INSTRUCTIONAL M-LEARNING SYSTEM DESIGN BASED ON LEARNERS:
MPrinceTool

Habib M. Fardoun, Pedro G. Villanueva, Juan Enrique Garrido,
Laboratory of User Interaction and Software Engineering (LOUISE)
University of Castilla-La Mancha (UCLM)
Albacete, Spain
{habib.moussa, pedro.gonzalez, juanenrique.garrido}@uclm.es

Gabriel Sebastián Rivera, Sebastian Romero López
Laboratory of User Interaction and Software Engineering (LOUISE)
University of Castilla-La Mancha (UCLM)
Albacete, Spain
{gsebas.rivera, sebastian.romero}@uclm.es

***Abstract*— M-Learning is an exciting art of using mobile technologies to enhance learning skills. Mobile phones, PDAs, Pocket PCs and the Internet can be joined together in order to engage and motivate learners, anytime anywhere. The society is entering a new era of m-Learning, which makes important to analyze and innovate the current educational tools. In addition Learner-Centered Design (LCD) is considered to be important especially when new applications are created, it is an evolving design approach for designing tools that supports learners trying to engage in and understand educative practices. To develop and apply the LCD approach throughout the whole life cycle of the system an Instructional System Design process (ISD) which is the science of creating an instructional educative environments and materials that will bring the learner from the state of not being able to accomplish certain tasks to the state of being able to accomplish them. This article proposes a new tool that aims to improve the deficiencies identified in the usual analysis. The proposed tool, is called MPrinceTool, provides a new means to interact via mobile technology by using web services that facilitate learners to participate in educational activities and communication with working groups, synchronously: where students can participate in class and communicate with the teacher and the other students, also they can realize exams and exercises which needs the teacher presence; or asynchronously: Which allow students to feel free in realizing there educational activities out of school time.**

Keywords-component; (M-Learning, Learner-Centered Design "LCD", Instructional System Design "ISD", HCI technology, mobile devices, context awareness, collaborative environments, Distributed User Interfaces.)

I. INTRODUCTION

The most important factor for the success of m-Learning applications is the employ of the ISD to create instructional environment and materials that will move the learner from the state of not being able to accomplish certain tasks to the state of being able to do it. Additionally, the success of a software development project is associated not only with tools and technology but also depends on the development process to be instructional and Learner-Centered designed. By the end of 2009, there were an estimated 4.6 billion mobile cellular subscriptions, corresponding to 67 per 100 inhabitants globally [1]. This is more than three times the number of personal computers (PCs), and today's most sophisticated phones have the processing power of a mid-1990s PC.

These facts, and the range of computer-like functionality offered by top-of-the-range devices, are leading some observers to speculate that many people in the near future will start to see the mobile phone as an alternative to a PC. So it is normal to think that all teachers and students (university and school) make a use of it in their daily life.

The application of mobile technologies in 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.

These types of applications that take the LCD approach support the entire product development process with learner educative activities, so these applications become easy to use and fulfill the needs of the students.

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 enhancement of people that need to prosper throughout their lifetime. These activities are not confined to scheduled times and places as traditional education requires, which are so difficult to achieve when people finishes formal learning.

Thus, mobile technologies became an effective means to support appropriate life-long learning, by being highly mobile, individual, unobtrusive, adaptable to the context of learning, so that learners can evolve their skills and knowledge [4].

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 liberates 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 constructive point of view that encourages the idea of "discover to learn".

Therefore, the main idea of this proposal is to present an innovated interaction way where Learners are able to interact with the environment to build knowledge from relationships acquired from the ambient, in an instructional process taking

into consideration the learner-centered design as the center of the work.

In this paper we continue with the presentation of the MPrinceTool [5] design process as a new education tool which is a combination of two existing tools the “Interactive Learning Panel” [6] and the “WallShare” [7], with several modifications that enrich the classroom study allowing students to work in a collaborative way as it is indicated in European Higher Education Area [8].

The structure of the paper is as follow: first we present the state of art of the two tools that we merged together is presented, secondly, we describe the system (server and client functionality), thirdly, the motivation of the creation of this tool by this way is discussed, fourthly, the LCD process that we employed in the construction of the tool. At the fifth point the instructional structured phased approach design applied in the construction of the used materials to adequate to the Learner needs is presented. And finally, the conclusions that have been observed and obtained after using the tool and the future work upon it will be presented.

II. STATE OF ART AND MOTIVATION

There are more and more educational tools for mobile device use, and each is specialized in a particular field. Here, the two tools that we developed and merged together, mentioned above, will be introduce.

A. Interactive Learning Panel

Using this device, the students can 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, they 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.

B. WallShare

Is a system based on a shared zone that is projected on a wall or screen, which is clearly visible by the participants of the meeting.

In order to interact with the system, each participant connects his mobile device to the system.

Once the connection procedure was accomplished successfully, a pointer representing the participant is shown on the wall or screen.

An interesting aspect of WallShare is the possibility of providing each participant with the capability of controlling the movement of his cursor on the screen by performing dragging gestures on the mobile device screen. Thus, users can use the mobile device as an enhanced X-Pointer device.

Therefore, connected participants can download and upload all kind of resources from and to the shared zone.

Thus, participants are able to share a resource just by uploading it to the shared space. To perform this task, users select a resource on the mobile device through the client application and upload it performing a simple gesture. When the resource was uploaded, it is shown on the screen.

In order to download a shared resource from the shared zone, a participant has to point the resource with the cursor and select it. Once the object was selected, the user has to perform a double click on the mobile device screen. As result of this action, the user receives the selected resource in the mobile device.

Following, the explanation of how we have developed the combination of these two tools in order to create MPrinceTool. So we present its specific models and how it was deployed and created by describing its software functionality and its system architecture.

III. SYSTEM DESCRIPTION

MPrinceTool system is presented in a projected area onto a wall or large screen, which is clearly visible to students who use the system.

The functionality of the system can be divided into two parts. First, we have the functionality of the client and, second, we have the server functionality (see Figure 1.).

A. The server functionality

The server application (MPTServer) is responsible for controlling the customer interaction and display all the information that students and teachers need.

MPTServer shows, or projects, in a split screen the questions that teachers asked to students, who are connected to the system; they make use of the chat room to comment on the required question at a given time and about the resources that the teachers share with their students.

Thus the shared area that is projected is divided into four parts as shown Figure 1.

The upper left region is the reserved area for the presented question by the teachers. It shows the formulation of the question and all its possible answers.

One of the uses of the tool is that, next to each answer there is a counter that indicates the number of students who have selected this response. Each user can select from his mobile device the answer that he think it is the correct choice using his associated pointer in the shared pool.

The upper right region is reserved to indicate students who are currently online at MPTServer. Each student, who is connected to the server, is represented by his name and an image in this region. So the participants can easily identify each other.

The bottom left corner contains the resources (images, video, audio, or other file type) that teachers and students share; these materials are usually uploaded to help them in answering the questions.

Figure 1. MPrinceTool, general view.

Finally the lower right region is a chat room where students can talk to each other to interchange ideas or to explain their opinion from the current question in order to answer the question correctly. Each instant message that is sent by the student is marked with the name of student that is sending the message. In addition to this server-side functionality, it also offers other options in order to manage the look of the shared zone. The customization of shared zone wallpaper, the chat enabling/disabling function, the resource relocation functionality avoids resource overlapping and the shared zone clean function sends shared resources to the recycle bin.

B. The client functionality

It has two client applications, a version that offers the functionality that the student can make (MPTStudent) and the other version includes additional functionality that only teachers can do (MPTTeacher). Both versions are developed to be used within mobile device applications which are connected to MPTServer.

(a) main screen (b)chat screen

Figure 2. MPTStudent interface

In order to access the system, participants (students or teachers) download and install the client application into a mobile device from the MPTServer. This application is automatically updated whenever a new version is released in the server.

In order to interact with the system, participants connect their mobile devices to the server application. When participants get connected to MPTServer, they receive a double feedback, a sound from the server machine, and a pointer representing each user on the screen.

An interesting aspect of MPrinceTool is the possibility of providing each participant with the ability to control the movement of a cursor that represents him/her on the screen just by performing dragging gestures on the mobile device screen. Thus, users can use the mobile device as an enhanced X-Pointer device.

Both applications, MPTStudent and MPTTeacher, have the general functionality that has been discussed above. The specific functionality of each is explained as follow: Starting with MPTStudent, where the objective is to enable students to perform exercises proposed by the teacher. To do this, MPTStudent consists of a login screen through which students access the application. Once login is performed, a screen displays the main region of questions and the shared materials of MPTServer.

In the main screen (Figure 2. a), students can answer the questions that the teacher assigns for them, by simply selecting the answer with the allocated pointer. Each time, only the selected students can answer the question posed by the teacher. In MPTServer, it makes appear only the pointer of the students who can answer the question, all other pointers are disabled. Also they can download the shared resources (Help material) by double-clicking on it.

At the bottom of the screen there is a tab, by clicking it, there will display a panel that appears in the chat area through which students can discuss and resolve inquisitions (Figure 2. b). In the other side, there is the teachers application; MPTTeacher. The purpose of this application is to give the teacher the necessary functionality to monitor and assess students through a series of questionnaires, in a comfortable way using their mobile devices.

MPTTeacher consists of a login screen where the teacher is identified to access the system. The main screen displays the questions region of MPTServer offering the teacher a navigation option to select the questions and earmark the student/s to answer it, see Figure 3.

Clicking the tab located in the bottom of the main screen; it displays a panel with the chat, similar to MPTStudent.

Using the chat resource teachers can resolve any inquisitions that the students make. Also it can be used as a FAQ or a discussion area.

On the right side we can find another tab, which displays the file panel. The teacher uses this file browser to select the file/s he wants to share with students so they can download it/them. The shared resources by the teacher appear in the lower left region of the MPTServer Panel. All the s*ystem architecture* is composed of an MPrinceTool system which is a client-server application (see Figure 4.). Therefore, MPrinceTool is based on three systems, as can be seen on Figure 4., the server and two client systems (MPTTeacher and MPTStudent).

Figure 3. MPTTeacher interface

The server system runs on a desktop computer that it is connected to a wireless network via a Wi-Fi or Bluetooth connection. It is also connected to the visualization system, i.e. a projector or large screen, which supports the shared zone visualization by the participants.

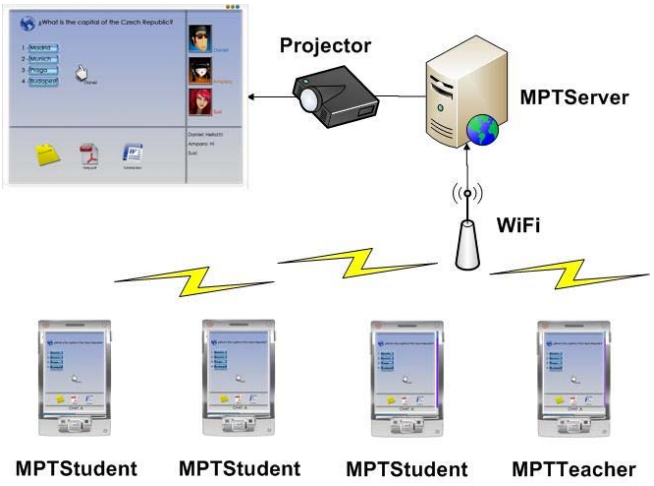

Figure 4. Funcionality of MPrinceTool system.

C. *Learner-Centered Design*

Our Learner-Centered Design philosophy is an evolving design approach for designing m-Learning Systems. It presents a set of design principles aimed to reduce the cognitive complexity of learning how to perform a task through the redesign of the task itself. Once we determined the root causes of complexity, we apply the relevant LCD principles [9] to ensure that the learner encounter as little confusion as possible. In this LCD, we propose several models of learners, classified by the goal of the learning process at hand. For example, the learner as categorizer model considers ways to help learners filter and categorize large amounts of information, while the learner as searcher model suggests ways to help learners search through an information space to identify high-quality, useful and relevant information. For each model, we proposed a set of techniques for reducing cognitive complexity for tasks that fit the model.

While designing the learning-support tool we find that LCD principles and approaches must train to employ fall short in addressing many design issues that are common in learning situations. How should designers create interactive user interfaces, that provides teachers instant feedback and robust understanding of subject matter knowledge, construction of new knowledge, and higher-order thinking skills, while also improve lifelong inquiry? Traditional LCD task analytic methodologies (For example, GOMS analysis) work well when a task or domain is well-specified. In the case of learning, we observed that the goals are not only differ across learners (both students and teachers) who have different intentions, but also across content domains and pedagogical approaches. In our Learner-Centered Design system we recognizes that users have changing needs and abilities and user interfaces need to support these changes in the process.

Learners often need more guidance at the beginning of instruction, but these supports need to change interactively and "fade" as the learner builds competencies and new expertise. Our LCD recognizes the need to balance the amount of help provided to users while encouraging users to become more independent in their learning. LCD also recognizes the diversity of learners and teaching styles: topics and problems need to be selected to promote interest in the task at hand, and motivate further inquiry independent of the technology.

While designing the software environment, we notice that there are three top-level issues that must be addressed; our suggestion is that the system we create must permit us to put the learner at the center see. We describe Learner-Centered Design by considering three principal aspects: the audience design perspective which presents the needs of both teacher and learner, the central design problem which presents the used tools to develop the appropriate teaching and learning environment (USIXML [10], IDEALXML [11], etc.), and the underlying theory design perspective to address the design methods that allow the planning and iterations in the students training. For each aspect, we will give a brief description of how this LCD take into account these aspects by extend the UCD description to present an approachable and more structured LCD philosophy.

As a conclusion of our study of m-Learning systems and the importance of setting up learners at the center of the design, the special needs of learners, we decided to cover, are addressed:

- Understanding is the Goal: The content material, we manage, must be presented in a way that students can learn it easily and at the same time be controlled by the teacher.
- Motivation is the Basis: Students must be motivated to learn, that is done when collaboration exists between learners (Chat, etc.) and applying the appropriate teaching techniques and methods: students have a strong tendency to delay resolving labors when confronted with a task for which they

are unprepared. Our systems resolve the problem and answer the question of: How can the teaching techniques and software play a role in supporting the learner's wavering motivation?

- Collaborative and Cooperative Learning: Classrooms students are composed of individuals from a diverse set of backgrounds, with a diverse set of levels, skills and abilities. How can our proposed e-Learning system be "one size fits all"?
- Interactive, Adaptable and present Feedback: the systems must be interactive and adaptable to the user needs and present the teacher a feedback, also it must present a user interface adaptable to the environment where the platform of the device where the application is installed.

After identifying the LCD approach we apply in the learning system, we present above the process we used to construct the learning system environment, between all the known instructional philosophies we elect the ADDIE model with some modifications to improve its use and adapt it to our system.

D. Instructional System DevelopmentEenvironment

The ADDIE model [12] is the most popular rendering of the specific phases using the ISD approach; it represents the five phases of any project, being Analyze, Design, Develop, Implement and Evaluate. Each phase is characterized by a set of activities and a sequence of project inputs/outputs. The output for one phase is the input for the next. Each phase also finishes in a retrial, which forms the decision, whether to proceed to the next phase or not.

A project initiation and planning phase precede ADDIE model phases. The planning phase determines the costs associated with the project and the expected organizational benefits from it. The basic project parameters such as objectives, scope, milestones and resource requirements are then drawn up to hand over to the Project Manager. To complete this phase, the Project Manager develops the project plan that is then used to guide and manage the project.

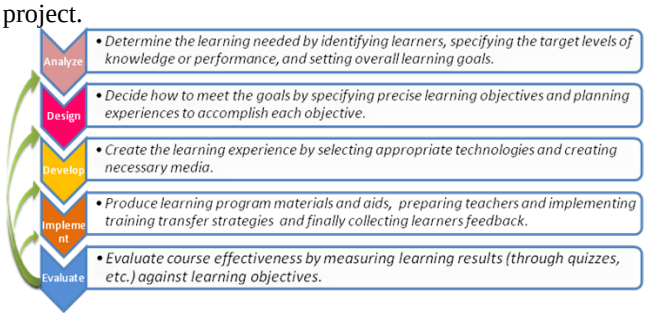

Figure 5. Instructional Development Process

Using ADDIE approach to create and make our system effective with high quality by involving teachers, learners, contents, learning environment and all the needed factors required to create the m-Learning system. It insures the identification of the proper target audience, instructional need, establish the instructional objectives, select the instructional strategies and evaluate and implement it. As we come identifying ADDIE process is the focus and center of our ISD as it serves as the fundamental basis for ISD models, and provides a valuable tool in creating effective systems. By applying ADDIE we ensure a step-by-step process in planning and creating the system. Figure 5. Shows a simple schematic of the ADDIE process, it covers the whole m-Learning system making questions that may provide the system all the needed elements and actions to make it complete. ''What do our students need to learn?'' to ''did they learn what is necessary and has performance improved?'' to ''what can be revised to improve learning?''. The improvement of the modern instructional systems, Model-Based, even that its development is not complex; there is no deep knowledge or exhaustive experience in this field. This imposes us to make use of new instructional design models in order to achieve our aim, without high cost, time efficiency, and high pedagogical quality of the final system, which will capitalize on the potential of the work with the MB-UIDE approach [13] [14]. This paper presents a model for constructing such systems, using a problem solving approach that defines the solution of an instructional problem in both a pedagogical and a technical manner in a complete view. This model tries to standardize the development of such systems supporting reusability at the design, implementation and presentation levels.

The system solution contains implementation of sub-systems: the human subsystem, final users (learner and teacher) actions and tasks, the learning resources subsystem, and the technical infrastructure subsystem. These subsystems are related entities that interact with each other in a complete way for the creation of the system architecture of the instructional system design environment, which is engineered to satisfy the requirements specified by the learning collaborative and interactive system adapting the learner-centered design needs, methods and tool, presented at section C. So in our case the aim of the instructional system is to support and automate the instructional process on the learning system, which might concern, for example, a course, a seminar or even a series of lectures [15]. From a different perspective, our systems intend to satisfy certain instructional needs for the subject domain, which have surfaced mainly because of the advances in research and technology. Instructional systems make a wide use of network technologies, especially the Internet, because of their potential, in advancing interactivity between learners and tutors, in offering flexibility concerning the way of learning, and in providing easy, one-stop maintenance and reusability of resources [16]. This trend entails the construction of complex instructional systems, and in our case the Instructional Systems Design Environments (ISDE) that incorporate a variety of organizational, administrative, instructional, iterative, collaborative and technological components.

IV. CONCLUSIONS AND FUTURE WORKS

This paper presents the mode which we use to construct our m-learning system, the learner educational content and teaching techniques all have been important factors in shaping in our design. Perhaps more crucial has been the

study and the focus on the students and teachers needs, tools and methods where students and teachers were involved in the design process. Through iterative and Learner-Centered Design and evaluation, we gained valuable information about designing m-Learning systems. LCD is a long-established goal in interface development; tools support for user-centered interface design in an integrated environment has lagged behind and currently is not available. One reason for this problem is that designing user interfaces requires relating, form one side, abstract concepts, such as user tasks, and in the other hand, relating concrete interface elements, such as the widgets in a dialog box. Current tools for interface development do not support that process, and tend to focus on widget layout. The question of what part of a user task is accomplished via a given interface component is answerable only in the designer's mind. In this thesis, we introduce a methodology, a development environment that uses declarative interface models as conceptual design units. These units allow the construction of interfaces by defining and relating user tasks and domain objects to presentation and dialog interface components.

Furthermore, ISD synthesizes for systematic learning development a methodology of instructional practice, research, and theory, as it exist a symbiotic relationship between its components. Designing and displaying a successful e-Learning system involves a variety of users coordinating their efforts to achieve the desired accomplishment, which is creating an instructional environment and materials that shall make learners be able to realize all needed tasks. As the system we are working with is an e-Learning system it incorporates e-Learning components, instructional design is applied to work as the process that construct the needed learning activities and instructional materials, from the general principles of learning for that a professional information technology is involved in several parts of the combination of learning resources and the analysis, design, development, implementation and evaluation process, ensuring that each part of work is performed at the correct time by using the needed amount of resources and according to the correct standard.

By crossing the road of these two approaches before mentioned we obtained a solution for the classroom education, by presenting the educational tool, MPrinceTool which make use of the high technology, like the mobile devices, Wi-Fi connection, as presenting collaborative environments. Also it helps students to participate more in class and join each other in the educational activities. It allows them to interact with the learned subjects, and teachers can have direct feedback and more detailed information about student's progress. As we are developing this tool in a way that students who are out of classroom can participate in the class work.

As a future work we are studying new methods and teaching techniques like the classroom assessment techniques to make it more collaborative and interactive, as we have start to work in merge it development to Model-Based environment so the content and the interface can be totally independent and it could run over another platforms and operating systems without any changes in it.

ACKNOWLEDGMENT

We would like to thank CENIT project (CENIT 2008-1019-MIO!) for funding this work.

Also we would like to express special gratefulness to Jose Santiago Tercero Alfaro for his support in the tool design.

REFERENCES

[1] ITU. International Telecommunication Union. Measuring the Information Society. 2010. Last access 12/04/2010. http://www.itu.int/ITU-D/ict/publications/idi/2010/Material/MIS_2010_Summary_E.pdf

[2] Y.S. Chen, T.C. Kao, J.P. Sheu, C.Y. Chiang, 2002: 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.

[3] S. Cakula, M-Learning: new way to access knowledge library online. IEEE Multidisciplinary Engineering Education Magazine, Vol 4, No 1 (2009).

[4] M. Sharples, 2000. The Design of Personal Mobile Technologies for Lifelong Learning. Computers and Education, 34, 177-193.

[5] Habib M. Fardoun, Pedro G. Villanueva, Juan Enrique Garrido, et al., "NEW ERA OF M-LEARNING TOOLS Creation of MPrinceTool a Mobile Educative Tool". ICEIS 8-12 June. Portugal

[6] R. Tesoriero, H. Fardoun, eta., 2009. Human-Computer Interaction. Interacting in Various Application Domains. ISBN: 978-3-642-02582-2. 236-245. Pages 236-245.

[7] P., Gonzalez-Villanueva, S. Romero, R. Tesoriero, J. A. Gallud., 2009. WallShare: A Collaborative Multi-pointer System for Portable Devices. Universidad de Castilla-La Mancha. Departamento de Sistemas Informáticos. DIAB-09-10-1.

[8] EHEA, European Higher Education Area. Last access 01/01/2010. http://ec.europa.eu/education/lifelong-learning-policy/doc62_en.htm

[9] Jackson, S., Stratford, S., Krajcik, J., & Soloway, E. (1996). A Learner-Centered Tool for Students Building Models. Communications of the ACM, 39 (4): 48-49.

[10] Usixml: http://www.usixml.org/

[11] Francisco montero, Victor Lpez-Jaquero. IdealXML: An Interaction Design Tool, A Task-based Approach to User Interface Design. Computer-Aided Design of User Interfaces V. ISBN: 978-1-4020-5819-6 (Print) 978-1-4020-5820-2 (Online). Pages245-252. October 05, 2007.

[12] College of education: ADDIE. http://ed.isu.edu/addie/

[13] Paulo Pinheiro da Silva. User Interface Declarative Models and Development Environments: A Survey. Proceedings of DSV-IS2000, volume 1946 of LNCS. 2000

[14] Habib M. Fardoun, Francisco Montero, Víctor López Jaquero. eLearniXML: Towards a model-based approach for the development of e-Learning systems considering quality. Advances in Engineering Software Volume 40, Issue 12, December 2009, Pages 1297-1305.

[15] Gagné, R., Briggs, L., & Wager, L. (1994). Principles of Instructional Design. Fort Worth TX: HBJ College Publishers.

[16] McCormack, C., & Jones, J. D. (1997). Building a Web-based Education System. Wiley Computer Publishing.