Interactive Learning Panels

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Abstract. New sensing technologies, as RFID readers, are being incorporated into mobile devices to provide users with new interaction experiences. And, the combinations of these new technologies open up new challenging application scenarios. One of the areas that could exploit this potential is the design of interactive solutions for context-aware applications applied to learning environments. This article describes an m-learning environment that is enriched with new interaction features that are, or may, be provided by actual or future mobile device technologies. The proposed gesture based interface allows users to relate ideas and concepts through the improvement of traditional methods. This environment is based on the reuse of existent physical resources, such as the learning panels used in school classes. For instance maps, historical posters, timelines, and so on. These panels are improved with the low cost and widely used RFID technology that enables students to interact with them through mobile devices, encouraging the interest the students applying the constructivist education theory.

Keywords: HCI, RFID technology, mobile devices, context awareness, collaborative environment, m-learning, social software.

1 Introduction

The application of computing technologies on education starts almost simultaneously to the beginning of computing science itself improving education methods, either formal or informal, and educational mediums, such as online, in-situ or blended.

Substantial achievements in this field include: the introduction of new multimedia infrastructure into schools and colleges, such as personal computers connected to the Internet, and the development of new educational software that improve student learning through imaginative software.

Nowadays mobile technologies are an essential part of our lives. Teachers, students, workers, and so on are familiarized with this technology using it everywhere anytime.

Main advantage of mobile computing is the provision of a communication link not only to people but to computing systems to access or store information. Even more mobile devices also provide users with the ability to take photographs; write ideas, record out thoughts on voice and video, etc. Consequently, the combination of these powerful characteristics this information can be shared among friends, colleagues, teachers, co-workers, companies or the whole world.

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New developments in mobile phone technologies are not only offering rich multimedia experiences to the users, but the possibility to implement new applications that exploits the physical environment of the users; for instance, GPS, accelerometers and RFID technologies among many other.

The application of mobile technologies to the learning process is basically named mobile learning. So, from a pedagogical perspective, mobile learning provides a whole new dimension to support either traditional or novel educational processes. Some characteristics of this type of applications described in [1] include: the urgency of learning need, the initiative of knowledge acquisition, the mobility of learning setting, the interactivity of the learning process, the "Situatedness" of instructional activities and the integration of instructional content.

These characteristics make mobile learning quite different compared to traditional classroom learning environment, where all the educational activities are carried out at a designated time and place. Although the use of laptops extends the range of education to places where wired connections are available; mobile technologies go beyond wires and take education possibilities to places where wireless connection is feasible.

Another issue to take into account is the adaptation of mobile technology to contextual life-long learning, which is defined as the knowledge and skills people need to prosper throughout their lifetime. These activities are not confined to scheduled times and places as traditional education requires that are so difficult to achieve when people finishes formal learning.

Thus, mobile technologies become a powerful tool to support contextual life-long learning, by being highly portable, individual, unobtrusive, adaptable to the context of learning, the learner's evolving skills and knowledge [2].

Our proposal can be seen as an interaction improvement to m-learning systems inheriting m-learning advantages, as long-life learning is.

So, mobile learning frees users from being anchored to a specific space, providing the possibility to explore the environment and interact with the world outside the desktop. This is an interesting point to highlight because it restricts student explorations to a fixed place limiting one of the most meaningful ways of building knowledge from a constructivist point of view that encourages the idea of discover to learn.

Therefore, the main idea of this proposal is a novel interaction way where users are able to interact with the environment to build knowledge from relationships acquired from the ambient.

There are many ways of building these relationships, in this paper we present a new device called the "Interactive Learning Panel" where students relate information that is presented by the mobile application to a physical region of a panel. It is based on the idea of relating concepts with lines, or multiple choice questionnaires.

Concretely, we have implemented a PDA web based application where users have to relate a flag to a region on a map. For instance, if a flag is given on the PDA screen, students have to relate it to the country depicted on the map and vice-versa.

These panels are equipped with RFID tags that represent concepts on the panel and the PDA is equipped with a RFID reader that is able to read these tags and detect how user relate these concepts through their readings. So, to relate the concepts exposed in the PDA screen to those on the panel, users have to put the reader (mobile device) over the graphical representation in the panel.

The structure of the article is organized as follows. In Section 2 we present the informal learning concept that is the learning theory foundation of this approach, and then in Section 3 we perform a review to the most related informal learning applications in the field. Section 4 presents the most relevant functional and technological aspects of "Interactive Learning Panels". Then, in Section 5 a case of study where we expose a fully functional application applying these technologies. Finally on Section 6 we present conclusions and future work.

2 Formal and Informal Learning

Combs in [3] defines informal learning as "the spontaneous, unstructured learning that goes on daily in the home and neighborhood, behind the school and on the play field, in the workplace, library and museum, and through the various mass media, informal learning is by far the most prevalent from of adult learning".

As principal features we can mention that it has no place in education to be carried out in normal life or professional practice. There is no curriculum and is not organized professionally instead, originates accidentally, sporadically, and sometimes, depending on the requirements of practical situations. Besides, it is not systematically planned pedagogically according to unconsciously, related to problems in a holistic manner, and related to the situations management. And it is directly experienced in his "natural" role as a tool to live and survive.

The concept of informal learning, as used by Dewey in an initial stage and then by Knowles, has experienced a renaissance, especially in the context of development policies. At first, informal learning was bounded on formal school and non-formal learning in courses [3]. From organizational informal learning processes are not formally organized and are not funded institutions [4]. A broader approach is that of Livingstone which is geared towards learning and self-directed and self emphasizes self of the process by the student [5].

The form of learning from people in their informal work is 80%. The workers learn a lot more than look to others, trial and error, asking colleagues for help that formal training.

However, defining informal learning is not so simple and is subject of an ongoing debate [6, 7, 8 and 9].

A complete vision is presented in [9] and suggests that informal learning should be defined as a learning process that occurs independently and casually without being tied to a directive or instructive curriculum by presenting a typology. Thus in the intentional informal learning, learning goals and process are explicitly defined by the teacher or the institution. And the learner is the one who defined the goals and the process of the intentional informal learning. On the other hand, in the unintended informal learning targets are not defined beforehand, and there is no prescribed learning process, but can be developed at runtime when a learning occasion arises.

There are also hybrid types of learning, such as museums and schools. Although the case study presented in this article is suited to formal learning, it is not limited to it.

As reader may have noticed, panels can be placed almost anywhere, for instance bus stops, train stations, museums, libraries, town halls, schools, etc., leading to a every time – everywhere learning environment.

We have to highlight the fact that in this article we present a new way of interaction to learn, not the learning method itself. Besides, this interaction capability can be applied in both formal and informal education seemingly.

3 Learning Using Digital Technologies in Museums, Science Centers and Galleries

This section describes the most relevant aspects of m-learning as part of learning in general.

In this case, we relied on the report by Roy Hawkey, from King's Collage of London. This report describes the experiences in the field of education at the scene, inside museums, science centers and galleries.

The goal of this section goal is to show that we can relate ubiquitous computing concepts, through context awareness (mainly location awareness), to the learning activity. Moreover, our intent is to provide specific points of contact on this domain and the collaborative learning networks.

3.1 On-Site Learning

The work presented in [10] indicates that there are two types of exhibits, static and dynamic. The later one is divided into three categories: automatic, operational and interactive. According to this classification, this approach suits into the dynamic-interactive category. On the other hand, [11] makes a distinction between exhibit (broadcasts facts) and informal learning. Main difference is the support level of personal interaction among users involved in the system. Participation is an important point in all kinds of social activities. Examples of different types of participation can be observed in: The "In Touch" that allows visitors to create their own page and access it after the visit, or at "Bristol, get connected" where visitors can compare their ideas in a variety of topics. Another example is the "Victoria and Albert Museum" that allows students to create their own digital images. And finally, the "Wish you were here" where visitors can use a digital camera and an editing program to create postcards.

The collaboration is an important aspect related to education. The article [12] reveals that there are manly three ways of collaboration in these scenarios: real collaboration between learners (now present in an exhibition), virtual students (online) and in 3D virtual reality environment. Among the most prominent examples are: the "STEM project" [13] promotes the publication of ideas on the part of museum visitors physical or virtual, in an educational use of the National Museum of Science and Industry on the Web [14], and the "Keystone online project" of Franklin Institute, in which the activity-based research and professional development opportunities are combined into a Web site devoted to facilitating the teaching of science-based research.

Our approach is based on real collaboration through the Web. Students are able collaborate with their teachers to check practices and even see exam corrections by email automatically. Even more, from this point of view, students are collaborating with their environment. In a producer-consumer scenario, panels play the role of information producers; and students play the role of information consumers.

3.2 Personalization and Mobility

Flexibility is crucial for students to pursue their own paths and can do so in their times.

In [2] they have developed the theory of long-life learning through mobile devices such as PDAs and others, considering the hardware, software, communications and the interface design. Among the features of these systems we can mention:

- The high portability and availability to anyone who wants to learn.
- They should be individually adapted to the learners' abilities, knowledge and learning styles; and designed to withstand the personal learning, instead of the general office work.
- They should be not obstructive, so that we can capture the apprentice situation and retrieve knowledge that the technology clogging the situation.
- They should be available on either side, to allow communication between teachers, experts and peers.
- They should cater the evolution of knowledge and skills of the apprentice.
- They should be able to manage learning over time, in this way the apprentice accumulates resources and knowledge that will be immediately accessible despite changes in technology. For instance, reference work.
- They should be intuitive for people who are inexperienced with the technology.

The Sparacino article [15] describes a study in the MIT Museum, more specifically in the exhibit "Robots and Beyond" where the system tries to "understand the use and produce an output based on the interpretation of the user context intention". To do so, it is based on the behavior (places time, visited objects, etc.). On the other hand, the project "The Electronic Guidebook" at the Exploratorium in San Francisco makes effective use of the PDA to make "Bookmarks" materials and then visit them [16]

One negative aspect appears in two dimensions, mechanical and cognitive skills. The need to hold the device reduces the activities related with their hands while reading the conversation inhibited demand. The article viewpoint [17] describes the "investigation nomadic" in which the trainees can manipulate the information and conduct research while moving the physical exhibits. In this learning type, is threatening to replace the Excel interaction with gestures "mediated talks with others and cognitively challenging". Discarding this, which requires a careful design of instruction, trainees may benefit from their mobility within a context of physical objects and without feeling exhibits socially or physically isolated.

There are many alternatives of applying this approach. The case study set in this paper is about evaluation. However, the same idea can be applied to retrieve information that may be hidden at first sight. It provides users with the ability to explore information through a learning panel just by going over the panel with the mobile device. For instance, students can easily explore the panel surface discovering or augmenting information that may not fully available for physical space.

4 ILP Interactive Learning Panels

This section will explain the implementation details of the system. This description starts with a conceptual description of how the system works, it continues with the software system architecture, then it explains the interaction model it was employed, and finally it presents the interface design that has been followed to model the interaction.

4.1 Conceptual Description

The System is based on three key elements: the panel, the mobile device and the service provider. The panel acts as a medium to interact between the user and the system. Basically it defines "hot spots" where: commands can be selected from the panel just by the gesture of putting the device near a "hot spot". For example, in a questionnaire, this gesture may be used to select an answer for a question, to go to the next question, go back to the previous one, to end the questionnaire and so on. On the other hand, the mobile device is a tool that enables users to interact with the panel and perform tasks according to the user behavior. It provides the physical link between a physical representation (in the panel) and information received from service provider. Thus, the service provider: It is responsible for interpreting information of the user (acquired through the mobile device) and the information store into the database system.

Although the system can be easily extended, it supports the recovery and playback of multimedia content (audio, text, video, etc.). It also supports a learning specific application, the questionnaire. This tool asks users about information that is represented into the panel, and they have to answer pointing the right graphical representation on the panel. For instance, if users are asked about which region on the map is related to a defined flag, they have to point the region on the map to answer that question. The application will be exposed in detail on Section 5.

4.2 System Architecture

Users receive multimedia content on their mobile device through a Web based architecture. As explained on Fig. 1, in a first step, the user perform a simple gesture of bringing their mobile device to the panel, exciting, through the mobile device RFID reader magnetic field, any tag deployed on the reverse of the panel. This action results on the retrieval of the tag unique identifier. Immediately afterwards, the mobile device sends this identifier to the Web server. The server processes this request interpreting this identifier as a command, and generates a response to the action. The

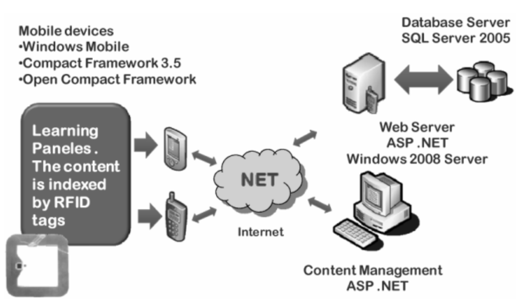


Fig. 1. System Architecture

answer may result on a resource transfer (video, photography, audio, text, etc.) or information, stored in the database system (for example, the result of a question). Thus, users finally perceive on their mobile devices the result of the interaction between them and the panel.

4.3 Interaction Modeling

The system was implemented using the MVC (model-view-controller) architecture depicted on Fig. 2. Through this architecture we mapped the rugged natural gestures of user commands to certain events and actions that are processed by our domain model.

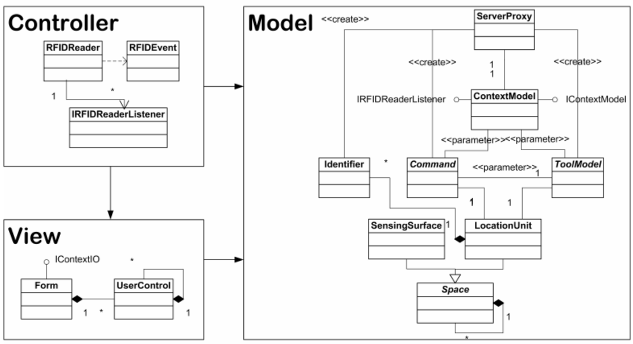


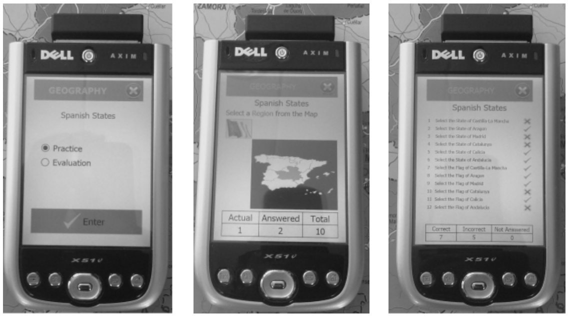
Fig. 2. The distributed Model View Controller implemented by the system

We are facing a distributed system. So, on the client side, the RFIDReader entity signals to the EcoPanelModel entity that a tag was read. The EcoPanelModel transmits the identifier to the server through a proxy represented by the ServerProxy class. This identifier is processed by the server and is mapped to a Command (for instance: next question) or ToolModel (a questionnaire) as necessary. Thus, as a result of the previous process, EcoPanelModel, which is part of the customer, receives the result as a set of serialized instances.

5 Case of Study

For the case of study we will present one of the developed projects we made in our research laboratory. It treats the idea of teaching the Geography in the school, the library or any other learning environment. What we want to present is a connection between the student and the material provided by this subject. This material will be presented in such a simple and intuitive way that students can understand and interact with it without the help of any tutor.

The goal of the panel is the identification of spatial entities as countries, cities, seas, oceans, etc. in a given map (the panel). On Fig. 3-a the system asks students for personal information and operation modes. Students are free to choose between two operation modes: the exam or a practice. The difference between these two modes lies on whether results are sent to the professor or not.



(a) (b) (c)

Fig. 3. Main application screens

Once an operation mode is selected, a question is displayed. The question may be the identification of a region in the map or a flag corresponding to a defined region on the PDA screen (Fig. 3-b). For instance: “Select a state flag and then locate it into the map”. At the right bottom of the page the user can observe the number of the question he/she is answering and the total number of questions. As mentioned before, to select something, he/she has just to bring the PDA device near to the flag or region image depicted in the panel. It is a simple and clear process to develop. Commands and information retrieval are preformed analogously. Once questionnaire was fulfilled by a student, the results are displayed on the PDA screen (Fig. 3-c). The panel contains the map, flags, and other interactive buttons that the user will need to realize the practice or evaluation process.

The next item to describe is the interaction panel based on RFID tags. While Fig. 4-a shows the map panel from the student point of view, Fig. 4-b shows the implementation of the panel based on a RFID tag matrix. On the right of Fig. 4-a we can see the map of the political division of the country and on the left we can see the list of flags that represent all the states of this county.

At the bottom of the panel, there should appear a control panel. Usually, they are: the go back or forward panel buttons, to go back and forward through the questions, the confirm and cancel panel buttons to accept or cancel any action, and finally the exit panel button, to exit with or without saving the activity sending results by email.

(a) (b)

Fig. 4. The map panel

6 Conclusions

This article describes an m-learning solution that exploits mobile technologies that are actually available, or will be available in the near future allowing students to interact directly with the materials they have to learn. Besides, ILPs also provide information to teachers about students' progress. This system is implemented using several technologies, including mobile devices which support communication, RFID technology enabling gestural interaction, and the subject material which is introduced to enhance the student participation. And among main advantages of the system is worth to highlight the following issues:

- Implementation of new interfaces for any mobile device.
- New resources can be introduced in a scalable and open way through the Web.
- Accessibility features, as audio-text for blind people, are easy to add.
- Multi-lingual support for resources on the PDA side.
- Great flexibility due to the panels can be updated quickly and efficiently.
- Economic deploy, because passive lo priced RFID tags and RFID popularity.

As future work, we can mention the extension of this interfaces to existing social networks to expand the service, for instance to Google Maps. Besides this form of interaction is not limited to retrieving information, instead it allows the execution of parameterized commands that can lead to the creation of active control panels that can evolve dynamically.

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References

1. Chen, Y.S., Kao, T.C., Sheu, J.P., Chiang, C.Y.: A Mobile Scaffolding-Aid-Based Bird-Watching Learning System. In: Milrad, M., Hoppe, H.U. (eds.) IEEE International Workshop on Wireless and Mobile Technologies in Education, pp. 15–22. IEEE Computer Society, Los Alamitos (2002)
2. Sharples, M.: The design of personal mobile technologies for lifelong learning. Computers & Education 34, 177–193 (2000)
3. Coombs, P., Ahmed, H.: Attacking rural poverty. How nonformal education can help, Baltimore (1974)
4. Watkins, K., Marsick, V.: Informal and Incidental Learning in the Workplace (1990)
5. Livingstone, D.W.: Mapping the Iceberg. NALL Working Paper number 54 (2002)
6. Mocker, D.W., Spear, G.E.: Lifelong Learning: Formal, Nonformal, Informal and Self-Directed. Information Series No. 241. ERIC Clearing House on Adult, Columbus (1982)
7. Hawkey, R.: Learning with Digital Technologies in Museums, Science Centres and Galleries. A Report for NESTA Futurelab (Report 9). Future Lab. King's College, London (2004), http://www.nestafuturelab.org/research/reviews/09_01.htm (Last access 26.08.05)

8. Sefton-Green, J.: Literature Review in Informal Learning with Technology Outside School (2004), http://www.nestafuturelab.org/research/reviews/07_01.htm (Last access 26.08.05)
9. Vavoula, G.: KLeOS: A Knowledge and Learning Organization System in Support of Lifelong Learning. PhD Thesis, University of Birmingham, UK (2004)
10. Miles, R.S., Alt, M.B., Gosling, D.C., Lewis, B.N., Tout, A.F.: The Design of Educational Exhibits. George, Allen & Unwin, London (1982)
11. Bradburne, J.: A new strategic approach to the museum and its relationship to society. Museum Management and Curatorship 19(1), 75–84 (2001)
12. Galani, A., Chalmers, M.: Can you see me? Exploring co-visiting between physical and virtual visitors. In: Museums and the Web 2002, Archives & Museums Informatics, Pittsburgh (2002)
13. The STEM project, http://www.sciencemuseum.org.uk/education/item
14. Bazley, M.: The internet: who needs it? Journal for Education in Museums 19, 40–43 (1998)
15. Sparacino, F.: The museum wearable: real-time sensor-driven understanding of visitors interests for personalized visually-augmented museum experiences. In: Museums and the Web 2002, Archives & Museums Informatics, Pittsburgh (2002)
16. Semper, R., Spasojevic, M.: Devices and a wireless web-based network to extend the museum experience. In: Museums and the Web 2002 (2002)
17. Hsi, S.: A study of user experiences mediated by nomadic web content in a museum. Journal of Computer Assisted Learning 19(3), 308–319 (2003)