates the study of ubiquitous learning, investigating mobile and contextual learning, challenging small devices with sophisticated computing and networking capacities, testing the pervasive internet and exploring intelligent tags.

The goal of project GGULIVRR is to present learning communities a framework enabling learners to practice and enhance 21st century skills while generating and playing mobile contextual games.

Project GGULIVRR entices learners to get in touch. To play the contextual game one needs to physically go to a 'touchable' location, where real objects are tagged with an intelligent tag. By touching a tag one gets in touch with the contextual content. Through playing and developing GGULIVRR games one meets other gamers and developers as the project format induces interdisciplinarity, inter-social and intercultural communication and collaboration empowering local people to unlock contextual content with a minimal technical threshold.

1. Introduction

1.1 Emerging Technologies

Responding to the rapidly shifting context of higher education, learning communities are moving into flexible learning and are using more online learning (Scott, 2003). Evidence shows that these two concepts engage learners in productive learning optimizing their retention and outcomes (Foley, 2000). While education increasingly discovers relevant applications of Information and Communication Technology (ICT) and scales up the use of ICT in learning programmes, ICT evolves swiftly. Software to develop and author learning content sprout up as web services, delivery platforms shift towards mobile devices, operating systems are transiting to Android and iOS, programming tools mature to HTML 5 and so forth (Pandey, 2012).

1.2 Mobile Technology

Evidence of mobile penetration is irrefutable (Corbeil & Valdes-Corbeil, 2007). With current cell phone market targeting faster multimedia mobiles and the price drop of data trans-

fer through mobile networks, rich and interactive online learning experiences become available for everybody everywhere at all times. As mobile operators tend to increase the Average Revenue Per User (ARPU) their focus moves from voice to the increasing demand on multimedia data (Radisys Corporation, 2012). The area of entertainment is bound to become one of the future key areas for mobile operators. The new challenges of the future 4G networks allow a high rate traffic with better latency bringing a much richer experience to the users. Better Quality of Service (QoS) during the entire user mobility, roaming the network indoors and outdoors is made possible through the development of network agnostic devices. Even then, poor coverage spots are tackled by implementing a Delay Tolerant Network approach in the gaming application.

The growing number of mobile devices capable of using new Automatic Identification and Data Capture (AIDC) techniques such as Quick Response (QR) codes, Radio Frequency Identification (RFID) tags or Near Field Communication (NFC) tags promote the development of applications using this technology to link physical objects with the digital world (Vazquez-Briseno, et al, 2012).

Although focusing smart phones, any mobile device capable of connecting with a cellular network and reading NFC tags (or QR codes) is usable in this project.

1.3 Mixed Realities

Positioning intelligent tags like NFC tags or QR tags on physical objects permits linking these objects with the digital world introducing the real world environment as an intrinsic game element. This mixed reality transforms rich learning content into a rich learning context (Benford, et al, 2005). Through tangible interactions where the gamer uses his/her mobile device to read the tag by making a picture of it or by touching it, the digital content layered over the context becomes accessible to the gamer.

1.4 Intelligent tags, QR and NFC

QR tags contain a QR code or a two dimensional barcode. The main advantages of QR codes are that they are rapidly decoded and able to contain more data than conventional one dimensional barcodes. Since early in the 21st century the majority of mobile phones in use are camera phones with which one can take a picture of the QR code. Software to read and decode QR code is freely available for practically all mobile operating sys-

tems. Currently QR codes are a popular topic in both research and practical applications. Initially the information provided by QR codes was solely static showing exactly what was encoded. Already research studies the notion of contextual QR codes that merge a public QR code and private information, in order to provide data related to a particular context, time and place (Rouillard, 2008).

NFC tags establish radio communication between the tag - an unpowered chip - and the tag reader by touching them together or bringing them into close proximity making two way, reading and writing, data exchange possible. NFC has gained a lot of interest recently due to its use in mobile payments. Unlike QR tags, which require conscious actions on the part of the mobile user, NFC tags create a seamless experience between digital and physical interactions, as the mobile user only has to sweep the device over the NFC tag in order to read the information. Although NFC technology is not yet adopted mainstream in mobile devices, current releases of Android support NFC and expected is the embedding of NFC chips in Apple devices.

1.5 Gamification

Gamification is the application of game elements in nongaming situations, often to motivate or influence behavior. Companies are achieving significant results by incorporating game mechanics (Sleep, 2011) and Gartner predicts that one quarter of day-to-day business processes are likely to take advantage of some aspect of gamification by 2015 (Gartner, 2012). Education is a particular area with high potential for the application of gamification (Gibson, 2011). Unlike serious games, gamification is more about translating and transferring the knowledge about the potential of games for captivating attention, motivating to do things and coming back for more in educational settings (Buchem, 2011).

As an educational tool, gamification encourages research, inspires creativity, teaches basic principles and sharpens problem-solving skills as the spirit of competition will spur students' concentration and interest and lead to more effective learning (Educause, 2011). Gamification will be a part of students' lives for years to come and could lead to results that are especially important for developing 21st century skills (Lee & Hammer, 2011).

The use of games in the teaching-learning process has been proved to be very useful, bringing motivation to the learning process, developing skills, competences and a much faster un-

derstanding of the involved concepts (Castro Garrido, et al, 2011). The relevance and application of game based learning has grown as research shows the added values (Shiratuddin, 2011).

1.6 21st Century skills

Developments in society and economy require that educational systems equip young people with new skills and competencies, which allow them to benefit from the emerging new forms of socialization and to contribute actively to economic development under a system where the main asset is knowledge. These skills and competencies are often referred to as 21st century skills and competencies, to indicate that they are more related to the needs of the emerging models of economic and social development than with those of the past century, which were suited to an industrial mode of production (Ananiadou & Claro, 2009).

Today's learning communities are demanded to prepare learners to be efficient time managers, sound team players, innovative thinkers, empathetic employees, inquisitive investigators, collaborative creators, effective communicators, creative designers and productive project completers (Wiscount, 2012) apart from teaching core subjects.

Creating a 21st century education system requires broad and intensive use of technology and a strong technology infrastructure (Setda, 2007). Originated from the opportunities offered by emerging technologies, among which mobile technologies, project GGULIVRR explores the application of these technologies in education. Project GGULIVRR endeavours the development of proficiency in the 21st century skills through the creation and use of mobile and contextual educational games.

2. Concept GGULIVRR

2.1 Description

The search for a framework in which participants are enabled to work on their 21st century skills in a social constructivist setting, holistically combining the principles of gamification, contextual learning and mixed realities, resulted in project GGULIVRR wherein is being developed a Generic Game for Ubiquitous Learning in Interacting Virtual and Real Realities.

Four major parts are distinguishable in GGULIVRR: the game-player, the game-cloud, the game-editor and the game-script.

The game-player is a cross-platform mobile client (at the moment only for iOS), handling the gaming, following the thread of the game. The software translates the readings of the tags, communicates with the database, responds to input from the user and delivers multimedia content. The game-cloud is a web-based Learning Management System (LMS) controlling several underlying systems. The user management system deals with the user accounts and their profiles. The built-in scoring system keeps track of the gaming so users can review and compare their gaming results. A rating system promotes the best games and the best players to the top of the list. A content management system takes care of the multimedia game resources. The game-cloud also includes communication and collaboration tools like messaging and forums. An important inclusion of the cloud is the game-editor or scripting-engine which incorporates a set of tools enabling non-technical skilled users to create, edit and author new games. These games exist of content and gaming rules combined in a game-script.

As GGULIVRR thrives on user generated content, the used software should be open-source empowering users to enhance and improve its functionality.

2.2 Generic game

In a game rules, actions and conditions are triggered by the input of the gamer or the identification of tangible and tagged objects by reading their intelligent tag. As a result the gamer is presented with virtual multimedia content or interaction. The generic structure of the game, using scripting to code the major functionalities of the game, enables non-technical skilled people to construct a new game stories with conditional rules. The infrastructure of the game editor and the scripting language should be extensible allowing more technically skilled users to add suitable functionality.

2.3 Interacting virtual and real realities

The gamer must interact with the real environment and read the intelligent tag of a tangible object to cause a communication with the database which will link the object's identification to a specific game action, for example, to play the voice of a game character. A great deal of these game actions demand the gamer to interact through choosing an onscreen option or giving an answer to a question in order to proceed the game.

2.4 Ubiquitous learning

Each GGULIVRR game should have to goal to persuade people into exploring new places, to get immersed in the context, have fun and learn. The use of pervasive technologies and networking and the challenge of the game plunges the gamer in an informal learning process linking learning content with the real world.

The creation of a game offers new educational opportunities bringing diverse people in close connection to each other and specific contexts. As development of a new game implies an interdisciplinary approach, the diversity of the collaborators becomes an educational resource. And of course, teams must explore the context giving way for situated learning.

2.5 Scenario

This scenario describes GGULIVRR in four parts. The first part tells a story of a person choosing a GGULIVRR game in a specific location. The second part sketches how the game was created. The third part briefly illustrates the rich context and the fourth part shows a specific function of the networked game-clouds.

On my way from Helsinki airport to the hotel I noticed the GGULIVRR logo on passing by the Sibelius Park and I decided to skip a few hours of conference presentations to check out which games I could play. The next day I touched the intelligent tag with the GGULIVRR logo at the entrance of the park in the district of Töölö with my smartphone and was immediately welcomed by the voice of Bengt Schalin through my earplug. While a list of choices appears on the screen of my device, Bengt welcomes me and introduces himself as the City Gardener for Helsinki in 1946-1957, responsible for designing parks. Bengt explains the list of options on my screen, representing the different GGULIVRR games available in this district. Among the options are 'The Land of Kalevala', 'The White Independence', 'Hidden City' and 'The Bohnhof Legacy'. In 'The Land of Kalevala' it is Seppo Ilmarinen, the eternal designer, smith and inventor in the Finnish Kalevala mythology who will take the gamer on a trip around Helsinki to retrieve the stolen Sampo, a magical artifact. During this search the gamer learns more about basic design principles and Finnish design. With 'The White Independence' the gamer finds himself/herself at the side of Jean Sibelius, the famous Finnish composer, who is in the midst of composing the Jäger March. The gamer must help Jean Sibelius collecting the words of the Finnish Jäger which are being smuggled into Finland. Throughout this search in the streets of

Helsinki, the gamer meets the 'Whites' fighting for independence against the 'Reds'. Since the 1960s, the city of Helsinki utilizes widely the opportunities of underground construction and 'Hidden City' is a game in which Helsingin takes the gamer to the underground city evaluating suggested purposes for yet unnamed rock resources. In this game the gamer learns about the strategic underground city plan, sustainable development and sound planning of land-use within the area's red and black granite. Proudly Bengt announces that he will accompany me during 'The Bohnhof Legacy' which leads the gamer along parks and other green areas which represent one third of the city. Bengt says that he will train me to be more perceptive noticing the different forms the terrain can take whilst narrating about how Christian Bohnhof, imperial gardener and gardener of the large private gardens of the Sinebrychoff family, achieved to create expansive flowerbeds and enjoyed the beer of the Sinebrychoff brewery. It is no coincidence that Bengt suggest these games as the underlying software checks my GGULIVRR profile for my interests. As I choose 'Hidden City', Bengt wishes me success and a new voice introduces herself as Helsingin. While she starts explaining me the challenge of the game, onscreen information appears leading me to the next tag where the game will start.

Only a year ago several students of very different disciplines worked together for the creation of 'Hidden City', the newest GGULIVRR game in Helsinki. In collaboration with the city services and town planning interdisciplinary groups of students of several grades created, collected and assembled the content for this game. As GGULIVRR is a generic system it took the students of applied informatics little time to figure out all the different ways to imbed interactivity into the game. They even created new functionality. Art students provided the images used in the game. They searched for pictures of old and new underground facilities, digitized them and made them more vivid. They also succeeded in getting some famous voices in front of the microphone. In this way several characters in this game, among which is Helsingin and a cranky mole, received their voices. Languages students translates material into English and lower grade students worked together with the maintenance services to install the intelligent tags all around the public underground projects. Several researchers study the planning of the underground projects of facilities, traffic and maintenance tunnels and their findings illustrate the theory of sustainable development. University college students used these materials to create the game which challenges the gamer to find the optimal layout of the hidden city.

GGULIVRR uses a mix of the real reality with a virtual one. During the game, gamers use their mobile devices to hear recordings, to watch pictures or movies and to interact. The mobile devices enable the user through touching intelligent tags to experience virtual information. After touching the tag of the entrance of a public facility, the user can (for example) see how the inside of the facility looks like and communicate with the virtual architect.

As ratings on the GGULIVRR website show, 'Hidden City' is clearly a popular game in Helsinki. And there appears to be a competition with a similar game 'Fiery Naples' in Naples Italy.

3. Features

3.1 Learning Community

The GGULIVRR cloud is a virtual space for a growing learning community. People are invited to log in and participate in the playing of GGULIVRR games, commenting and reviewing these games, meeting other gamers and game builders. Although similar development projects can be found, GGULIVRRs uniqueness lies in the engagement to induce interdisciplinary, inter-social and intercultural communication and collaboration.

The enticing games, the competition, the low threshold building tools motivate and empower gamers to create new games. The creation of a new GGULIVRR game implies that one needs to explore the context, communicate and collaborate in the search for content, resources and different kinds of expertise. The impact of the building process influences a larger community. As such the project develops and implements technology to effectively facilitate and enable the practise of the 21st Century skills.

3.2 Voice-over

The purpose of the game is to explore an area, hence the senses of the gamer must be focused on his/her surroundings. On screen information is therefore mostly limited to buttons with which the gamer can choose an option or an answer a multiple choice question. If needed fill-in boxes, to type in an answer, or more graphical information as pictures or movies can be shown. It is far more comfortable for the gamer to receive information by audio. The human voice is less demanding than music and can be sampled at a small bit-rate to maintain a good quality. This mono audio accompanied by the data to generate the on-screen buttons uses a fairly small bandwidth and this makes it more easy to deliver a consistent experience to gamers in an

inherently inconsistent environment where cell phone signals tend to rise and fall.

3.3 Positioning through intelligent tags

While the gamer is exploring a GGULIVRR activated area, it is important to record the physical whereabouts of the gamer. A possible solution is the use of supported technologies like the Global Positioning System (GPS) or wireless local area network (WiFi). GPS has limited or no indoor coverage and WiFi signal propagation outdoors is very complex, both provide weak accuracy. A possible solution, making the game experience independent of the described constraints is to develop an architecture supporting the use of intelligent tags. The use of NFC as well as QR to localize one's position in the real world is explored by several authors (Siira, et al, 2009; Ozdenizci, et al, 2011) and is relatively easy to implement. Each time a gamer touches an intelligent tag, the cloud records the tag identification which refers to a certain location. From that point the cloud can push the gamer directions to the next tag. In between tags the cloud loses track of the gamer. In case the gamer has gone astray he or she can make use of other devices or just ask and use this opportunity to get in touch with local people.

3.4 Focus on NFC

Although NFC and QR are both equally usable for this project, NFC is significantly more robust and offers more future opportunities. The NFC data can be secured, the NFC can trigger Bluetooth or WiFi connections, the NFC can provide network authentication, the NFC can be used for ticketing, and so on. Some implications of these features are that the gamer can easily switch to alternative networks and can win commercial coupons.

4. Architecture

Currently the client-server architecture for classic Internet games depends on the client device for storage and computation. This is not feasible when the client device is a much less powerful mobile device. The cloud computing approach, in which computing and storage is delivered as a service, is certainly the best solution for the proposed project.

To implement a game system as proposed in this paper, we use several open-source techniques. Taking into account the fact that two operating systems (iOS and Android) dominate the mobile ecosystem and the fact that we want to minimize de-

velopment time, we would like to propose a generic system to eliminate the need for designing two user interfaces. Also, to enhance the responsiveness and robustness of the game system we want to propose techniques to make sure that the absence of an internet connection does not hinder the game. To allow for easy scripting of the game rules, an embedded instance of the Ruby language (Ruby, 2012) is used.

The game system consists of several components. A web-service and master database that contains all information for the game (user accounts, HTML content, multimedia files, tag information, scores, ...) and the Ruby code that implements the game rules. Secondly, a mobile client that has its own local database. This client replicates continuously parts of the master database information so the gamer can start instantly without waiting for this process and during the play the local database is used as buffer in case of connection failure. The client also presents the game UI and multimedia files and interprets the game rules.

4.1 HTML Content

For the client app, a framework is developed in iOS and Android that uses HTML as mark-up language for the user interface. In iOS there is a UI component called `UIWebView`, while Android has `WebView`. Both components act like a full-fledged browser with support for all mime types and they even have a built-in Javascript engine. This way, plain HTML can transparently function as the UI. In the database, the HTML snippets are stored inside JSON documents together with their attachments. These attachments can be anything a browser understands (pictures, sounds, movie clips, etc...).

The use of HTML has following advantages. The interface design only has to be done once for all platforms. The game designer does not have to have special technical skills, UI development can be done in a simple HTML editor. Through the use of HTML forms, the application posts everything to the REST API of the local CouchDB (The Apache Software Foundation, 2012) instance. This way, generic JSON documents can be generated with all the values that the user has filled in. And style sheets can change the look and feel and even the behavior of the UI quickly and efficiently.

When the client reads the code, the HTML and attachments are retrieved from the JSON document and shown in the UI of the mobile device. The open-source ZBar library (ZBar, 2011), available on iOS and Android for reading the QR codes, is used.

4.2 CouchDB

For the web-service component and the local client database, we have chosen Apache CouchDB. This new database application is a noSQL (Wikipedia NoSQL, 2012)), scheme-less, document-oriented database that exposes all operations through a RESTful web-service (Wikipedia REST, 2012). The format of the records is JSON (Wikipedia, JSON, 2012). The database also has strong support for replication and last but not least can be run on iOS as well as Android.

By using CouchDB, we get following important advantages. Through the replication features, we can transparently and continuously sync the latest game information with the CouchDB instance on the mobile device. Once the information is synced, the game can be played without an internet connection since everything now resides in the database instance on the mobile device (Couchbase Blog, 2011). All values posted by the user can be aggregated in a JSON document and replicated to the master database once an internet connection is available. Network latencies are eliminated since all information comes from the local database. And there is no need to write a separate web-service layer, since CouchDB has a built-in webservice API.

4.3 Embedded Ruby

To allow game developers to script rules, we have embedded version 1.8.7 of the Ruby language. Since this is a script language, all code can be stored in the database, downloaded and interpreted on the client.

Using the embedded script engine, the game developer can steer the game in different directions, depending on the correctness of the given answers. Questions that follow can even be completely rewritten by flexible routines implemented in an easy and dynamic language. Predefined game and question classes will be provided in the framework so that they can be extended and / or modified. This will allow the game rules to be implemented in an object-oriented way without requiring the game maker to learn a complex API. Whenever the script is changed on the server side, it will be synced transparently to the client and the new rules will be implemented from that moment on. This allows for very great flexibility.

4.4 Network Access

An important challenge is to develop a solution supporting an ubiquitous access with a network failure tolerance. In order to

enrich the experience of m-learning the exchange of the needed contents and data should be done efficiently. Allow for networks to fail while continuously generating traffic for the local database to be up to date, has proved to be thorny issue for the development team. There could be several scenarios for developing the platform: the 'always connected' approach and a network failure tolerant solution. The first approach is a common answer to the problem, used in several gaming systems, supported by bi-directional traffic interchanged between the mobile device and the game server. Even in the actual state of development of the network technologies (e.g. 4G, WiFi, etc.) these solutions suffer from several network disruption along with different data rates, latency and bandwidth allocation. All of those referred issues compromise the gaming experience. Therefore the team works towards a system that includes a network failure tolerance. The broad range of mobile devices, with different architectures and a heterogeneous communications technologies access, from Bluetooth, NFC, WiFi, and 4G radio interfaces may also suggest to adopt Delay Tolerant Network (DTN) architecture on these devices, in addition to the usual TCP/IP protocol stack.

The DTN approach, manages to divide each end-to-end communication path, into several smaller paths. The communication is divided into hop-by-hop sessions and provides an asynchronous data delivery over physical, delayed or discontinuous network coverage. Several proposals are presented in R&D (Ochiai, et al, 2010).

5. Business Plan

The objective is to create a GGULIVRR community and to provide the software for free in order to invite people to use GGULIVRR and to increase rapidly the number of users. The business model is based on four activities: development, training and maintenance, advertisement and GGULIVRR derivatives. Those four activities will create revenues.

Activity 1: development

- Description: developing games, educational courses, guided tours,.. for third parties.
- Target group: museums, art galleries, cities and local authorities, zoos,...
- Earnings model: a development fee for a complete package. The fee will be determined by the size and the complexity of the job.

Activity 2: training and maintenance

- Description: Training: providing our knowledge for training on how to make a game, assisting in game creation, ...; Maintenance for existing games: it is possible that once a game has been created, the customer needs to make adjustments (removals, additions or updates).
- Target group: Training: individuals and companies; Maintenance: same target group as the development activity.
- Earnings model: Training: fee per hour, day or project; Maintenance: fee per period or intervention fee.

Activity 3: advertisement

- Description: the idea is to incorporate companies into the GGULIVRR community. This can be done by adding advertisement for specific companies in the game. The gamer is informed of a sales opportunity after reading a specific tag near a specific shop.
- Target group: companies (operating in a wide range of economic sectors).
- Earnings model: advertisement fee.
- Example: A supermarket brand could decide to build a GGULIVRR game in their stores providing customers with dinner ideas according to budget and seasonal products.

Activity 4: GGULIVRR derivatives

- Description: creation of specific apps based on GGULIVRR.
- Target group: individuals
- Earnings model: fee per app
- Example: An industry could decide on the build of a GGULIVRR located in a certain production plant for safety training purposes. Through the use of specific NFC tags and security add-ons, the game can be used as an assessment tool.

We can manage the complexity of the service, games,... we want to sell. It depends on the availability of resources (human, time,...). Development will be very important in the beginning. We need development in order to promote GGULIVRR and to create a GGULIVRR community. Both elements are crucial in order to persuade companies to use GGULIVRR technology and thus creating income. On short term we need to focus on development, creation and expansion of the GGULIVRR community. On long term we need to focus on advertisement.

6. Conclusion

The development of GGULIVRR is an ongoing process. A small but fierce technical team succeeded in presenting a proof of concept on iOS as well as Android and is currently working on implementing more functionality into the game system. GGULIVRR is an appealing example of mobile and contextual learning inspiring lecturers and students of different disciplines. The Applied Informatics programme has incorporated the development for mobile platforms. Students in this program are challenged to solve small problems that surface during the development of GGULIVRR. And an Erasmus Intensive Programme (IP) (part of the European Life Long Learning Programmes), MAD (<http://www.mad-ip.eu/>), has taken place in which an international group of students created simple games for mobile devices. The Teacher Training programme is reviewing the opportunities of mobile and contextual learning. Students in this programme are given to task to come up several scenarios for mobile and contextual learning. One scenario resulted in a useful contextual mobile game combining mathematica, history and a specific part of Antwerp. Within their final project students, from different programmes have delivered various results: a GGULIVRR infographic; a Flash and a Drupal website.

While writing this document the GGULIVRR team awaits the approval of 2 new projects. A small research project focusing on the newly added. This will enable the team to spread the GGULIVRR concept over the business management programme. With this project an new IP, WalkAbout. During this IP students from six different European University Colleges will assemble in interdisciplinary groups to explore mobile and contextual learning while creating games using the developed game system. This collaboration will generate a list of flaws, strengths and desired functionalities which will be used to enhance the game system. During the second year of the IP this sequence will be repeated and the third year will see the release of an open beta version of the game system along with a website publishing the realized games and tutorials on how to use the game system.

As such the GGULIVRR concept gives us the opportunity to get in touch with mobile and contextual learning, new technologies and new applications, allowing us to advance the mission and vision of our educational programmes.

References

- Ananiadou, K., & Claro, M.** (2009, 12 18). 21st Century Skills and Competences for New Millennium Learners in OECD Countries. Retrieved 5 25, 2012, from: http://www.oecd-ilibrary.org/education/21st-century-skills-and-competences-for-new-millennium-learners-in-oecd-countries_218525261154
- Benford, S., Magerkurth, C., & Ljungstrand, P.** (2005, 3). COMMUNICATIONS OF THE ACM. Retrieved 5 25, 2012, from: <http://www.crg.cs.nott.ac.uk/~sdb/research/downloadable%20papers/pervasive-gaming-overview.pdf>
- Buchem, I.** (2011, 12 30). Gamification in Education 2012. Retrieved 5 25, 2012, from: <http://ibuchem.wordpress.com/2011/12/30/gamification-in-education-2012/>
- Castro Garrido, P., Matas Miraz, G., Luque Ruiz, I., & Gómez-Nieto, M.** (2011). Use of NFC-based Pervasive Games for Encouraging Learning and Student Motivation. Third International Workshop on Near Field Communication, (pp. 32-37). Hageberg, Austria.
- Corbeil, J. R., & Valdes-Corbeil, M. E.** (2007). Are You Ready for Mobile Learning? Retrieved 5 25, 2012, from: <http://www.educause.edu/EDUCAUSE+Quarterly/EDUCAUSEQuarterlyMagazineVolum/AreYouReadyforMobileLearning/157455>
- Couchbase Blog.** (2011, 5 2). Mobile Couchbase for iOS Beta. Retrieved 5 25, 2012, from www.couchbase.com: <http://blog.couchbase.com/mobile-couchbase-ios-beta>
- Educause** (2011). 7 Things You Should Know About Gamification. Retrieved 5 25, 2012, from: <http://net.educause.edu/ir/library/pdf/ELI7075.pdf>
- Foley, G. e.** (2000). Understanding Adult Education and Training. St. Leonards, New South Wales Australia: Allen & Unwin.
- Gartner** (2012, 2 6). Gartner Says Organizational Politics Will Prevent at Least One-Third of BPM Efforts Through 2016. Retrieved 5 25, 2012, from: <http://www.gartner.com/it/page.jsp?id=1914714>
- Gibson, R.** (2011, 7 12). Show gamification some love. Retrieved 5 25, 2012, from: <http://www.develop-online.net/blog/197/Show-gamification-some-love>
- Lee, J., & Hammer, J.** (2011). Gamification in Education: What, How, Why Bother? Retrieved 5 25, 2012, from: <http://www.gamifyingeducation.org/files/Lee-Hammer-AEQ-2011.pdf>
- Ochiai, H., Shimotada, K., & Esaki, H.** (2010). DTIPN: Delay Tolerant IP Networking for Opportunistic. The Second ACM International Workshop on Mobile Opportunistic Networking. Pisa, Italy.
- Ozdenizci, B., Kerem, O., Coskun, V., & Aydin, M. N.** (2011). Development of an Indoor Navigation System Using NFC

Technology, Information and Computing (ICIC), 2011 Fourth International Conference on, (pp. 11-14). Phuket Island.

Pandey, V. (2012, 3 28). Emerging technologies & challenges in e-Learning content creation: Global resourcing to rescue. Retrieved 5 25, 2012, from: <http://www.gc-solutions.net/blog/emerging-technologies-manpower-challenges-in-e-learning-content-creation-global-resourcing-to-rescue/>

Radisys Corporation (2012, 2 22). Mobile Operator Survey: Increase in Data-Hungry Devices Set to Be Most Disruptive Force, but Driving Revenues Still the Biggest Challenge. Retrieved 5 25, 2012, from: <http://www.businesswire.com/news/home/20120222005499/en/Mobile-Operator-Survey-Increase-Data-Hungry-Devices-Set>

Rouillard, J. (2008, 7 27). Contextual QR Codes. Retrieved 5 25, 2012, from: <http://qrcodethursday.wordpress.com/bibliographies/%E2%80%9Ccontextual-qr-codes%E2%80%9D-rouillard/>

Ruby. (2012). Ruby, A Programmer's Best Friend. Retrieved 5 25, 2012, from: <http://www.ruby-lang.org/en/>

Scott, G. (2003). Effective Change Management in Higher Education. Retrieved 5 25, 2012, from: <http://www.educause.edu/EDUCAUSE+Review/EDUCAUSEReviewMagazineVolume38/EffectiveChangeManagementinHig/157869>

Setda. (2007). Maximizing the Impact: "The Pivotal Role of Technology in a 21st Century Education System". Retrieved 5 25, 2012, from: http://www.setda.org/c/journal_articles/view_article_content?groupId=2422&articleId=437&version=1.0&p_l_id=PUB.1.131

Shiratudin, M. F. (2011). Integrating computer game-based learning into construction education. Information Technology and Multimedia (ICIM), (pp. 1-6). Kuala Lumpur.

Siira, E., Tuikka, T., & Törmänen, V. (2009). Location-Based Mobile Wiki Using NFC Tag Infrastructure. NFC '09 Proceedings

of the 2009 First International Workshop on Near Field Communication (pp. 56-60). IEEE Computer Society Washington, DC, USA.

Sleep, D. (2011, 9 27). More than a game. Retrieved 5 25, 2012, from: <http://www.research-live.com/features/more-than-a-game/4006083.article>

The Apache Software Foundation. (2012). CouchDB, A Database for the Web. Retrieved 5 25, 2012, from: <http://couchdb.apache.org/>

Vazquez-Briseno, M., Hirata, F. I., Sanchez-Lopez, J., Jimenez-Garcia, E., Navarro-Cota, C., & Nieto-Hipolito, J. I. (2012). Using RFID/NFC and QR-Code in Mobile Phones to Link the Physical and the Digital World. Retrieved 5 25, 2012, from: <http://www.intechopen.com/books/interactive-multimedia/using-rfid-nfc-and-qr-code-in-mobile-phones-to-link-the-physical-and-the-digital-world>

Wikipedia NoSQL. (2012, 5 25). NoSQL. Retrieved 5 25, 2012, from: <http://en.wikipedia.org/wiki/NoSQL>

Wikipedia REST. (2012, 5 22). Representational state transfer. Retrieved 5 12, 2012, from: http://en.wikipedia.org/wiki/Representational_state_transfer

Wikipedia, JSON. (2012, 5 20). JSON. Retrieved 5 25, 2012, from: <http://en.wikipedia.org/wiki/JSON>

Wiscount, M. (2012, 4 4). Guest post: 21st Century Skills a Must-Do in 21st Century Instruction. Retrieved 5 25, 2012, from: <http://blogs.msdn.com/b/teachertech/archive/2012/04/04/guest-post-21st-century-skills-a-must-do-in-21st-century-instruction.aspx>

ZBar. (2011, 7 15). ZBar bar code reader. Retrieved 5 25, 2012, from: <http://zbar.sourceforge.net/>

Edition and production

Name of the publication: eLearning Papers

ISSN: 1887-1542

Publisher: elearningeuropa.info

Edited by: P.A.U. Education, S.L.

Postal address: c/Muntaner 262, 3r, 08021 Barcelona (Spain)

Phone: +34 933 670 400

Email: editorial@elearningeuropa.info

Internet: www.elearningpapers.eu

Copyrights

The texts published in this journal, unless otherwise indicated, are subject to a Creative Commons Attribution-Noncommercial-NoDerivativeWorks 3.0 Unported licence. They may be copied, distributed and broadcast provided that the author and the e-journal that publishes them, eLearning Papers, are cited. Commercial use and derivative works are not permitted. The full licence can be consulted on <http://creativecommons.org/licenses/by-nc-nd/3.0/>

