Research on Medical Learning Management System based on SCORM

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Abstract – **Learning Management System (LMS) becomes more and more important for medical training mangement along with the developing of learning informationlization in medical college. How to improve reusing and sharing the learning resources, and to track the learning progress in medical training are interesting topics on Medical Learning Mangement System (MLMS). This paper tries to propose a designing method to improve MLMS by using Sharable Content Object Reference Model (SCORM) technology,. It can enhance the reusing and sharing level of learning resources, and encourage the learning interaction between tutors and students as well. The SCORM-based MLMS can greatly improve the medical training quality in medical college.**

Keywords- LMS; medical training; SCORM; sharable content;

I. INTRODUCTION

Since the 1990s, the education of medical simulation has advocated to train in a clinical simulation environment which is close to the reality [1]. In recent years, many countries start building medical simulation center in varying degrees. In China, Peking Union Medical College takes the lead in medical training and tries to use several technical means to improve the clinical skills of students, such as standardized patients (SP), clinical scenario simulation and so on. Many companies such as SkillSoft Company, Smarforce Company and Saba Company have made great effort in e-learning area, but it is still rarely used in medical training [2][3]. In this case, a learning management system for medical training turns to be important and imperative. In order to manage the medical learning activities, Web and Software Research Center in Tsinghua University developed a Medical Learning Management System (MLMS) for Peking Union Medical College [4]. However, the problems about learning resource reusing and learning progress tracking still limit the usage of MLMS. This paper proposes a designing method to improve current MLMS by using Sharable Content Object Reference Model (SCORM) to solve these problems, which is widely used in e-learning area to build intelligent learning environment and contribute to courseware making [5][6]. The system architecture is designed and implementation is introduced.

II. CURRENT MLMS

A. Learning Management Systems (LMS)

Learning Management System (LMS) is a kind of software for delivering, tracking and managing online training. It ranges from simple system for managing training records to software for distributing courses over the Internet and offering features for online collaboration [7]. This pattern for teaching and e-learning has been widely used in many universities all over the world. In accordance with the report written by Massachusetts Institute of Technology, locally developed LMSs are more popular and beneficial in universities, especially for medical college usage [8].

B. Introduction of Current MLMS

In 2009, a medical simulation center was established in Peking Union Medical College. Medical students can practice their clinical skills in different typical scenarios by using clinical simulation equipments. As a core system of medical simulation center, the Medical Learning Management System (MLMS) is in charge of managing training courses selection and clinical operation data. The MLMS is mainly designed with three functions: courses management, evaluation management and equipment management. Tutors can make a reservation of practice rooms, the clinical equipments they need and the students who should be involved. After clinical practice, all the operation data from standard patient (SP) and other devices will be sent to evaluation module of MLMS so that tutors can give a final result for student's performance.

C. Problems

The MLMS has been deployed in medical simulation center. But, there are some problems emerging in its daily use:

1) Low level resource sharing and reusing

In medical college, there is almost no resource sharing between different courses. Students cannot get the learning resources from other tutors under same knowledge background. The electronic copy of courseware is usually designed as Microsoft PowerPoint file or Microsoft Word file, and the resource content is hardly to be reused in courseware making, which means tutors will waste a lot of time to reinvent the wheel. Some student's practice videos could be successful examples or failure examples to share in

whole learning processes. However, only the trainee himself or herself can view and learn from it now. This kind of learning resource made by students themselves is ignored in courseware making.

2) Difficult to track learning progress

After clinical practice, simulation equipment will transfer the operation data into MLMS and store them in database respectively for reviewing. Students can check all details about their practices, such as operation total time, turnovers and so on. However, they cannot compare their performances this time to the one at last time. It is difficult for students to be aware of their faults and advancements, and it's also difficult for tutor to track students' learning progresses.

3) Lack of learning path management

Learning resources are designed based on same standard, while students are learning in different levels. There are no customized learning paths for students in each level. It is hard for students to make efforts targeting their own weakness. Furthermore, the clinical simulation education and training is not only used for medical college, but also used for hospital. The evaluation rules of professional tests are different for intern doctors and specialists, but there is no such a method to set training paths and training goals in the same testing module for each user individually.

III. SCORM TECHNOLOGY

In order to reduce the cost of courseware and enhance the sharing and reusing level, American government started Advanced Distributed Learning Initiative (ADL) in 1997[9]. ADL worked out a set of technical guideline called Sharable Content Object Reference Model (SCORM) through the contribution of courseware developers, users, IMS2, AICC, IEEE and etc. In 2004, ADL released SCORM 2004 version as an important milestone in the history of e-learning, which has been widely used in LMS development. In this paper, we will use SCORM to improve the MLMS.

A. SCORM Content Model

SCORM 2004 version consists of Content Aggregation Model (CAM), Run-time Environment (RTE) and Sequencing and Navigation (SN) [10]. As the most important part of SCORM, content model describes the SCORM components which are used to build a learning experience from learning resources. It also defines how these lower-level sharable, learning resources are aggregated and organized into higher-level units. The SCORM Content Model consists of following elements [10]:

- Asset. As the basic building block of a learning resource, asset is the electronic representation of media, such as text, image, sound, assessment object or any other piece of data that can be rendered by Web client and presented to learner.
- Sharable Content Object (SCO) [11]. SCO is a collection of one or more assets, which can use the SCORM RTE to communicate with an LMS. It represents the lowest level of learning resources and usually is described with metadata.
- Activities. A learning activity is described as a meaningful unit of instruction in content organization in order to provide a learning resource.
- Content Organization. A content organization is a representation that defines the intended use of the content through structured units of instruction. It shows how activities relate to others.
- Content Aggregation. Content aggregation describes the action or process of composing a set of functionally related content objects.

B. Content Package Components

According to IMS Content Packaging Specification, Content Package contains two major components: manifest file and content [10]. Manifest file is a special XML document that describes the content structure and associated resources of the package, and content is usually made of physical files.

C. Metadata

Metadata is used to describe contents and properties of learning resources in order to contribute to managing and evaluating the teaching resources [12]. The metadata in SCORM describes the several parts of content model in a unified approach so that users can access to their information.

IV. SCORM-BASED MLMS DESIGN

A. SCORM Courseware Design

To improve the current MLMS, SCORM-based courseware is one of the most important parts in whole learning management system. There are two steps to design SCORM-based courseware. First, a metadata XML file, which is named *imsmanifest.xml* here, is created for each page (the minimum level) of courseware and each SCO. Second, sequencing and navigation are well managed. According to SCORM specification, there are nine kinds of sequence for designing learning list, such as linear, linear and control, forced choice, knowledge tracking, ability evaluation and so on. Tutors can choose one of them to arrange their courseware in the light of actual training conditions. After importing the organized content package, MLMS will parse i*msmanifest.xml* file and get the item mapped with corresponding folder or knowledge item in information structure model. The resource information and organization information parsed from *imsmanifest.xml* file will be stored in database.

SCO is the collection of basic assets described by metadata. It can be released and communicate with MLMS through SCORM Run-Time Environment (RTE) [13][14]. Figure 1 shows the SCORM RTE structure.

In SCORM specification, SCO communicates with LMS by using API Adapter. There are 8 important functions defined in API: *LMSInitilize, LMSFinish, LMSSetValue, LMSGetValue, LMSCommit, LMSGetLastError, LMSGetErrorString,* and *LMSGetDiagnostic* [15].

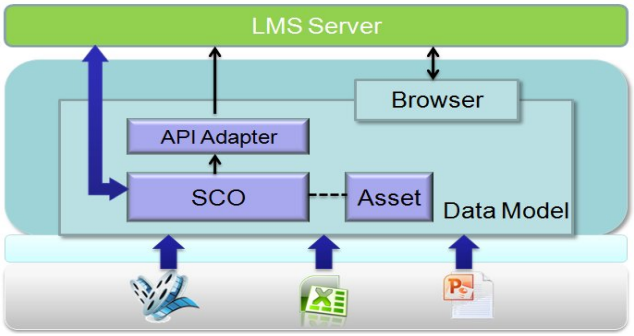

Figure 1. SCORM RTE

Figure 2 shows the communication logic between SCO and MLMS. After MLMS server receives the request from Client, it will validate user's information and decide which SCO should be sent. Client receives the SCO resources and calls API adapter to initialize the connection with MLMS and start the learning interaction between user and SCO. In Figure 2, Step 3 to Step 6 will move in a circulation during the whole learning activity.

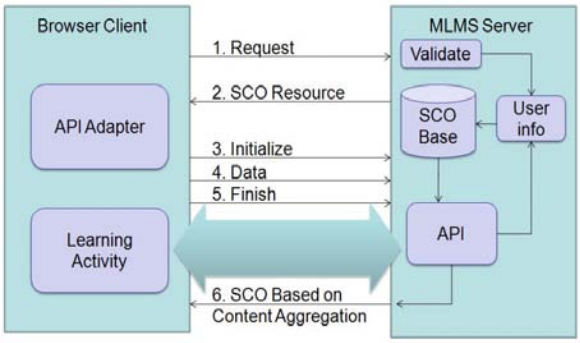

Figure 2. Processes of using SCO and MLMS

B. *Improved MLMS Architecture Design*

Considering the demand of Medical Learning Management System and the practical problems in medical training, an improved MLMS system architecture is designed.

There are five layers in the improved MLMS architecture shown in Figure 3. From bottom to top, they are OS layer, persistence layer, enterprise service bus (ESB) layer, middleware and business control layer, and user interface layer. Database is above the OS layer, and communicates with persistence layer through DAO. There are three types of component to store data: SQL server is used to store structured data, file system is used to store unstructured data and half-structured data, and rule base is used to store the business rules prepared for intelligent decision. Middleware layer and persistence layer are managed by ESB to provide service to upper layer. Three subsystems are designed as components connecting with ESB. The upper layer is user interface. Users can choose the appropriate application services for learning activities.

SCORM-based courseware is used in SCORM-based course management component and evaluation management component. While choosing the involved students and equipments, the tutors can upload their training materials and share the information within an optional group so that other students can view the courseware. Other tutors can also take the courseware as references if they are interested in. Meanwhile, the tutors can track each student's learning progresses and give them assignments individually. The clinical practice data, for instance, the video of whole actual operation, could be tagged as training demonstration for sharing and reusing.

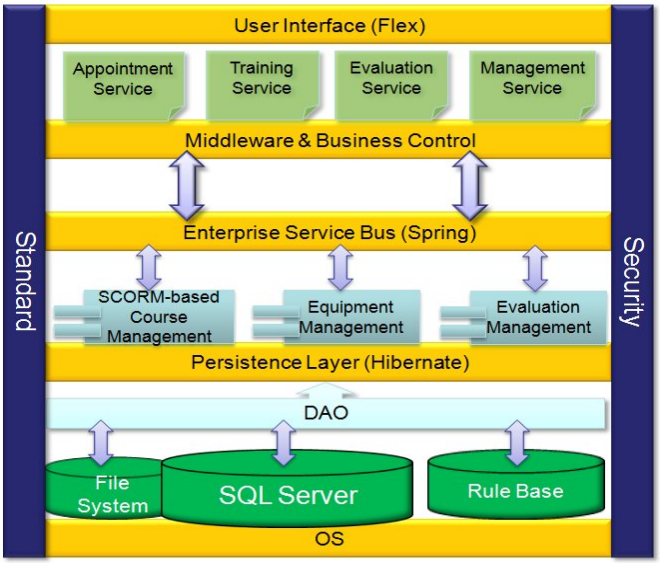

Figure 3. Imrpoved MLMS architecture

V. SCORM-BASED MLMS IMPLEMENTATION

A. *System Implementation*

Figure 4 shows the metadata management for medical training courseware by using SCORM technology. The SCO information and sequencing will be defined in this module. SCO is considered as training subject, which is edited under tutor's training plan. Metadata is for describing content tag so that system components can find the required information directly.

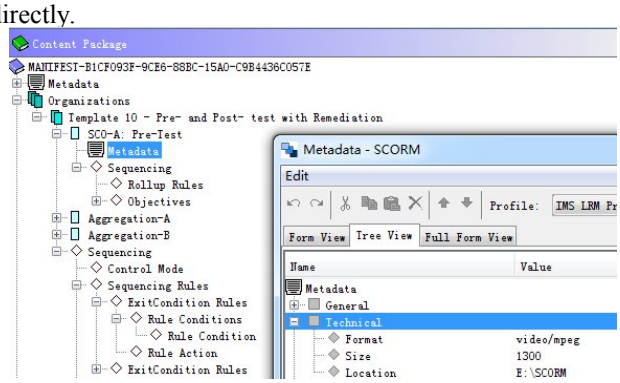

Figure 4. Metadata management

Besides, the successful and unsuccessful training materials are taken as demos in training courseware so that users can learn from it and avoid repeating same mistakes.

There are three main function modules in the improved MLMS and evaluation management is one of it. Figure 5 shows the evaluation interface for clinical training practice. The improved MLMS will record all the operation information such as user, date, department, tutor, equipment, operation name, and practice data. Students will give a score for themselves according to the operation processes, while tutors will review it and take it as reference for final evaluation. Meanwhile, the practice data is recorded in data base for automatic system assessment, using evaluation rules defined in rule engine of MLMS. Tutors will give students more clinical training instructions individually based on these different kinds of evaluation results and revise the training materials if needed.

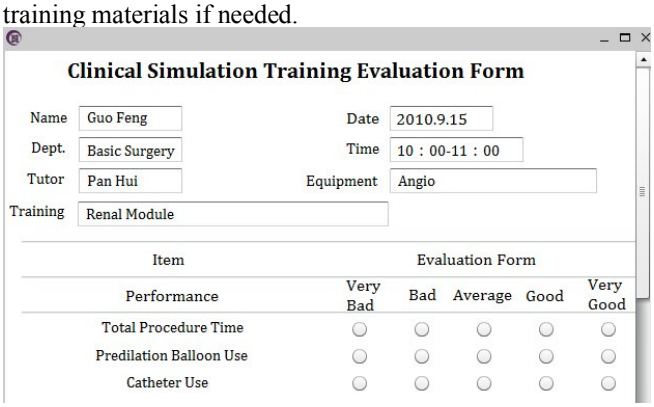

Figure 5. Evaluation interface

B. *Discussion*

Medical training courseware has an obvious advantage in content re-organization and scheduling after using SCORM technology. Both the learning content and logical structure get better organized under SCORM definition. Tutors can modify and reuse this kind of resources more conveniently. In addition, it is necessary to provide sharing and reusing training content systematically when the data grows to an unmanageable size.

SCORM encourages the interaction between learning content and learning platform. SCORM-based MLMS will record the training result in every step of training activities so that tutors can set new learning path and multiple goals for each student according to their own situations. Students can motivate themselves and take initiative in learning activities, and that will help them to make greater progress than before. It contributes to improve training quality and evaluation system.

VI. CONCLUSIONS

Medical Learning Management System (MLMS) has been widely used in medical college. This paper tries to improve MLMS by using SCORM technology. An improved MLMS architecture is designed and implemented. The SCORM-based MLMS can reuse and share learning resources, and improve training quality by tracking learning progresses and giving students individual instructions during whole training activity. As future research, we plan to develop some intelligent components for giving students individual instructions.

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