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A Configurable and Extensible Portal Framework for E-Learning Environments

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Abstract. The development of ICT and web technology provides e-learning many useful and effective tools such as wikis, blogs, asynchronous/synchronous communication. Research has shown that specific learning context and objectives require particular e-learning settings. This paper describes a configurable and extensible portal framework that can be tailored to specific e-learning environments. There are three key features of the portal framework: (1) learning community configuration, role settings and system extension; (2) knowledge sharing and management; (3) learning space integrating various e-learning tools. The portal framework can be used for configuring specific e-learning environment and can integrate state of the art e-learning tools.

Keywords: e-learning environment, portal, CSCL, knowledge management, learning community.

1. Introduction

With rapid development of ICT and its applications, especially web technology and applications, e-learning has received substantial attention from both research and practice community. Generic tools such as e-mail, file transmission, electronic bulletin boards, chat, blogs, wikis, audio and video systems, asynchronous/synchronous communication tools have been proven useful and effective in education and learning [4]. More advanced and integrated e-learning systems such as CMS (Course Management System) and LMS (Learning Management System) integrated various tools to support more effective learning. There are also various virtual learning environments such as Blackboard/WebCT, Moodel, Sakai, Claroline and FirstClass widely used in both business and education sectors. With the emerging of CSCL (Computer Supported Collaborative Learning) in recent years, tools and environments supporting collaborative learning attract research in educational, pedagogical, technological perspectives [1,4,5,6,7,8]. Various researches also show that e-learning tools and environments should be developed with respect to the learning objectives, educational and pedagogical principles [4,5,6,7]. Any specific e-learning tool is not sufficient to best use the state of the art technology and make the most effective learning support. It is therefore needed software tools and frameworks that are flexible for settings of different learning purposes and context, and extensible for integrating specific learning tools for particular learning effect.

The objective of the research reported in this paper is to develop an integrated software platform in which a range of learning environments can be configured for different learning context. The software platform should also provide facilities to support integration of various learning tools in future. The research at the current stage has a focus on university level e-learning environments supporting blended learning approach rather than fully online learning.

The research uses enterprise portal architecture for the design and development of the configurable and extensible portal framework to development desired e-learning environments. The portal framework supports

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three distinguished features: (1) a learning organization and role management system supporting configurations of learning communities, roles and new tools integration; (2) a knowledge management facility to support organization of structural knowledge and roles to manage the knowledge; (3) a learning space to support an integration of learning tools in supporting individual learning, knowledge sharing, collaborative knowledge creation and construction, and assessment.

Section 2 describes the background and related works. Section 3 describes the architecture and main components of the portal framework. We briefly conclude the paper and discuss future work in Section 4.

2. Background and Related Works

The portal architecture, especially enterprise portal architecture, has been proven an ideal architecture for service-oriented architecture in many areas such as business intelligence [3, 9]. The architecture is particularly useful in building collaborative environment, such as in multidisciplinary design engineering [2].

Resta and Laferriere conduct a systematic review of technology on support of collaborative learning in the past 20 years before 2007 [4]. Based on their research, six recommendations for future research are discussed. Among them, the fifth recommendation is directly related to software tool support: "*More research is needed on the design elements of CSCL tool software to determine the extent to which they support, structure, regulate, facilitate of constrain the interactions of teachers and students (...)*."

There have been many research and tool development in the last few years. For examples, Knowledge Forum supports intentional learning and high-level processes of collaborative learning; TAPPED_IN supports virtual rooms for distributed communities to communicate synchronously; Belvedere supports collaborative learning through inquiry diagrams; CoVis uses collaborative visualization for cooperative project work. Few of existing e-learning tools are developed for configuration and extension.

Research described in [8] studies a more structural approach that uses knowledge mapping representations to replace the threaded discussion in the context of problem solving by asynchronously communication. The results show that the users of knowledge maps created more hypotheses earlier than users of threaded discussions. Research described in [7] proposes a process-oriented methodology in which a systematic design attention is paid to the relationship between learning outcome and group interaction. The research concludes that a number of variable critical elements affect interactions for collaboration: learning objectives, task-type, levels of pre-structuring, group size and computer support. This indicates that a learning environment supporting collaborative learning should support flexibility in configuration on interaction process, along with many other learning environment factors.

Many previous collaborative learning environments and tools were more or less from the software point of view with little consideration on the educational and pedagogical background. Research in [5] describes how to design web-based collaborative learning environments with respect to seven pedagogical learning principles. The paper also evaluates the software applications developed along the line and concludes that the applications have satisfactory results. The five of the seven pedagogical principles are directly relevant to the objectives of this paper: designing for flexibility and modularity, facilitating knowledge construction rather than providing a discussion forum, providing tools for structuring and coordinating activity, designing tools for process analysis, and providing support for community building.

Soller, et al review the state of the art technology for supporting collaborative learning more from the types and depth of interaction support [6]. Their study shows that there are different types of supports for interactions in collaborative learning environments, ranging from mirroring to guiding interactions. The research indicates that different types and depth of supports would be needed for different learning objectives and might be extended from time to time. This requires a learning environment should be more flexible in terms of configurability and extendibility.

Gogoulou et al report a web-based educational setting that supports individual learning, collaborative learning and assessment [1]. A framework referred to as SCALE (Supporting Collaboration and Adaptation in a Learning Environment) is described and positive formative evaluation of the framework is reported. SCALE supports learners to work individually and collaboratively, as well as to be involved in various assessments. The framework also supports integration of other e-learning tools but how the integration is

done is not described. The framework SCALE is more of a logical framework and the software framework implementation is not discussed.

3. The Portal Framework for E-Learning Environments

3.1. The Portal Architecture and Components

The design and development of the portal framework are based on the following overall objectives: (1) it should have basic features of portal such as single entry point, organization configuration, authority and role settings;(2) it has support for proven effective basic learning tools and functionality such as online audio and video support, various knowledge construction communication facilities, structural knowledge management;(3) it has configuration supports for learning community, knowledge organization, and learning tool settings; (4) it should support integration of new components without modifying and redeveloping the software as long as the new components confirm the interface protocols. The interface protocols are based on the underlying database design and support web service methodology [3]. The following Fig 1 illustrates the basic architecture of the portal framework.

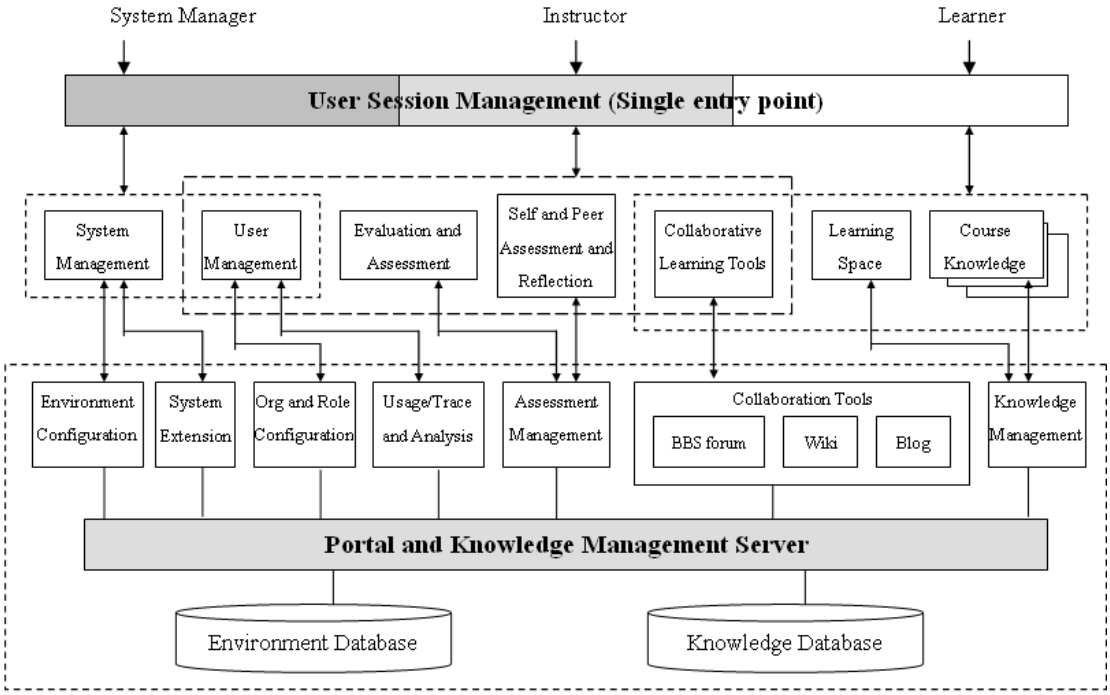

Fig 1 Basic architecture of the portal framework for e-learning environments

The portal framework is implemented in J2EE, using Struts, Hibernate and Spring architectural frameworks. An application based on the portal framework can be easily deployed on a workgroup level server, supporting over 2,000 registered users with a maximal number 600 of simultaneously online users.

Due to the space limitation, Fig 1 does not illustrate all components of the current version of the portal framework. Fig 2 illustrates the logical components of the current version. On top of the portal framework, there are three major components: knowledge portal supports structural knowledge organization including the knowledge to be learned or constructed, and the information related to the learning community; learning space supports individual learning, online learning such as free learning or guided learning in forms of text, audio and video, collaborative learning, assessment, self and instructor management; management and maintenance contains three sub-components: (1) system support on learning community, authority and role configuration and management; (2) system support for integrating further learning tools, either by compliant to the component interface protocols (tightly coupled) or by web service UUDI facility (loosely coupled); (3) specific support for usage statistics and analysis for the effectiveness assessment from educational purposes. Once a specific e-learning environment is configured and deployed, instructors and learners can easily use the system for learning, communication, and assessment without a need to know further technological details. With sufficient training, normally can be done within three to five days, more advanced users can use the

portal framework to modify, re-configure, and extend the environments for further specific requirements and context.

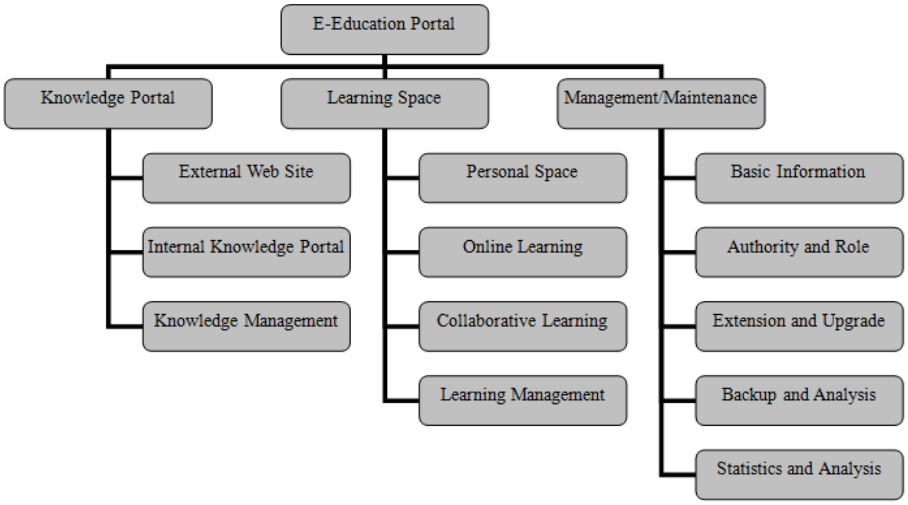

Fig 2 Components of the portal framework for e-learning environments

3.2. The Configuration for an E-Education Portal

An e-learning environment can be configured using the portal framework. The configuration consists of three steps. The first is to define and set the learning community, including the structure, different authority and roles in term of using various tools and functionality. The second step is to configure a set of tools supporting a range of learning tools. The third step is to define and organize a knowledge portal specific to a particular learning context. In the followings, we illustrate the configuration of a university course.

Fig 3 is the learning community configuration for a university course. The configuration can be further modified with appropriate authority, using the "management/maintenance" of the portal framework.

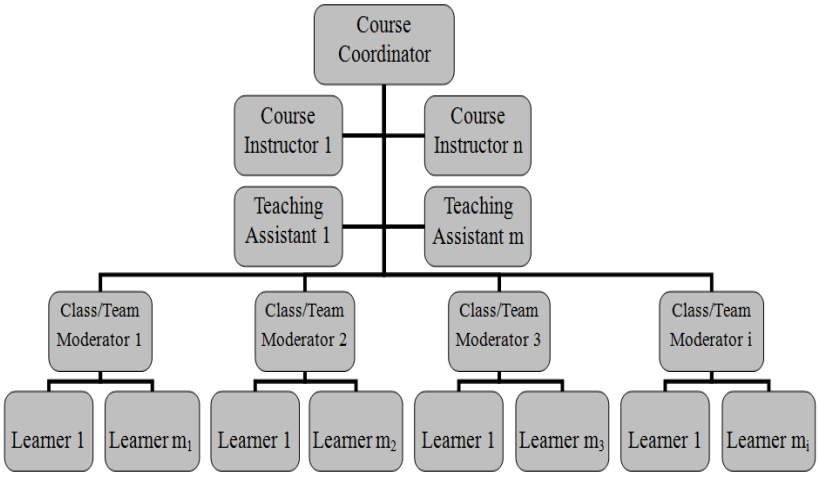

Fig 3 Learning community configuration for a university course

The learning space configuration for a university course usually contains: (1) the course information; (2) the teaching and management information and news; (3) the knowledge of the course; (4) sometimes the knowledge settings for organization of the knowledge constructed by learners, such as using wikis.

For a specific university course, there is normally a set of knowledge contained in the textbook and references. The knowledge could be in the form of text, multimedia text, audio and video records. The corresponding portion in the knowledge portal can be organized in a structural manner. Fig 4 illustrated the knowledge portion of a specific course "E-Service Technology" for senior computing students.

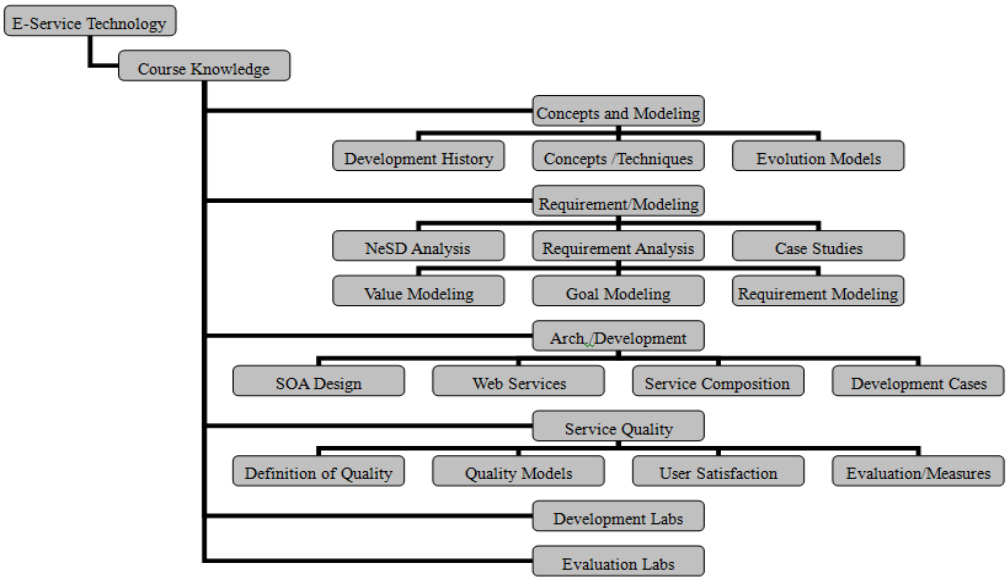

Fig 4 The configuration of the course knowledge for a university course

Setting up an e-learning environment is based on the context, objectives and pedagogical considerations of learning. The most important factor is the learning community in which various roles and the corresponding authority settings form the ways of instruction and guidance, the process of learning, and the collaborations in learning. The instructor of a learning context has the option for learning community configuration, although we normally recommend that there should be trainings on the use of the portal framework, as well as a good understanding of educational and pedagogical methodology, in order to be effective. For a specific type of learning context and objectives, such as courses of a particular discipline, the e-learning environment could be pre-configured based on proven teaching methods.

3.3. The Extension of an E-Education Portal or the Portal Framework

There are two types of situations where an extension of a specific e-education portal or the generic portal framework needs extensions. For a specific e-education portal of certain learning context, there might be the need to further add a learning tool or functionality, where the original setting does not have. With the rapid development and extensive research in e-learning discipline, there might be new tools and functionality available, so there is a need to extend the portal framework. In both situations, such a new tool or functionality can be "loaded" into the portal framework, as long as the new tool is developed compliant to the software interface protocols. The current version of the portal framework has a system extension support for the "loading". The "loading" could even be done for a specific existing configuration without a need to modify other parts of the environment, its information and knowledge settings.

4. Discussion and Future Work

We described the motivations, design principles, the architecture and components of a configurable and extensible portal framework for e-learning environments. The novelty of the framework is that it could be used to configure and deploy particular e-learning environments with respect to the learning context (part of blended learning or full online e-learning), the educational principles and pedagogical considerations. The current version of the framework has a focus on supporting blended learning, in which the e-learning environment is used as part of the learning and instructional context. The framework has been used in several university courses. The initial results from the applications in university courses have been promising in terms of flexibility for instructors and the rich learning facilities for learners. There are however feedbacks from both instructors and learners on the usability of the e-learning environments based on the framework, mostly resulted from the system management and maintenance functionality. Further works are needed in three directions: (1) improvements in usability of the environments for instructors and learners, separating the environment configuration and the use; (2) formative and scientific empirical evaluation of the portal framework for specific e-learning context and configurations, currently the focus being on university courses;

(3) further improvement on the framework support for learning experience in term of better self service technology application. Other future works are needed as well, such as support on integration of hybrid learning components developed independently without considerations of the software interface protocols.

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