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Knowledge Mining in Web-based Learning Environments

Nittaya Kerdprasop, and Kittisak Kerdprasop

***Abstract*—**The state of the art in instructional design for computer-assisted learning has been strongly influenced by advances in information technology, Internet and Web-based systems. The emphasis of educational systems has shifted from training to learning. The course delivered has also been changed from large inflexible content to sequential small chunks of learning objects. The concepts of learning objects together with the advanced technologies of Web and communications support the reusability, interoperability, and accessibility design criteria currently exploited by most learning systems. These concepts enable just-in-time learning. We propose to extend theses design criteria further to include the learnability concept that will help adapting content to the needs of learners. The learnability concept offers a better personalization leading to the creation and delivery of course content more appropriate to performance and interest of each learner. In this paper we present a new framework of learning environments containing knowledge discovery as a tool to automatically learn patterns of learning behavior from learners' profiles and history.

***Keywords*—**Knowledge mining, Web-based learning, Learning environments.

I. Introduction

KNOWLEDGE mining is the discovery of hidden knowledge stored possibly in various forms and places in large data repositories. Knowledge is a valuable asset to most organizations as a substantial source to enhance organizational competency [10]. Researchers and practitioners in the area of knowledge management view knowledge in a broad sense as a state of mind, an object, a process, an access to information, or a capability [1]. People in knowledge management community use the term knowledge assets to refer to any organizational intangible assets related to knowledge such as know-how, expertise, intellectual property. Knowledge assets can be stored in data repositories either in implicit or explicit form [12], [14]. Explicit knowledge can be managed through the existing tools available in the current database technology. Implicit knowledge, on the contrary, is harder to achieve and retrieve. Specific tools and suitable environments are needed to extract such knowledge.

Recently, Li and Chang [11] proposed a model to systematically mine and manage useful knowledge in R&D organizations. This model is a user-centric approach to manage knowledge objects in a cyclic manner along the transitional processes, i.e. knowledge sharing, knowledge processing, knowledge presentation, knowledge capture and knowledge discovery. The authors [11] designed this model to exploit and transferred presentational knowledge such as MS Powerpoint presentation and spreadsheet application. We, nevertheless, consider the model sufficiently captures generic idea in knowledge mining and management to be useful in other context as well. We propose to apply the model to manage knowledge in the web-based learning environments.

A top-level of knowledge management model in web-based learning environments is shown in Fig. 1. From the data and knowledge repositories, the process of knowledge discovery has been applied to acquire knowledge objects that will be subsequently processed in the indexing and mapping stage. This stage supports the search for suitable contents presented to learners. Performance and learners' preference are then captured to store as history and learnable objects to be later used in the discovery stage.

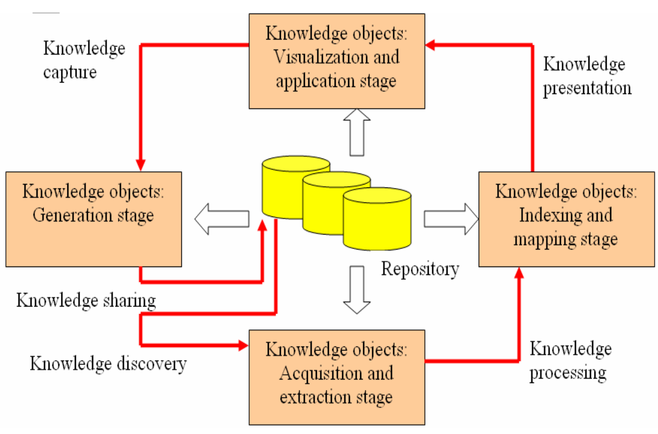

Fig. 1 A top-level management model of knowledge objects in web-based learning

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The rest of this paper is organized as follows. Section 2 presents the concept of web-based learning environments. Section 3 discusses in detail our framework of integrating knowledge mining capability to the web-based learning environments to enhance content management ability. Section 4 concludes the paper.

II. Web-based Learning Environments

Web-based learning environments refer to computer-based and computer supported education and training systems exploiting Web as the representation and delivery medium. A web-based learning system is a state-of-the-art in the field of e-learning due to the advantages of reusability, interoperability and accessibility provided by the Internet technology [16]. Reusability, interoperability and accessibility are major concepts in the development of modern learning environments studied and extensively proposed by many researchers [7].

Davis et al. [3] proposed learning environments to work with didactic materials. Their design is based on interoperability and reusability concepts. Valderrama et al. [16] designed web-based education systems as a multi-agent architecture working with intelligent reusable learning objects. Saddik et al. [13] conducted a project to develop a web-based adaptive hypermedia learning system called Multibook. Fong et al. [4] also studied multimedia courseware in a wireless campus environment. Gunther et al. [6] proposed the concept of sharing statistical computing modules in a web-based system.

Reusability concept offers facility for course content developers to avoid rewriting on updated materials and duplicating effort from the design process. With the interoperability and accessibility concepts, learners are not restricted to a specific content system in a single and static site. The ability to learn contents from multiple sources on different kinds of machines ranging from notebook and PC to handheld and PDA devices requires standardizing the learning contents.

SCORM (Shareable Content Object Reference Model) [5] is currently adopted by a lot of industrial and educational organizations as a set of standards to specify course structure and content delivery process. SCORM is a collection of standards that enable interoperability, accessibility and reusability of distributed heterogeneous web-based learning systems. Reusability in SCORM model can be achieved through the concept of learning objects.

A learning object is defined as an independent collection of content and media elements. A learning object is thus the granule of content. Its size can be varied from a word, a sentence, a paragraph, to a whole chapter of content material. The general guideline on designing learning content is that each learning object should cover an instructional learning objective. SCORM describes the way content objects should be created, discovered and aggregated into more complex learning objects and then organized into a sequence of delivery.

Besides SCORM which is the product of Advanced Distributed Learning (ADL) organization, there exist other standards such as Instructional Management Standards (IMS) [8]. Standardization in web-based learning is an evolving aspect and its extension has been proposed in several work [5], [7]. This paper is yet another extension of a learning model. We propose to raise the learning objects as commonly referred to by SCORM standard to the level of knowledge objects. Our proposed learning model emphasizes the inclusion of knowledge discovery module to discover new knowledge that can be exploited to better planning and individualizing course content.

Individualizing or personalization concept has emerged from the observation that a one-fits-all style of instructional design and teaching strategy is unlikely to lead to learning effectiveness. This is due to the fact that each learner is different from others in terms of background, learning goal, learning skill and learning ability. Instructional methods that match learning style individually will be the most effective learning environment.

Personalization thus leads to adaptive learning environments in which individual learners can be uniquely identified. A learning system designer can take a step further to make the learning process autonomous by providing the environments that learners can take control over their own organization of learning. In distance learning where course is to be delivered to distributed learners, collaborative learning is necessary. Collaborative learning requires communication technologies either in the form of email, shared workspaces, or video conferencing in order to provide learners with the means of group-oriented learning and discussion exchange between instructor and group of learners.

To design a successful web-based learning system, the designer has to aware of the four main factors as graphically displayed in Fig. 2. These factors form the basis for most learning environments including ours as will be discussed in Section 3.

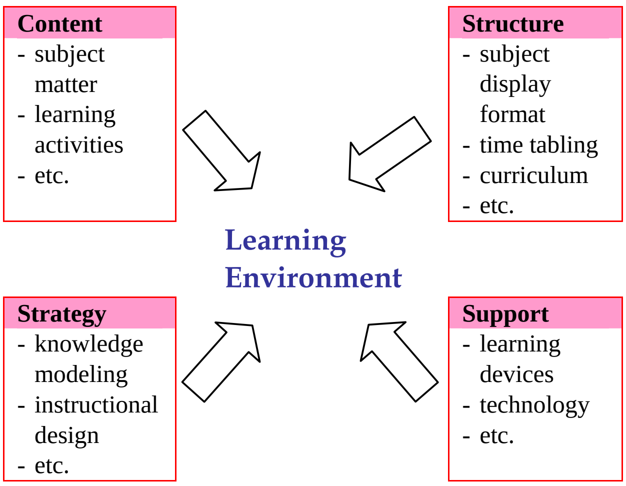

Fig. 2 A group of major factors influencing the success of a learning system

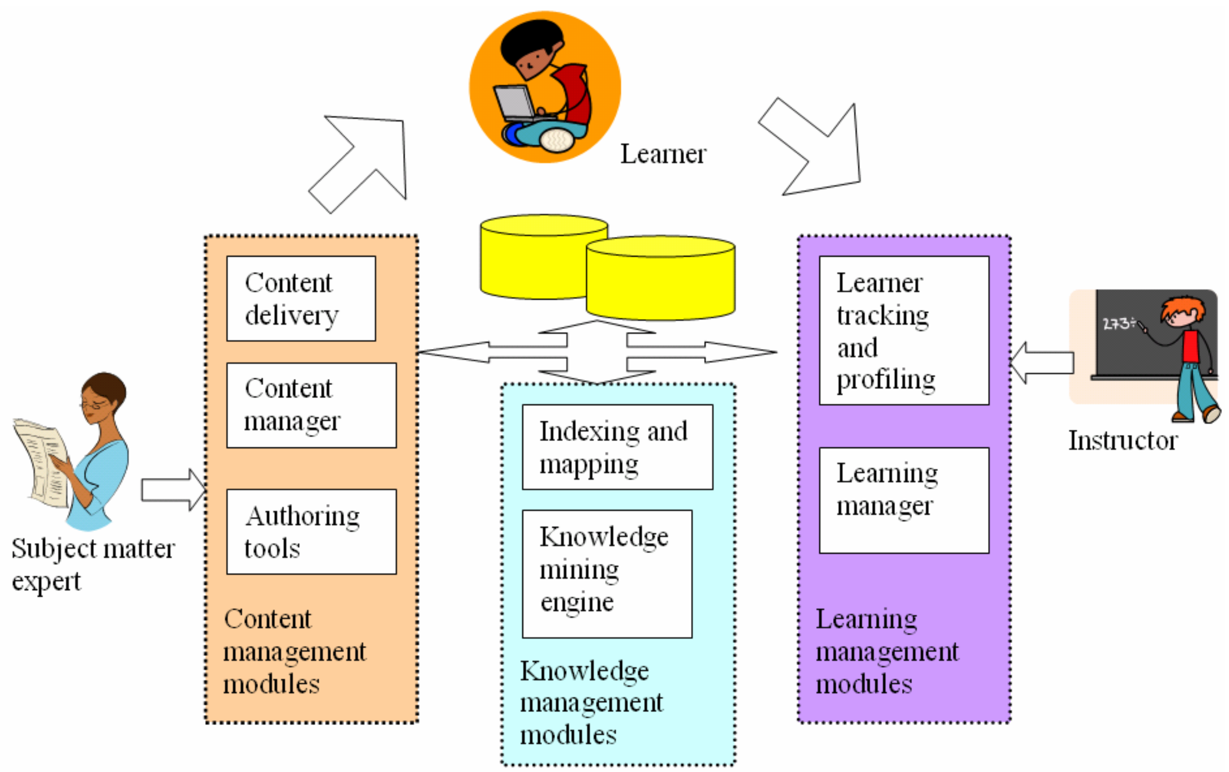

Fig. 3 A framework of a web-based learning environment with main modules for learning management, content management and knowledge management

III. Knowledge Discovery and Web-based Learning

The design of our learning model is on the basis of learning content management system [2], [9]. There are three main modules in our proposed framework (as shown in Fig. 3), i.e. learning management, content management, and knowledge management modules. Our framework is proposed to support web-based learning with several scheme of learning including adaptive, autonomous, and collaborative learning.

Learning management modules: provide the following capabilities:

- support instructors to post syllabi, class schedules, assignments, lecture notes, slides and other supplemental materials for learners to access via Web browsing tool.
- support instructors to conduct assessments in various forms such as online tests, surveys, quizzes using a variety of standard question formats, e.g. multiple choice, true/false, essay, short-answer, matching, etc.
- support learners to submit assignments remotely either as file upload or interactive through Web interface.
- provide profiling tool to collect personal data of learner and tracking tool to observe learners' actions including like and dislike information.
- provide matchmaking tool to compare the created profile with the available content.
- support instructors and learners in collaborative discussion on assignments and course content.

Content management modules: provide the following capabilities:

- support the content developers in importing and exporting content through the authoring tools.
- support the content manager in individualize the presented content.
- support the content manager in archiving and versioning the content.
- interface with learning management modules in getting desired form for delivered content.
- interface with data repository containing learners' personal information and other metadata including knowledge assets created by knowledge management modules and apply these data in creating personalized sequence of content material suitable for each learner.

Knowledge management modules: provide the following capabilities:

- discover valuable knowledge assets from the data repository containing learners' personal data, tracked data of learners' performance and behavior, and data related to content sequences that were presented in the past with the evaluation results according to that content sequence.

- support the indexing and mapping of knowledge assets that are discovered by the knowledge mining engine.

The major component of learning management modules is learning manager which acts as a conductor controlling and synchronizing every component within the modules. The manager component is also responsible for interfacing with the storage. This is also the case for the content manager in content management modules. The authoring tools in content management modules support creation of all types of digital content materials such as word documents, spreadsheet data, pictures in standard formats, video content, animation and multimedia data.

For the knowledge management modules, knowledge mining engine is responsible for the synchronizing process. Indexing and mapping is a component for storing and searching knowledge assets to be used in the learning process.

IV. Conclusion

Recent developments in information and communication technology certainly influence the design and implementation of educational systems. An emergence of the World Wide Web in the early 1990s has resulted in a substantial change in both the content representation and the delivery mechanism. The XML (eXtensible Markup Language) is a currently acclaimed technology as the main content representation format. The main advantage of XML over other hypertext languages such as HTML is its property of being interoperable data interchange format. This language technology helps improving the courseware design concept toward interoperability, which is one of the major design criteria for most software products these days.

Improvements in hardware and communication technology such as mobile microprocessors and wireless communication have evolved learning environments to the mobile and distributed platforms. Such information infrastructures provide learners a remote access to experts and distributed resources. Web browser is a software device offering learners with open and flexible accessibility to distant course contents. The organization of learning resources has also been changed from creating and delivering large inflexible course content to producing database-driven learning objects that can be reused, searched and modified independent of the delivery media.

Interoperability, accessibility and reusability are therefore the main design concepts of current instructional systems. These concepts have shifted the learning paradigm from static learning to collaborative, adaptive and autonomous learning. Collaborative learning allows direct contact between instructor and group of learners through the communication technologies ranging from email and share workspaces to video conference systems. Adaptive and autonomous learning allows learners to take control over their own organization of learning pace and scheme.

In this paper we argue that with the matured technology of knowledge discovery in databases or KDD, the integration of knowledge discovery capability to the creation, delivery and management of learning objects should be the next step in e-learning. Our proposed architecture of learning environments will enable the convergence of e-learning with knowledge management. A repository containing learner-related materials is a valuable source of knowledge to support personalization information for independent learners.

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