

FROM E-LEARNING CONTENTS TO M-LEARNING CONTENTS

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ABSTRACT

M-learning or Mobile learning represents the last frontier of e-learning, a natural development of the “anytime, anywhere, anyhow” slogan, and identifies every possible learning experience in which the learner uses mobile technologies – PDAs, mobile phones – and/or s/he is not in a specific, predetermined place. In order to provide each user with a really effective learning experience, several users’ characteristics should be taken into account, the so-called context, thus the interaction and the contents to deliver should be adapted according to these characteristics. Unfortunately, nowadays the adaptation of content to mobile devices becomes often synonymous with simple content reduction and loss of information. Moreover, the device scenario is too heterogeneous and depending on its own limits and the contents not so standardized to think it is possible to keep the original educational load unchanged with an automatic adaptation.

The present work describes a sailing course for PDA, already existing in PC version, and the approach we used to adapt PC version contents to mobile device, trying to avoid loss of information during the adapting process.

The adaptive approach we propose represents a response to the current needs, a first step towards a new direction of information and educational knowledge reuse, which can get new benefit from mobile devices. This approach has been defined “mediated” because it tries to mediate between the result obtained by an automatic adaptive mechanism, namely the possibility of reusing the same mechanism with different contents, and the necessity of keeping the educational load high, also varying the device or the whole access mechanism.

KEYWORDS

Mobile Learning, Content adaptation, Scaffolding.

1. INTRODUCTION

Distance learning is a practice started in the past and that has always taken advantage of technological progress. Nowadays, in particular, the wireless communication and the introduction on the market of handheld computers, which are cheaper and more ergonomic than notebook, have given new chance for the development of distance learning. The possibility of “wireless” connections to educational content delivery centers – lessons, materials for in-depth study, dictionaries – allow increasing freedom in material fruition and real possibility to follow learning courses any time and anywhere convenient for the student.

M-learning or Mobile learning represents e-learning last frontier, a natural development of the “anytime, anywhere, anyhow” slogan, and identifies every possible learning experience in which the learner uses mobile technologies – PDAs, mobile phones – and/or s/he is not in a specific, predetermined place.

A current trend in academic and business world is the definition and, more frequently, the transformation of existing e-learning platform architectures into m-learning platform architectures (Andronico et al. 2004, Trifonova and Ronchetti 2004).

Mobile learning can improve both individual and group learning opportunities and facilitate the creation of collaborative environments (Brand et al. 2002). A PDA, for example, can provide students with a tool to send/communicate short notes that, in turn, might establish the basis for discussion later in the classroom (Bollen et al. 2004); while a mobile phone can allow more effective scaffolding on part of a tutor who wants to support opportunely/in time her/his own students’ activities (Stone 2004).

In order to provide each user with a really effective learning experience, several users’ characteristics should be taken into account, the so-called context, thus the interaction and the contents to deliver should be

adapted according to these characteristics. The user's characteristics (preferences), her/his specific location, the device used by her/him and, finally, the typology of communication between the mobile device and the content delivery center are the main dimensions of m-learning context.

Therefore, the most recent Mobile research has been focusing on the problem of delivering contents which are more and more adequate to the current user's needs, and on their adaptation according to: the building and the use of user models and profiles (Bull and Reid 2004); the communication/description of user characteristics and device capabilities and, sometimes, also the meaning of pages requested by the user (Lemlouma and Layaïda 2004); the user localization and the activities s/he is carrying on (Michahelles and Samulowitz 2001, Lonsdale at al. 2003, Sharifi at al. 2004); the communication technologies to be used (GSM, GPRS, UMTS, Wi-Fi, BlueTooth, IrDA, etc.).

Also the presentation of non-textual contents, such as audio and video, poses adapting problems, related to the heterogeneous characteristics of different users' devices.

Unfortunately, nowadays the adaptation of content to mobile devices becomes often synonymous with simple content reduction and loss of information. Moreover, the device scenario is too heterogeneous and depending on its own limits and the contents not so standardized to think it is possible to keep the original educational load unchanged with an automatic adaptation. The present work describes a sailing course for PDA, already existing in PC version, and the approach we used to adapt PC version contents to mobile device, trying to avoid loss of information during the adapting process. In details, section 2 discusses the problems related to content adaptation in m-learning, section 3 presents the PDA "M-sailing" course and the adaptive approach used for its content. Conclusions are illustrated in section 4.

2. CONTENT ADAPTATION IN M-LEARNING

Analyzing currently available projects, and especially those in an advanced phase of research (for example MOBIlearn), it is evident that M-learning does not represent only a further form to offer and display contents, but it is a separate sector with its own characteristics and rules, aiming at complete independence of data/information from the structures and the devices suitable for displaying them.

In this area, the fundamental principles of W3C Device Independence Working Group - W3C DIWG - (W3C 2001) place stress on the concept of independence from the device in use, analyzing the question from three different points of view: the user, the author and the delivery process which connects the user and the author's product. Assuming that the Delivery Context is an attribute set describing the capabilities of the access mechanism and the user's preferences, Web applications and contents are device independent when the user can obtain a functional (useful and re-applicable) experience in every Delivery Context, as long as s/he has an adequate access mechanism. Furthermore, it should be possible for the user to insert or update any adaptation preferences, providing Delivery Context characteristics. This clearly summarizes the fact that the adaptive process should always allow the user to obtain the most appropriate experience with respect to her/his own abilities, possibilities and objective circumstances. For example, if in a hurry, a user may request a lower quality presentation, such as lower resolution images, in order to speed up page delivery.

A generic adaptive process provides a method or a set of instructions in order to transform a content with some characteristics into a second content, which is partly different from the first on the basis of some criteria.

Adapting a text to be displayed on PC could be a feasible operation, even in short time and without particular constraints, for example on the basis of its maximum length. A quite different matter is adapting the text to a completely different context, for example passing from an hypertext to a content for M-learning, when you do not have a computer but a PDA, not a wide screen but just 3,5 inches screen, not one user but different user typologies, in other words a lot of problems and most of them not at all easy to solve. Hence, the accomplishment of an adaptive process, especially for M-learning contents, must be based on a set of peculiarities and assumptions about handheld devices, which completely revolutionize the way of programming, and must have specific orientation to the user and to her/his real problems linked to the device use (Gomes at al, 2001). Besides, it is also necessary to take into consideration the great difficulty in solving these problems, since the available tools to create Mobile contents and projects are much more limited.

On this matter, W3C DIWG (W3C 2004) provides a general view of adaptive mechanisms usable to select, adapt and modify the offered contents in relation to devices and functional experiences. However, the

process of content adaptation can usually take place automatically on server-side, on client-side or on intermediated level (proxy).

3. M-SAILING

M-Sailing is an application developed to allow sailing instructors and their young pupils to benefit from a first level sailing course through PDAs. This application can be used on Pocket PC systems with MS Windows Mobile 2002/2003 operating system and requires the installation of Macromedia Flash Player 6.0, since every lesson has been developed by using Macromedia Flash MX.

The sailing course had already been developed in a hypermedia version for PC desktop or Notebook by using Asymetrix ToolBook Instructor. Hence, on this version an adaptive process was applied mainly aiming at keeping in the new PDA version the whole educational content offered by the original application.

3.1 The Adaptive Approach

In section 2 we mentioned automatic adaptation perspectives on both server and client side, feasible in the medium term because they start from application paradigms in which the adaptation process is as dynamic as the contents to be dealt. At present, mechanisms like these are feasible only in a partial way and often with not very effective results. For example, if we consider a group of Learning Objects, completely structured by means of XML technologies, the text adaptation could be standardized on the whole group. Whereas if the Learning Objects are not structured in the same way, an automatic mechanism will risk spending too many resources in comparison with the benefits that could be derived from it.

Therefore, in M-Sailing the adaptation has been applied not automatically, but in a "reasoned" way, because in the current state of technologies - implementation and not only - the device scenario is too heterogeneous and depending on its own limits to be able to think that an automatic content adaptation could be satisfactory. The information and educational load would be necessarily compromised and so the users' functional experience would be. Moreover, the starting base - not standardized and self-consistent contents - does not allow automatic mechanisms.

Separating problems allow managing them in a precise and efficient way and the goal of M-Sailing is exactly to introduce this "mediated" way of dealing with the existing contents, awaiting the new completely automatic step. The adaptive approach applied to M-Sailing represents a response to the current needs, a first step towards a new direction of information and educational knowledge reuse, which can get new benefit from mobile devices. This approach can be defined using the word "mediated" because it tries to mediate between the result obtained by an automatic adaptive mechanism, namely the possibility of reusing the same mechanism with different contents, and the necessity of keeping the educational load high, also varying the device or the whole access mechanism.

The basic idea of our adaptive approach is the following: if in input there is a multimedia system, with hypertext structure, a "mediated" adaptive mechanism can transform the hypermedia system content into mobile local content, adapted to the characteristics of the new devices, and can move the system subsidiary parts (user profiling and user testing, for example) to Web for a merging that would foster the engineering reuse. Hence, when a course for handheld computer is built, the original course for PC computer is divided into two parts: Web-Side and Pocket PC Local-Side.

The first part meets real engineering creation criteria, because the Web-Side is as changeable and open as possible, i.e. easy to re-use and to adapt to other Mobile courses without too many changes. For the development of M-Sailing Web-Side an embedded scripting solution (PHP) has been adopted (Butler 2001).

The second part, which is resident on PDA (in our case Pocket PC), is strictly connected with the original PC course and represents a practical application of transmigration rules from a device to another, while looking for the maximum efficiency and exploiting the maximum potential of the local device characteristics. In particular, concepts, images, video, lessons in general can be accessed locally on the handheld computer, while the subsidiary components have been individually evaluated and then modified, changed and/or removed (W3C 2004).

In detail, the main purpose of content adaptation was to adapt the whole content of the original sailing course to PDA, without losing any of the original course notions. To obtain this result it was necessary to

execute the following steps.

- Analyzing the original application in order to find interface basic characteristics, mainly textual contents and navigation between pages and to build a hierarchic tree of links between different tasks. This step is necessary to better understand the links between the original application pages and decide what content to cut for the new Mobile version.
- Analyzing the subsidiary characteristics of the original application, namely video and images. This step is necessary to understand which of these contents to cut and which ones to modify, by reducing their dimension, for example.
- Preparing a list of hardware constraints to be considered when building the Mobile application prototypes, i.e. small screen dimension, hard disk space availability, processor speed and RAM capacity.
- Decomposing textual contents of the original application to meet the new screen dimensions of the Mobile device.
- Building Mobile application page prototypes (using Microsoft PowerPoint, for example) to determine the maximum usable display area. By introducing text in these pages, it is possible to determine the real quantity of text that can be inserted in each page, its right dimension, and, consequently, to decide how to restructure the original application content. Actually, to avoid download problems every page and also every lesson should be as light as possible.
- Restructuring the navigation tools, i.e. removing unnecessary operations existing in the original application (printing, for example), choosing meaningful icons for every function.
- Compressing videos and retouching images to make them easy to download. It might be better to use icons in the text as links to full screen images or video and to allow the user to go back using a proper button.

The scheme of the adaptive approach applied in transforming the original sailing course into the new version for handheld computer is shown in Figure 1.

Resources to be downloaded on PDA can be downloaded on PC and then imported into PDA when download via Pocket PC would be difficult or inapplicable.

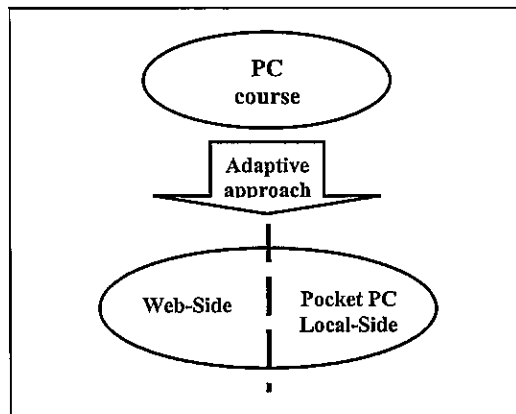


Figure 1. The adaptive approach

3.2 The Interaction with the System

After accessing M-Sailing Web-Side by PDA the user can log in.

When the user is at her/his first interaction with the system s/he can register by entering simple information into some text fields. After confirming this information, an introductory questionnaire is shown, which consists of three simple questions with different levels of difficulty, and the user is obliged to answer it. According to the result of this mini-questionnaire the student's knowledge level is defined and, consequently, the lessons that the user will be allowed to download and the questionnaires that s/he will be allowed to fill in at her/his first access.

Once the account has been created, the user can log in to access M-sailing.

After every login to M-Sailing, a personal page is displayed to show the user downloaded lessons (which can be downloaded again because s/he might lose or delete them by mistake) new lessons to download, questionnaires relating to them and the result of the last completed questionnaire.

In case the user has downloaded lessons and want to access the on-line version of the relating questionnaire, s/he will be able to do it according to his/her current knowledge level.

Especially due of the difficulties that M-Sailing young users can have, its Web-Side is not overloaded at all. This happens because most of the work is automated and, hence, is done in a way that is transparent for the user.

3.3 User Modeling

As it has already been said in the previous section, at his/her first access to the system every user completes a general questionnaire according to which s/he will be classified as beginner, intermediate or expert user.

According to the answers given by the user, the system makes score analysis, comparisons with the estimated thresholds during the authoring phase and assigns the first profile to the system user. As a matter of fact, after the questionnaire the user is assigned to one of the above-mentioned categories to which particular stereotypes correspond.

The system provides differentiated scaffolding on the basis of the user typology, as shown in Table 1. This scaffolding supplied by the system consists of "advices" about the content access – lessons – and not about the interface "surfing", because the interface, modified and reduced to essential in comparison with the PC desktop application, allows each of the three user typologies an immediate navigation.

Table 1. Scaffolding

User classes	Scaffolding
Beginner user	COMPLETE
Intermediated user	LIMITED
Expert user	ABSENT

The educational purpose of the course is that of teaching the rudiments of sailing, as long as the lessons are followed in the proposed order. Exactly this point is controlled by the Web-Side, which supervises users and suggests them the steps to follow.

As results of the evaluations (questionnaires) the user's knowledge level can improve or worsen. The system, correspondingly, changes the user class and, therefore, the user is provided with different advices about the lessons to revise and the questionnaire to fill in. For example, the user will not be allowed to fill in an intermediate level questionnaire if s/he is still at the beginner level.

3.4 M-sailing Usability

Usability requirements have always been taken into consideration to make every choice in M-Sailing, along with problems relating to the user target, potentially inexperienced in informatics, and complications connected with the use of mobile devices. Thanks to this, the resulting application is natural and intuitive because it allows the user to find whatever s/he expects in every moment. The screenshot shown in Figure 2 is an example of usability and concerns icons used in M-Sailing lessons.

The navigation is complete. In fact, there are not points impossible to reach, both locally and on the Web. If during the study the user enters another lesson for an in-depth study, s/he can exit only coming back to the previous lesson. This facilitates the return to the starting point even on part of the most inexperienced user. Unnecessary buttons and links have been removed in order to avoid possible unexpected "escapes".

The application is adaptable and flexible. In fact, contents and questionnaires are shown and proposed according to the preparation level reached by the user.

Moreover, the common backgrounds and the choices concerning the layout – colors, font type, font dimension – make the application internally and externally consistent.

Finally, the application is not complex both from visual and functional points of view. In fact, a strong task hierarchization limits the functional complexity, harmful for users especially in mobile applications that are rich with functions: on a small display, in fact, the sensation of "lack of space" is even more amplified. The visual complexity is limited by the correct task separation and by the lack of need to represent on the screen the functions to be performed. Obviously, the complete removal of unnecessary links also affects this point. For example, during the execution of a video tutorial, the user can only exit, s/he does not have any distraction and, therefore, can better concentrate on it. In M-Sailing Web-Side the Back button was also removed, given the possibility of using the well visible and already present browser function.

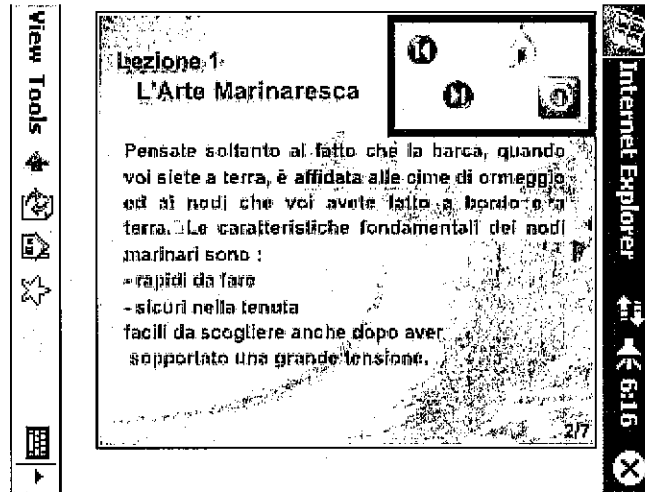


Figure 2. An example of interface in M-sailing

4. CONCLUSIONS AND FUTURE DEVELOPMENTS

Mobile programming is still "young", especially as far as Web resources are concerned. Differences among platforms, browsers and also operating system versions, along with problems such as sipped pixel consumption, study of text/background chromatism and extreme video optimization to save space as much as possible, are continuously at stake when one is programming on the Web for mobile. Because of the lack of suitable authoring tools, it is necessary to use the available tools that are perfectible of errors, sometimes also very trivial.

M-Sailing has shown how existing contents can be reused in mobile world: not only has it been built a new way to implement again a course that was born for e-learning, but, more important, it has been shown that using an adaptive approach it is possible not to lose any of the original course notions, whereas, on the contrary, content reduction and adaptation frequently mean loss of notions.

If until now mobile Web services have been offered as alternatives to those for PC and also with enormous reduction of possibilities, it has been shown that advanced personalization and adaptation services can be available also on mobile devices. M-Sailing contents are not available in PC version, but only for handheld devices: this is evidence of the fact that resources devoted to mobile world can be really used to build services conceived only for mobile, without being afraid of losing effectiveness.

M-Sailing can be improved in many aspects, for example with the management tools for a possible tutor, or forcing a bit more the abstraction of PHP system used. Even now, in fact, a little work to adapt the system to other courses would suffice, but it will be done more when the tools and the available technologies improve.

Our next stage of work will be to use this first experience of content adaptation of an e-learning course to M-learning to derive the formal definition of a new adaptive approach (Mediated Adaptive Approach). In other words, to define formal rules for converting e-learning contents into Mobile contents, which take into

account software and hardware constraints linked to Mobile devices, while leaving the entire educational load of the original content unchanged in the Mobile version.

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