Adaptive Learning Using Moodle And Handheld Devices

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Abstract. Today, handheld devices in addition to efficiently perform the function for which they were created are also facilitators of all kinds of content through its integrated internet connectivity. The user can access and play multimedia information (pictures, videos, music, podcast, ...), read news, ... and complete educational activities. Regarding the role of learning facilitator, the challenge is to ensure that the mobile device is capable presenting the learning materials in terms of certain characteristics of the connected user. Our proposal is focused on the integration of an adaptive learning architecture into the learning management platform Moodle, application which is conveniently enhanced by the incorporation of mobile devices to the adaptive platform by providing mobile access to Moodle. Presents educational tasks to the client by means of interactive multimedia Flash activities which make possible both educational content adaptation according to a particular learner model and presentation adaptation of this content to any handheld device capabilities. Moreover, navigation adaptation will be supported in Moodle 2.0 with Conditional Activities. The idea behind conditional activities is that each resource/activity created by a teacher could have a set of criteria built into it in order to outline when and how it should be displayed.

Keywords. Mobile learning, Learning Management Systems, Moodle, Adaptive Multimedia, Flash based Applications

1. Handheld devices and e-Learning

According to Pownell & Balley [12], mobile devices are at the forefront of the fourth wave in the evolution of technology. In the first wave computers were large, expensive mainframes, used in education to make administration and managerial tasks easier. The second wave started at the end of the 1970s, with the emergence of microprocessors and was prolonged until the 1980s with microcomputers. Following that stage, computers became “personal” and schools introduced computer literacy courses for students to learn about technology and how to use it. The third wave in the 1990s was characterized by the development of the internet and the worldwide web, highlighting electronic communication and collaboration. The fourth wave is said to have begun as recently as 2001 and involves compact computers, wireless connectivity and mobile technology and delivering “anyone, anytime, anywhere learning” [13].

In this sense, mobile devices include media players such as iPods and other digital audio and video players; media capture and playback devices such as the iPod Touch or

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multimedia cell phones like Blackberrys or iPhones, mobile devices with integrated Geographic Positioning System (GPS) capability and small, ultra-lightweight personal computers or other converged devices that combine some or all of these functions. Coming in a variety of shapes and sizes, provided with different operating systems and used for a wide range of purposes, handheld gaming devices can be included within mobile devices. Despite these variations, wireless handheld devices share five commonalities: 1) Connectability – Significant WiFi infrastructure is already being installed at colleges, offices, universities, public places, etc., and cellular technology can provide ubiquitous uninterrupted access to the Internet, 2) Wearability – they are worn on one’s person and therefore constantly at the fingertips of the user, 3) Instant Accessibility – they turn instantly on and off, 4) Flexibility – they can collect data by accommodating a wide variety of peripheral extensions, and 5) Economic Viability – Handheld devices exhibit computing power and versatility comparable to those of desktop (or notebook) systems but at prices approaching those of graphing calculators [7].

Using wireless handheld devices for e-learning is an emerging trend, backed up with improved touch screen technology and software. These devices have been adopted for e-learning in schools, for instance in Japan and UK [11], to make learning more fun and easier for children and youth already familiar with using game consoles such as Nintendo DS and PSP, in addition to other portable devices like cellphones and iPods and other brands of Portable Media players (PMP).

The implementation of mobile devices is useful to access educational contents in places where no acceptable wired internet connection is available. Studies have been conducted on the use of videogames over cell phones to teach languages and safety knowledge in India [9], and the One Laptop Per Child initiative is certainly a step in this direction (www.laptop.org).

Furthermore, handheld devices are accepting handwriting as input. “Digital ink” and handwriting recognition technology allow natural and more versatile input, a factor that is increasingly important in educational applications. Handheld devices can be used by students for word processing, online information search and retrieval (including ebooks), testing in all subjects, computation, data acquisition, visual display and information processing, as well as provide genuine access to foreign languages and diverse cultures. These are the multiple applications currently underway in traditional classroom settings. As has been demonstrated with current handheld technology, the combination of access to information and the means to conveniently process it (visually, computationally or verbally) enables discovery and problem based learning.

Learning by using mobile technology demands, however, a new conception on the formative process which requires a series of adaptations that could occur both at a technological and pedagogical level.

At a technological level, learning may be conditioned by the characteristics of the mobile terminals and devices, as well as by the connection used in those terminals. The underlying technological basis will be composed of a platform that enables us to update and follow up contents through mobile devices. In order for that to happen, the platform should adapt to those new functionalities, becoming known as mobile Learning Management System, or mLMS.

The factors which must be considered whenever we want to adapt a LMS to mobile technology are, according to Keegan [10], as follows:
Information regarding registration and users. Determining the tools which enable registration and an adequate management of the data belonging to the different registered users. This type of information would include the access to different kinds of registration via mobile devices, registered users database, role definition, payment systems and information backup, according to the access allowance for users. All these services would be included in any LMS, which purposely implies the integration between those systems and the mobile services available.

Course development. Development tools should be added to the LMS, facilitating the creation of adequate contents to m-Learning. Furthermore several course searches should be provided, engine through which the learners are able to access to the contents and syllabus. The access to these courses presupposes an adaptation regarding the form of navigation in order to be easily achieved through mobile devices.

Communication. Communication tools are needed to enable contact between the learners and the tutor, as well as between the different learners through the mobile device. Some of the communication technologies which could be used are voice, data, SMS and MMS.

Tasks. The mobile learning platform must enable tasks and tests available to the different learners, as well as be able to interpret the data they provide.

There are several studies, namely the one from the University of Athabasca, reporting the use of mobile services in an open source LMS like Moodle [6]. This research includes a series of structural and methodological implications on the introduction of a mobile system in Moodle, and also a brief guide to future researchers in the area. The idea is to achieve convergence between information and communication media included in mobile learning, that is to say, to transmit a series of contents through different formats, including multimedia, and to apply the communication systems to mobile devices.

Research analysis shows that Moodle’s visual structure maintains itself in a mobile phone, and the majority of modules work properly, without requiring an excessive amount of adaptation. The greatest difficulties emerge from uploading archives, and from the fact that mobile devices are unable to support javascript validations present in examinations. The use of SCORM packaged elements could arise more than a problem, since these elements use a javascript API which enables the connection between packages and LMS Moodle. The adaptation of resource types should also be considered when looking for an adequate use of LMS advantages.

On the other hand, a version of Moodle for mobile phones has been developed in Japan, the so called Mobile Moodle. Though this version allows for the integration of several elements from this platform in mobile devices, these do not belong to the standard packages of Moodle, and its interfaces, defined through CHTML (Compact HTML), could receive support from different devices. To get beyond the problem of not being able to integrate all the desired elements, plugins were developed in order to obtain feedback and provide multiple-choice and matching quizzes. The general module included authentication, navigation, multilingual support, and several other activities.
2. Moodle and pedagogical adaptation

Moodle is a free learning management system that enables us to create powerful, flexible, and engaging online learning experiences. The phrase "online learning experience" implies web pages that can be easily explored in any order, courses with live chats among students and teachers, forums where users can rate messages on their relevance or insight, online workshops that enable students to collaborate and evaluate each other's work, impromptu polls that let the teacher evaluate what students think of a course's progress, directories set aside for students to upload and share their files. The design and development of Moodle is based on the educational learning theories of social constructivism [3, 15] which advocates that meaningful knowledge is built by participating in social interaction, i.e. sharing with others.

Moodle permits the distribution of digital educational material in the form of texts, images, audio, simulations and the like, in addition to enable open debates and the collaborative creation of texts combining different kinds of communication, management and teaching tools within its system.

However, and while courses which adapt to the individual needs of students make learning easier and lead to a positive effect in the learning process, management systems provide, little, or in most cases, no adaptivity. Adaptation techniques, broadly categorized into adaptive presentation support (based on links and including features such as direct guidance, adaptive sorting, hiding and annotating) and adaptive navigation support (including adaptation features based on content such as adaptive multimedia presentation and adaptive text presentation) [4], are generally focused on the adaptation to the different characteristics of learners. For instance, a system can incorporate the prior knowledge, the learning goals, the learning style and the cognitive abilities of students.

2.1. Navigation Adaptation in Moodle

To meet navigation adaptation, Conditional Activities are being developed as a core feature in Moodle 2.0. The idea behind conditional activities is that each resource/activity created by a teacher can have a set of criteria in order to arrange when and how it is to be displayed.

Conditional Activities in Moodle are closely tied to another Moodle 2.0 feature, the Completion Tracking, that is, the criteria a teacher sets in their conditionals under which activities/resources should be completed. Options that determine completion include:

- $x$ number of new posts or replies made in a forum
- $x$ scored on a quiz
- Has created $x$ pages in a wiki or has made $x$ edits
- A user has viewed a resource $x$ number of times
- A user has participated in an activity (i.e. has made a choice)
- A completion Criteria can be date based if required
- It can also be set so that students themselves can mark when they deem the activity complete
Consequently we have a wide range of diverse completion options though which students are invited to work their way within a course. Conditional activities indicate, for instance, if a student has successfully completed an activity/resource (or range of activities/resources) in order to show the subsequent prearranged task. Another example could include the case of failing the quiz so that as a result, a revision exercise could appear for the student to complete before moving on.

With conditional activities we can easily design a learning platform and adapt the navigation parameter considering the progress of the student and his/her actions in an activity or resource. However, conditional activities cannot be configured for adapting the course material to the objectives, interests, learning styles or other similar individual adaptation parameters.

3. Adaptive learning platform

If an educational activity has the capacity to adapt the instructional content dynamically according to the characteristics of a particular student and his/her progress, such activity is called adaptive educational activity.

In the context of the SHAIEx project [1], whose main objective is the design and development of a web-based adaptive hypermedia system that promotes the individualized learning of English at early ages, we have created a distributed, three-layered architecture that presents educational tasks to the client by means of interactive multimedia activities developed in Adobe Flash. SHAIEx provides the adaptation in the server by means of Java Servlets, extension which decides the most appropriate task for a particular student according to its user model and the way in which it must be build [2]. The three-tier architecture of SHAIEx keeps the structure and the multimedia components that compose the pedagogical domain (hyperspace) independent. This fact allows users to extend the user’s model with more parameters of adaptation.

These adaptation parameters affect the content of any educational activity. Being the same activity for each educational level built in runtime from the same template, the multimedia elements that comprise each game adapt to the child’s educational level in terms of vocabulary, linguistic concepts and content, enabling the most appropriate multimedia element to be loaded from the SHAIEx content database.

3.1. SHAIEx in Handheld Devices

As previously said, the user interface of SHAIEx consists of interactive multimedia activities developed in Adobe Flash.

With fewer possibilities than C or C++ for specific platforms or Java ME Flash Lite, the mobile version of Adobe Flash, is a language, which does not provide controls for GPS receptors or Bluetooth connection, lacks which significantly reduce the possibilities offered by mobile devices. On the other hand, the applications developed with Flash Lite are easier to write and offer outstanding visual effects without too much effort. Thus, in the latest version of this application, typical features of more complex languages, such as Internet connection for downloading new contexts or an object oriented language, have been provided. The applications developed for this platform are not executed natively over the operative system, but over the Flash engine. This characteristic makes the application more independent from the device being supported.
in any Flash Lite device. Kam et al. [9] shows how flash videogames can be useful for spreading educative contents in underprivileged regions.

4. Integrating handheld devices in Moodle and SHAIEx

In this section, the integration of two separate software systems with mobile devices, the LMS Moodle and SHAIEx will be discussed (Figure 1). By combining the strengths of both systems to act as one, a more advanced learning experience can be offered to the online learner, as he/she is provided with both the personalized learning experience of the AHS (Adaptive Hypermedia Systems) and the navigational and support facilities of the LMS. Moreover, the user interface of the integrated system can be viewed with wireless handheld devices with Flash / Flash Lite support and the browser installed on it. We can access to Moodle and SHAIEx independently with our device, but with the integration of both systems we can access to SHAIEx throw Moodle and therefore we can store and access the information of the student in both systems. In Moodle, teacher can consult all the information about marks in SHAIEx to evaluate the students. In the other hand, SHAIEx (Intelligent tutor) have the necessary information to adapt the tasks to the students’ characteristics.

According to Tiarnaigh [14], the information sharing key points required for creating a successful integration of Moodle and SHAIEx are summarized as follows: single user sign-on, updating of the user model from within Moodle, adding additional tracking information for the SHAIEx-user within Moodle, and, adding assessment information.

With single user sign-on, a learner can merely log into Moodle, and from within Moodle, choose the SHAIEx hyperlink, which will automatically logged him/her into the SHAIEx system. By doing so, the user is provided with a seamless integration of both systems without even being aware that two separate systems are being simultaneously used.

The Moodle local database stores a wealth of personal student information which can be implemented in the user model. For instance, the username, the first and last names, the user’s email address, home address, phone number etc. can all be extracted
and then used in the learner model. Meanwhile, the SHAIEx user model contains the
learner characteristics that enable the educational content adaptation: educative level,
previously acquired knowledge, mouse interaction style, learning style, etc. Thus, by
adding the SHAIEx user model to Moodle, the details contained therein can be
considerably increased, improving on particular learner model parameters, like
previously acquired knowledge, in conjunction with the evaluation of assessment
activities owned by Moodle.

Moodle provides various options like questionnaires, choice forms, quizzes and
workshops for assessing the user’s overall knowledge of the course material. Each
SHAIEx didactic unit includes an evaluation block based on adaptive multimedia
activities. The results of this evaluation should then be fed back to Moodle in order to
update the stored learning model of the user. The specific functioning of the integrated
learning system will now be described.

Each didactic unit inside Moodle has a link to the corresponding unit inside
SHAIEx. When the child clicks on this link, SHAIEx automatically searches for
activity scenes for the selected unit according to his/her user model related with
Moodle user data and whose pre-requisites have been satisfied by their newly acquired
knowledge. A transition scene is dynamically generated and presented to the child.
This type of scene contains graphical, audible and clickable icons showing links to the
next activities the learner is invited to carry out (Figure 2).

![Figure 2. SHAIEX integration in Moodle.](image)

When the child selects an educational activity, the intelligent tutor looks for the
corresponding user model in order to determine how to mount that activity and
discriminate the proper multimedia elements. Given this information, the intelligent
tutor builds a configuration file, which is sent to the student host and the browser loads
the adaptable Macromedia Flash game template and the multimedia elements. Thus, the
most suitable activity for this particular student is dynamically built. The configuration
file is a XML document that stores the specific values for each adaptation parameter.
By means of this file we can decide: content (educational objectives), language,
 difficulty, mouse interaction style (double click, drag & drop, one click, etc.) and
finally, if textual information is to be shown or not.
5. Conclusions

Nowadays, students of all ages live in a media-rich environment and interact with a diverse range of electronic devices both inside and outside their homes. These have the potential to provide even very young children with opportunities for new forms of creativity, communication and collaboration. Although the PC is at present the most widely-used classroom resource, ICT in learning entails much more than this. Highly innovative work [5, 8] is being carried out using programmable toys, floor robots, digital cameras, scanners, video/cassette recorders and handheld devices. Moodle is a free learning management system that enables the creation of powerful, flexible, and engaging online learning experiences. Online learning experience connotes web pages that can be explored in any order, courses with live chats among students and teachers, forums where users can rate messages on their relevance or insight, online workshops that enable students to collaborate and evaluate each other's work, impromptu polls that let the teacher evaluate what students think of the course progress, directories set aside for students to upload and share their files. However, Moodle makes little provision for adaptivity. On the contrary, courses which can adapt to the individual needs of students make learning easier for them and lead to a positive effect on learning. Adaptation techniques can be distinguished between adaptive presentation support and adaptive navigation support. To meet navigation adaptation, Conditional Activity is currently being developed as a core feature in Moodle 2.0. To meet presentation or educational content adaptation we propose the integration of two separate software systems, i.e. Moodle and SHAIEx. SHAIEx is a web-based adaptive hypermedia system that makes the learning of English individualized as it presents educational tasks to the learner by means of interactive multimedia activities developed in Adobe Flash. This makes the visualization of the user interface of the integrated learning system through handheld devices possible.

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