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THE IMPLEMENTATION AND EVALUATION OF AN ONLINE COURSE AUTHORING TOOL (OCATLO)

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ABSTRACT

This paper presents the development of bilingual e-learning system and reports on its usability on a set of computing courses according to a specific e-content development methodology. The system is organized into five layers. The selection of layers and their inter-dependencies is intended to make the functional responsibility clearer and to cover all of the e-learning functional components. The tool is equipped with a tracking system to observe users' learning activities in real-time by monitoring the major possible number of behavioural aspects. The tool can be used for Arabic or English e-contents, or a mix of the two languages. It has been used in various computing courses where it has been proven helpful to students and teachers alike.

Keywords: L*earning objective, learning object, LMS, online course authoring tool, e-content structuring.*

1. INTRODUCTION

During the last years and with the rapid growth of IT, e-learning has become increasingly popular. Several learning systems have been proposed, developed, and implemented in order to contribute in the modernization of the education system. However, many e-learning systems have grown organically without a clear picture of the components of typical e-learning system architecture or how they interrelate. There are standards about a conceptual component model of e-learning architecture such as LSTC of IEEE [1]. However, there is a lack of an implementable architecture that clearly defines the means to: (i) combine the information model with the component model, (ii) define an appropriate interface among various components, and (iii) achieve interoperability. Additionally, the existing e-learning solutions focused more on the convenience of construction and management of solution providers but less on the convenience of the system usability for learners and instructors.

The development of e-contents represents a pivotal importance in the success and efficiency of e-learning systems. Most systems use objects to create e-content. However, the reusability of the e-contents objects remains relatively low.

In an attempt to avoid the lack of the existing e-learning systems and to maximize the benefits of e-learning users whose native language is Arabic language but whose instructional media is either English, Arabic, or mix of the two, we propose, design, implement, and experiment with an architecture of an Arabic e-learning system. The system makes extensive use of a combination of learning standards. It has been designed and composed by re-usable entities. The proposed system satisfies the following requirements:

1. The support of a learning management system which offers a set of support services to different types of users (author, student and tutor).
2. The provision of an authoring tool that facilitates the building of e-content based on a particular structure called pedagogical learning objective, publish, update, delete reusable learning objects, and create the course structure.
3. The definition of a repository of e-content

that enable upload, classification and access of reusable learning objects.

The remaining of the paper is organized as follows: In section 2, we present the related work. In Section 3, we detail the proposed Arabic e-learning system, its entities and the interoperability between them, and the services it offers. We also describe the different components of the architecture from a conceptual point of view, and we argue how reusable-learning objects can be adapted and assembled in different e-learning scenarios. In section 4, we present an evaluation based on our experiment with the system. Section 6 concludes the paper.

2. RELATED WORK

The popularity of the Internet and the rapid growth of web-based service technologies have influenced the pursuit of education towards on-line learning. Online learning and education environments overcome geographical and temporal constraints as process of learning can occur at the independently determined convenience of instructors and learners [2]. Online education service markets such as Cyber University are rapidly expanding.

Increasing usage of on-line learning has lead researchers to propose different architectures [3] [4] [27] and standards [1] of their conceptual components. An e-learning architecture is impacted by various aspects including available technologies, pedagogical principles [5] [6], usability, true awareness and benefits as well as cultural impacts. It is observed, however, that there is a lack of an implementable architecture to define how to combine the information model with the component model and how to define an appropriate interface between each component and subsystem to achieve interoperability. Nowadays, the e-learning community has several sets of technology standards and is currently developing additional standards [7] [28]. The ultimate vision is to have interoperability throughout the entire e-learning market. Until then, the e-learning community is fragmented into different systems adhering to various standards.

Systems that use common standards include Blackboard, WebCT, Moodle, ALFANET, and .LRN. Blackboard [8] provides course and content management systems as well as a set of collaboration tools. It is one of the popular commercial e-learning systems. WebCT [9] is another commercial Course Management System. Moodle [10] is a freeware Course Management System (CMS). The general design in Moodle tries to consider pedagogical principles and learning theories. The lesson module of Moodle also provides different learning paths. ALFANET [11] [12] was developed within a European project from May 2002 to April 2005. Its architecture is service-oriented, uses multi-agent technology and is based on several standards [13] (e.g. IMS-LD, IMS-QTI, IMS-CP, IEEE-LOM, IMS-LIP). .LRN [14] is an open source e-learning and community building software originally developed at MIT. Today it is supported by a worldwide consortium of educational institutions, non-profit organisations, some industry partners and open source developers. .LRN is built on the top of OpenACS (Open Architecture Community System) [15] which is a toolkit that is intended for building scalable, community-oriented web applications.

Those platforms provide authoring tools based on the ADL Sharable Content Object Reference Model (SCORM) [16]. The main limitation of the SCORM-based courseware authoring tools is that they are based on a “single learner model” [17]. Moreover, the interactions between users in the SCORM and SCORM-based authoring tools limit the interoperability between systems to only content interoperability.

Other e-learning systems include. ATutor [18], Bodington [19], BSCW [20], CLIX [21] and Learning [22]. ATutor [18] is is an open source system supporting learning and content management and specifically considering accessibility and adaptability issues. Bodington [19] is an open source LMS specialized on higher and further education developed by the University of Leeds. The main target is to be pedagogically flexible. In September 2006 the University of Oxford, the University of Cambridge, the UHI Millennium Institute and the University of Hull announced the “Tetra Collaboration” between Sakai and Bodington. BSCW [20] (Basic Support for Cooperative Work) is a commercial shared workspace system mainly supporting advanced document management. Additionally it offers group and time management facilities as well as communication features like discussion boards, annotations and surveys. CLIX [21] is a commercial LMS developed by the information multimedia communication AG. It is available in different releases especially suitable for several different application scenarios. Additionally there are a couple of auxiliary features that can be added to the basic application in order to fit the individual needs of a scenario or project. OpenUSS with Freestyle Learning [22] was

developed by the University of M¨unster (starting in 2000). According to the website [22] “Freestyle Learning (FSL) and Open University Support System (OpenUSS) are specifications for Learning Content System (LCS) and Learning Management System (LMS). PeLP (Public e-Learning Platform) [23] [27] is a e-learning environment based on open source and open international ICT standards, where educational services can be developed and exchanged between as well as within systems.

The wide variety of the non-standards platforms provides specific pedagogical approaches including active learning, constructive learning, collaborative learning, etc. [24]. The main lack of those systems is the re-usability and the fact that they cannot support all the required functionalities in a learning process. Further, they are non-flexible in supporting different pedagogical approaches and they require extensive redesign effort in order to be used in different domains [17].

3. THE PROPOSED BILINGUAL E-LEARNING SYSTEM AND THE INTER-OPERABILITY AMONG ITS COMPONENTS

The proposed bilingual e-learning system (OCATLO) consists of the following layers: Users Layer, Interface Layer, E-Learning Management System Layer, Content Management Layer, E-learning Tracking System and the Database Content Layer. This structure makes the functional responsibility clearer and attempts to take accounts of all of the e-learning function components. It also defines the standards upon which the information should be interchanged among each component. Figure 1 depicts the overall structure of the proposed system. This is an improved architecture of the 3-layer functional model presented for OCATLO in [29]. Further, the system presented in [29] does not provide for a tracking component to monitor the usability of system and the learning activities. This has been particularly helpful in collecting data which is analyzed and reported in Section 4.

Interface Layer: The design of the e-learning platform depends on the different kinds of users (students, teachers, tutors, and administrator). It is purposed to meet their requirements. The user layer is supposed to keep the version of their learning assets for different online learning solutions in a re-usable and interoperable manner.

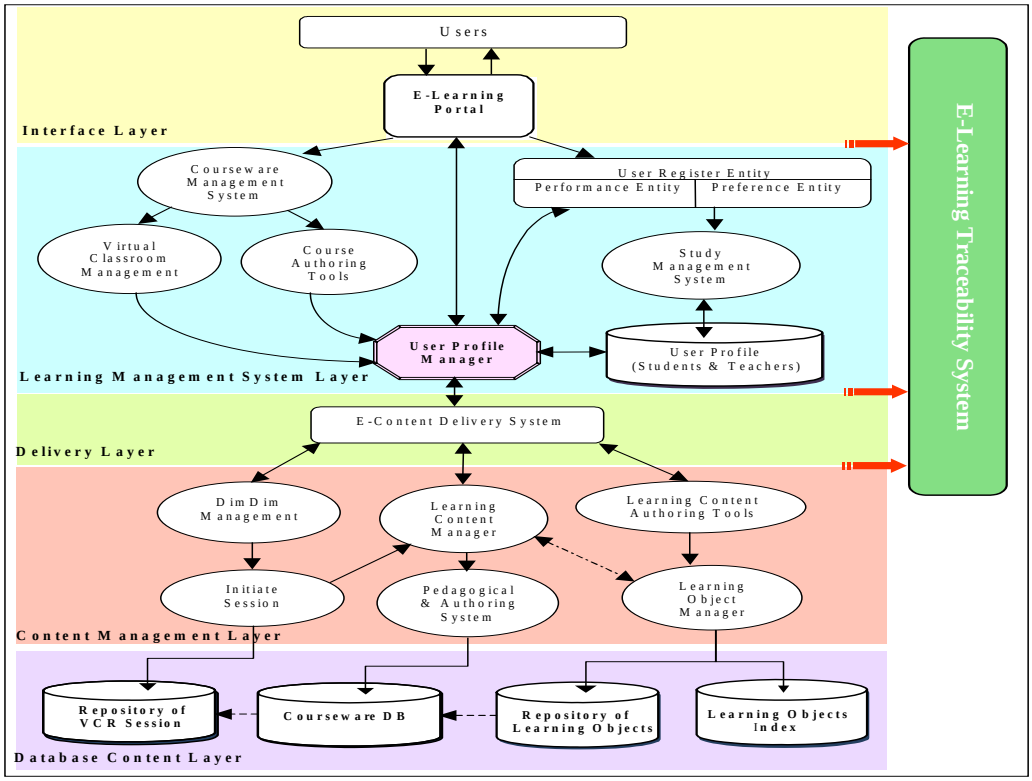

Figure 1: E-Learning Functional Model

The e-learning portal is an entity associated with the user's and interface with a wide range of goals. Mainly it monitors the user's actions, and giving access to e-learning system resources. This entity controls the access to the user's profile and can interact with tutor, teachers', and other students'. Users have access to the learning environment by connecting to the Arabic E-learning System via any browser supporting Java applets, and logging to the application. The users' interface is first presented as shown in figure 2-a.

Figure 2-a: Interface layer to access to the system

For example, from this window students have access to the class they belong to, the exercises to be solved and, from the bottom of the window; students can establish a simple dialogue with their personal interface. Once a student has chosen course or exercise to work on, content viewer (figure 2-b) is started including voice and other recording object.

Figure 2-b: Interface layer to the content viewer

The interface of the teacher is similar to the student's general interface with an extra functionalities in the application allow teachers to insert and distribute new learning objectives, supervise students while they are working and exchange messages (figure 2-c). Students and teachers are dynamically organized in virtual classes according to their levels. Virtual classes determine sub-societies of users, students and teachers. Members of the same virtual class can see each other and exchange messages.

Learning Management System Layer: The LMS integrates all the aspects for managing online teaching activities. In particular, it aims to offer management functionality to training platform users: system administrators, teachers and students (figure 3).

Figure 2-c: Teachers' Interface layer

Therefore, the functionalities of a LMS integrated within a distance learning platform can be synthesized as follows: Course management, Study management, Student skill assessment, Student activity monitoring and tracking, Activity reporting. In fact, the User Profile Manager is responsible for collecting all the information needed to give a decision, and then passes this information to the Delivery Layer. The Delivery Layer takes the information and processes it for effective decision making. User Profile DB includes personal data, learning plans, learning history, accessibility requirements, certifications and degrees, assessments of knowledge and the status of participation in current learning. Learner registration information allows learning delivery and administration components to know what offerings should be made available to a learner, and provides information about learning participants to the delivery environment.

The Learning Management System Layer provides the user profile manager with the user preferences. The information collected is stored in the user profile. All information concerning time-related parameters and the user's behaviors are obtained through the performance entity and the accounting entity. The preference entity perceives

the interaction of the user with the Interface Layer and continually performs actions to manage student's preferences. The performance entity calculates the performance metrics when the student leaves the system and evaluates the student activities.

Figure 3: Administrator page

Content Management Layer: It offers services that allow managing contents while paying particular attention to their creation, importation and exportation from a Database Content layer. It consists of:

a. Learning Content Manager: It offers a set of tools for the managements of courses, lessons and teaching materials. As soon as courses are built, the learning Content Manager retrieves the related teaching materials and arranges Learning Objects into learning objective according to profile information and the pedagogical and authoring system. The pedagogical and authoring system mirror the activities of the teachers to conduct the courses in heterogeneous environment, collaborative and synchronous situation. The content is structured on the basis of the concept of learning objective, defined as a set of learning objects that can be evaluated according to performance goals to develop coherent information structures that help to build knowledge schemata that are in the learner's mind. The Learning Content Manager component also allows previewing and publishing of courses that will be displayed to the students via the E-content Delivery System. The process of e-content structuring, created by the content authoring tool, is governed by objectives. The author has to be aware in each of the course creation steps from analysis to evaluation what objective is required and what information on the learner is of relevance.

At the beginning, the author lays down the global objective (GO) of the topic which he wants to create. Next, the GO is broken up into a list of general objectives (GnO). Using the list of GnO, the author will create the course plan. Following, each GnO is examined keeping in mind the specific knowledge that will contribute to attain the GnO. The specific knowledge constitutes a learning objective (LOb). A LOb is the specific knowledge that the learner has to acquire about a concept or skill and the tasks to be performed. It may be the case that a learning objective includes several Learning Objects (LO). Figure 4 illustrates.

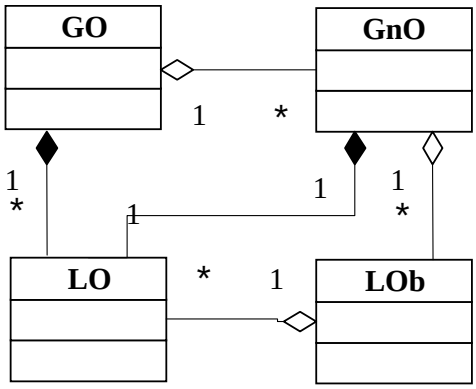

Figure 4: UML class diagram of the e-content

b. Learning Objects Manger and Learning Content Authoring Tools (figure 5): The learning objects manager allows authors to create and modify learning content objects. It allows content authors to locate existing contents to reuse or repurpose them rather than recreate them. This make use of the content and learning object repositories which allow users to develop, index, find, and reuse learning objects. The learning content authoring tools is intended to help instructors in our school to develop multimedia-based e-contents using a simple editor and its focused on making an interactive content using various rich media. The process of learning objects creation and registration follows a model of writing and registering on an information retrieval system to access easily by teacher. The tool has been developed from experiences and insights gained over a stage content development training process involving university lecturers in computer science and engineering subjects. Each teacher can create the contents and register them as writing using the learning content authoring tools by connecting his own lecture interface. The aim of the tool is to facilitate the process so that the teachers can prepare the course content in any software system (i.e., any format) and a developer converts the content to the tool format, or the teachers can develop the course in the tool format. It will guide the teacher to prepare the content via

a simple interface. Making an account for the cultural aspect as an important element of concern, the tool is made to support both the Arabic and English languages. Figure 5 shows the preparation of different learning objects concerning the topic programming language. When the prepared content was finished, it will be indexed in the Learning Objects Index DB and registered in the Repository of Learning Objects.

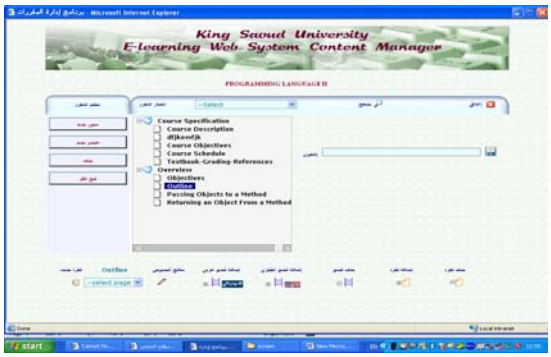

Figure 5: Management of the e-content

c. The e-content delivery system provides the learner with access to the learning contents and other components of a learning environment such as chat, email, quizzes, multimedia players, collaboration tools, application sharing, shared whiteboards (virtual classroom), etc. In addition, the environment provides necessary tools for instructors.

d. Dim Dim Management: **Dim Dim Inc.** [25] offers online Web conferencing service where the author can share its desktop, show slides, collaborate, chat, talk and broadcast via webcam with absolutely no download required for attendees. We integrated this tool in our e-learning system. Using Dim Dim the author can create a session of Virtual Class Room with their students (figure 6 shows the creation and activation of a Virtual Class Room (VCR) Session) and present a course using a whiteboard (figure 7).

Figure 6: Creation of activation of a VCR Session

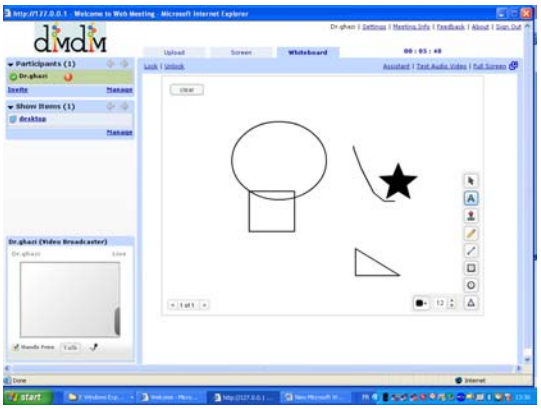
Figure 7: Online Web conferencing using a whiteboard

Database Content Layer: Learning content must be organized in a consistent way to support the indexing, storage, discovery (search), and retrieval of learning objects by multiple tools across multiple repositories. Our architecture supports a database repository, which includes learning contents of e-learning system, these contents are arranged into Repository of re-usable Learning Objects, Learning Objects Index, the Courseware Database and Repository of Virtual Class Room Session.

a. Repository of Learning Objects: It contains all the learning objects used in the various stages of an e-learning objective. The learning objects are defined, as a sequence which represents one idea about a specific topic, and can be displayed in one web page. It is a short text, image, exercise, video, audio …etc. and can be equivalent to one hour in traditional learning.

b. Learning Objects Index: Nowadays, the most successful techniques for medium size databases combine online and indexed searching. The Learning Objects Index is a word-oriented mechanism for indexing a learning object in order to speed up the searching task when we want to define an e-learning objective or to reuse learning object. The Learning Objects Index structure is composed of two elements: the vocabulary and the pointers. The vocabulary is the set of main words describe the learning object and each pointer points to an e-learning object.

c. Courseware Database: The Courseware Database is divided into three levels. The first level contains a set of domains. Every domain contains a precedence graph which describes the order of courses prerequisite. The second level contains plans of the Global Objectives of courses and General Objectives they consist of. The third

level contains the Learning Objectives. Each learning Objective is organized in an AND/OR directed acyclic graph with the various nodes connected by arcs representing whether one is preliminary to another. Each node represents a reference to a Learning Object in the Repository of Learning Objects.

d. Repository of VCR Session: It contains all the session of virtual classroom created by authors using Dim Dim.

E-learning tracking System (ETS): E-learning can be very helpful for different learning activities in various learning environments. However, in order to support different teaching and learning paradigms, e-learning should deal with more than simply reading online lessons. Therefore, content as well as communication and collaboration have to be supported in a highly personalized manner by e-learning systems [26]. Based on the global objectives of an enhanced e-learning environment, our system architecture contains an e-learning tracking system in order to observe users' learning activities in real-time by monitoring the major possible number of behavioural aspects and personal traits.

The ETS gives relevant information concerning the standards of design and development, and program delivery and provides a relatively easy approach for the evaluation of the richness of e-learning resources and interactions. Using the ETS, we can evaluate the full course cycle from course design to course validation and included authors, tutors and students. This is involves the concept of interactivity: how students interact with learning materials, with the teacher and with peer learners. The advantage of interpreting these data in real time lies in gaining prompt information about the user's state. However, a full understanding of e-learning situation requires measurements across two main domains which can determine the quality of e-learning in university: design and development, and program delivery which they are directly related to the nature of the online activities students are engaged in, and hence also to the level of engagement they have in the activities. The ETS summarizes the amount of information to be recorded concerning the question about popularity and about the nature of the online activities for each course and highlights the different information which can be collected to see to what extent the teachers and students have been engaged in the various types of activities, and how far we can go backward/forward to retrieve relevant information delivered by the platform concerning any user's actions. The tracking is based on the frequency of access by students and by teachers to the platforms in general. Our ETS provides the administrator with an evaluation report in a standard format. The report can be saved or printed. This report are related to the following main evaluation questions are being performed and they pertain to: the interface issues, pedagogical issues, information architecture issues, accessibility/delivery issues, multimedia issues and the quality and reusability of learning designs.

4. A PERFORMANCE EVALUATION OF OCATLO REUSABILITY

The high prices of the existing virtual environments for teaching and learning and the lack of interface in Arabic proved to be the main obstacle to the emerging Internet-based education. This was the reason why we elaborated our own environments for virtual education which provided interface in Arabic as well. In the last two years research project teams in our universities have been working on the design of e-learning information systems with Arabic interface, which undoubtedly contributes to the popularization of e-learning among academic staff, students and teachers. The development of e-contents is provided for both the Arabic and English languages. Evaluation of e-learning platforms requires evaluating not only the implementing software package, but additional features as well, including, among the others the supported teaching and delivering schema, the accessibility and so on. In fact, we developed a second prototype of e-contents in Arabic and English languages in several computing courses, including data structure, advanced database, artificial intelligence and compilers. The number of students registered in these courses, initially restricted to 200 students in the courses conducted in Arabic and 50 students in courses with English e-content. The reports from the ETS enable the following types of data comparison and histograms. The two histograms bellows concerns the question about the popularity and nature of the online activities for each course. The figure 8 illustrates the average of visits per week to the course after one month of the students' registration.

We notice that the popularity of the course depends on the nature of the language with which is written. We distinguish that the courses written in Arabic are more appreciate by students. Figure 9 illustrates the percentage of nature activities for

each e-content: the content, homework, assignment, and discussion.

Figure 8: Average of visits to e-content per week after one month.

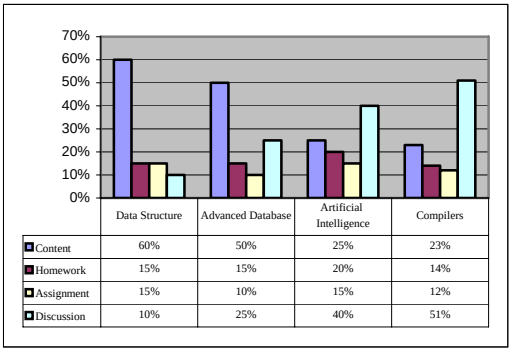

Figure 9: Percentage of nature activities for each e-content.

Concerning whether students are engaged in the various types of activities, we addressed the question about the engagement of students in the discussion activity. We wanted to know what tool of communication student prefer? Figure 10 shows that most students prefer e-mail and few students used forum.

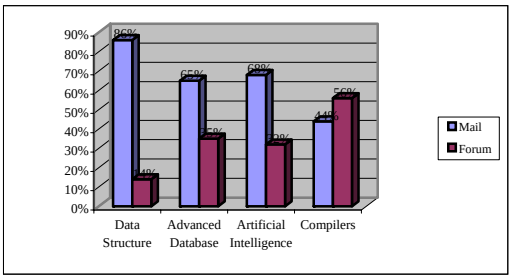

Figure 10: Percentage of students in each e-content who use mail or forum.

5. CONCLUSION

We have reported on the development and evaluation of an authoring tool that is intended for bilingual learners. The tool can be used in Arabic or English e-contents. It has been used in few computing courses where it has been proven helpful to students and teachers alike.

The functional model that has been adopted structures the learning system into the following layers: Users Layer, Interface Layer, E-Learning Management System Layer, Content Management Layer, E-learning Tracking System and the Database Content Layer. This structure makes the functional responsibilities clearer and covers all e-learning functional components. It also defines the flow of information and the manner in which they should be interchanged among components. The tool is equipped with a tracking system to observe users' learning activities in real-time by monitoring the major possible number of behavioural aspects and personal traits. Several functions were observed for different students and findings have been reported. Currently, we are in the process of improving the tracking system and in collecting data to be analyzed for possible improvement of the system.

The tool adopts a clear e-content development methodology that evolved from surveying previous experiences of computing teachers in different computing subjects. The content is structured on the basis of the concept of learning objective, defined as a set of learning objects that can be evaluated according to performance goals to develop coherent information structures that help to build knowledge schemata that are in the learner's mind.

Several instructors were presented with the methodology and were asked to re-design their courses so that they can be used in an e-learning environment using our tool. The courses include software engineering, project management, programming and data structure, databases, networking and information security courses. Students were voluntarily asked to use the system supporting the developed courses. Statistics were collected and are reported. The experiment showed that fifty six percent of the students in four computing courses use the platform for learning-related activities in a voluntary basis. Courses adopting Arabic e-contents compared favorably to courses adopting English e-contents. The system provides a mix of Arabic and English e-contents. We are in the process of evaluating

the impact of the system on the performance of students who are using Arabic and English e-contents separately as compared to that of mix e-contents.

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6. REFERENCES

[1] L. Xiaofei, A. El Saddik, and N. D. Georganas, "An implementable architecture of an e-learning system", presented at Electrical and Computer Engineering, 2003. IEEE CCECE 2003. Canadian Conference on, Montreal, Canada, 2003.

[2] Harris D., DiPaolo A., Goodman J. (1994), ADEPT proposal, http://stanfordonline. stanford.edu/history/fulldesc.html

[3] Ahmad, H., Udin, Z.M., Yusoff, R.Z. (2001), "Integrated process design for e-learning: a case study", The Sixth International Conference on Computer Supported Cooperative Work in Design 2001, 488-491.

[4] Gerhard, J., Mayr, P. (2002), "Competing in the elearning environment-strategies for universities", Proceedings of the 35th Annual Hawaii International Conference on System Sciences 2002, 3270-3279.

[5] Koper, Rob (2005). Learning Design. A handbook on modelling and delivering networked education and training. In Koper & Tattersall (Eds). Berlin: Springer

[6] Noble, D. "E-learning Application Infrastructure," "Fool's gold: Digital diploma mills, Part V", 2001, http://communication.ucsd.edu/ Sun Microsystems . White paper of Sun Microsystems, 2002.

[7] Jeff Harris, An Introduction to Authoring Tools, March 2002 edition of ASTD's Learning Circuits online magazine.

[8] Blackboard - Educate. Innovate. Everywhere. http://www.blackboard.com.

[9] WebCT.com. http://www.webct.com.

[10] Moodle - A Free, Open Source Course Management System for Online Learning. http://www.moodle.org.

[11] ALFANET. http://rtd.softwareag.es/alfanet.

[12] Peter Van Rosmalen et al, "Authoring a full life cycle model in standards-based, adaptive e-learning", (2006), Educational Technology&Society, 9 (1), 72-83.

[13] Santos, O. C., Boticario, J. G., & Barrera, C. "A Machine Learning Multi-Agent architecture to provide adaptation in a standard-based Learning Management System", 8th WSEAS International Conference on Computers, July 12-15, 2004, Athens, Greece.

[14] dotLRN. http://www.dotlrn.org.

[15] OpenACS Home. http://www.openacs.org.

[16] Sharable Content Object Reference Model. http://www.scorm.com.

[17] Pythagoras K. and Demetrios S. "A flexible authoring tool supporting learning activities" In Proc. Of IADIS International Conference on Cognition and Exploratory Learning in Digital Age (CELDA 2004), Lisbon, Portugal.

[18] ATutor Learning Content Management System. http://www.atutor.ca. [Blackboard].

[19] Bodington.org. http://bodington.org.

[20] BSCW. http://bscw.fit.fraunhofer.de.

[21] IMC - Lernplattform CLIX, Rapid Authoring LECTURNITY, LMS und eLearning L¨osungen. http://www.im-c.de.

[22] CampusSource, OpenUSS & FSL. http://campussource.de/software/openuss.

[23] Ambjörn Naeve, Mikael Nilsson, Matthias Palmér and Fredrik Paulsson "Contributions to a public e-learning platform: infrastructure; architecture; frameworks; tools" Int. J. Learning Technology, Vol. 1, No. 3, 2005.

[24] Constantino G. et al, "Coaching Web-based Collaborative Learning based on Problem Solution Differences and Participation". International Journal of Artificial Intelligence in Education, vol. 13(2-4), pp. 263-299.

[25] Dim Dim: http://dimdim.com/.

[26] Christian G. et al. "AdeLE (Adaptive e-Learning with Eye-Tracking): Theoretical Background, System Architecture and Application Scenarios". I-KNOW '04, Graz, Austria, 2004.

[27] Ambjörn N. et al, "Contributions to a public e-learning platform: infrastructure; architecture; frameworks; tools", Int. J. Learning Technology, Vol. 1, No. 3, 2005.

[28] Jemni M. et al. "Evaluation and perspectives of an innovative Tunisian e-learning experimentation". International Conference Advances in Infrastructure for e-Business, e-Education, e-Science, and e-Medicine on the Internet, L'Aquila, Jul 29 - Aug 04 2002, Italy.

[29] Mathkour, Hassan and Salah Hammami, "The Architecture and Design of an Online Course Authoring Tool Using Learning Objects (OCATLO)", The European Journal of Scientific Research, Vol. 21, No. 3, 2008.