PROJECT DESCRIPTION

1. Title and Project Summary

Open Content Communities for Supporting Development of Educational Materials

The long-term goal of this project is to foster highly collaborative development of comprehensive, rich, high-quality and freely distributable Educational Materials (EM) for instructors to construct their courseware and students to directly learn from. The approach to fulfill this goal, which is also the intellectual merit of the proposal, is to develop an Open Content Community (OCC) Website to facilitate and support Open Content Educational Material (OCEM) projects. The OCC model is adapted from the successful Open Source Software (OSS) model to support EM development. The OCC model uses fine-grained learning objects and recursive modules to increase the degree of collaboration and lower the cost of entry for participation and contribution. The OCC site is modeled after *sourceforge.net*, a successful OSS community site. It will provide utilities to foster teams of volunteers to develop OCEM projects of their selected topics. Since OCC focuses on EM development, by supplying freely distributable EM, it complements existing open courseware projects that focus on the development of courseware. This project proposes to build the OCC site prototype. To evaluate the prototype, external and internal collaborators have been contacted to create projects using OCC site once it becomes ready. Teams of students will also be assigned to create EM with and without the OCC site for a controlled experiment. Both controlled formative and summative evaluations will be collected to enhance OCC and prepare for a full blown and self-sustainable implementation. The broader impact of the project is the creation of the OCC model and its companion community Website. Because of its generality, it will not only provide EM and a community to learn for STEM education, but will equally benefits instructors and students in other areas.

2. Goals and Objectives

The long-term goal of this project is to enhance the collaborative development of comprehensive, rich, high-quality and freely distributable educational materials (EM), which can be used directly by students to learn and by instructors to construct their courseware. The proposed approach to fulfill this goal is by developing a Web-based Open Content Community (OCC) to facilitate and support Open Content Educational Material (OCEM) projects, i.e., a *sourceforge.net* for OCEM projects.

The objectives of this proof-of-concept project are:

a) Based on the successful Open Source Software (OSS) development model and its derived OCC model [Yue 2004a], develop a prototype OCC Website that serves as a community for supporting and fostering OCEM projects.

b) Engage educators and students to use the prototype OCC site for developing several OCEM projects.

c) Perform formative evaluations of the OCC site and the OCEM projects to refine the OCC model and its Website.

d) Perform summative evaluations to validate the effectiveness of the project.

e) Disseminate results to fellow educators, instructors and researchers.

f) Based on both formative and summative evaluations, develop plans and proposals for the full-scale development of a self-sustainable OCC model and site.

3. Detailed Project Plan

3.1 Background

The rapid advance of the Web has already significantly improved information availability. However, using existing Web resources as EM is not straightforward since they can be scattered, unstructured, outdated, misleading; have weak contents; are not developed as EM; and may have inconsistent quality and prohibitive copyright licenses. A major challenge of science, technology, engineering, and mathematics (STEM) education is thus the availability of EM that satisfy the following criteria:

(1) High quality: Although it is generally easy to find many relevant resources on a topic through search engines, tedious effort to sift through the voluminous resources to extract high quality and relevant contents has become a major inhibitor.

(2) Comprehensive: The collected EM should have a comprehensive coverage of all major subtopics of a given subject, which can then be custom selected to satisfy different learning and teaching scenarios.

(3) Rich: Students have different strategies, approaches, and capabilities for learning that are a function of prior experience and heredity [APA 1997]. Only a rich collection of EM can effectively support a large community of diverse students and instructors.

(4) Freely distributable: Learners and teachers can freely use the EM without any copyright concerns. More importantly, they can be modified for further improvement and customization, and then redistributed to benefit more people. This calls for an open copyright license similar to those used by OSS or other open content projects.

The OSS model is a good candidate to be adapted to satisfy these criteria. OSS is freely distributable. Successful OSS projects, such as Linux and Apache, have high quality and rich features covering the problem domain well. These projects have high degree of collaboration among developers and users. For example, the leading OSS Website, *sourceforge.net* [Sourceforge 2004], is a vibrant community hosting more than 81,000 projects and more than 900,000 members.

In fact, the OSS movement has helped to hatch many ongoing Open Content (OC) projects (such as *Wikipedia*, an OC encyclopedia [Wikipedia 2004]) and Open CourseWare (OCW) projects (such as MIT *OpenCourseWare* [MIT 2004]).

Our OCC model is based on the successful OSS model, which has been extensively studied [O'Reilly 1999, Raymond 2000]. It was found that an active community of highly collaborating users and developers are critical to the success of OSS projects, by improving both quality and richness. An OSS community Website such as *sourceforge.net* provides the necessary supporting tools and utilities for developing and promoting projects. Project management and development decisions are entirely made by the project's workgroup, which is composed of domain experts who are usually highly motivated. In order to be successful, it is very important to keep the *cost of entry* very low so that a large number of projects can be hatched. They then undergo natural evolution. The fittest survives and prospers, and the ones with scant community attention withers.

3.2 Proposed OCC Model and Website

Our proposed OCC model [Yue 2004a] for OCEM projects is designed to foster a very high degree of collaboration and provide a very low cost of entry. OCC will use an open copyright license based on *Creative Commons* licenses [Creative Commons 2004] so the developed EM can be freely used and adapted. Figure 1 is an UML diagram showing the high level architecture of the OCC model.

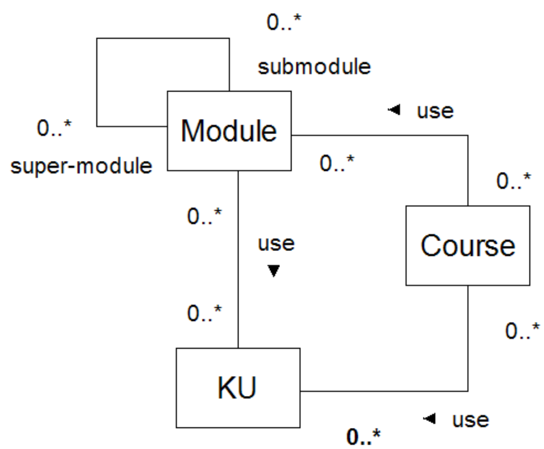

Figure 1. High Level UML Architecture of OCC

- *Modules* are recursive and have a many-to-many relationship among themselves. A module may be a *sub-module* or a *super-module* of many other modules. Volunteers can form *workgroups* to start a project to develop EM on a selected subject of interest. The workgroup can specify the necessary sub-modules to comprehensively cover the sub-topics for the subject. This structure can be refined to ensure that the subject is comprehensively covered. Based on the needs, the workgroup can solicit volunteers to contribute to different modules through the OCC site**.**
- Actual EM contents are stored in *knowledge units* (*KU*). Examples of KUs are lecture notes, objectives, examples, case studies, project assignments, exercises, annotated resources, glossaries, supporting software, etc. Note that KUs are independent of modules and they may be included in many modules. Thus, KUs provide the OCC a *fine-grained object* model to increase collaboration (see further details below).
- *Courses* can be constructed by selecting modules and KUs. However, the OCC site is not used primarily for *hosting* courseware, but for fostering the development of EM. Thus, constructing courses is only one example of how one may use the modules and KUs.

The OCC model proposes a community Website for fostering highly collaborative development of OCEM projects. The OCC site will provide features similar to *sourceforge.net*, such as version controls, feature (sub-modules and KUs) requests, bug fix (content correction) requests, search tools, promotional tools (e.g., most active and highest ranked projects), etc. It will also contain features unique to OCEM projects, including tools for defining modules and sub-modules, optional editors for editing modules and KUs, pre-publication and post-publication reviews, etc.

The OCC site provides flexibility by allowing the workgroup to select the best approaches that fit the current status of the project. For example, a small startup project may use no formal pre-publication review. This will lower the cost of entry, as strict quality may not be as important in the beginning. Once the project has attracted the attention of the community and becomes more mature, it may use a more formal pre-publication review to ensure quality. As another example, a startup project may accept any KU format, such as HTML, PDF, PPT or Words documents. Once the project has become mature, the workgroup may restrict acceptable formats to enhance quality and consistency.

Both instructors and students can directly use the OCC site. Students can use the rich collection of modules and KUs that best fit their own background and need. A known way of effective learning is by active participation. Students can team together to develop KUs and modules. The project workgroup members are usually domain experts, and communicating with them on fine-tuning their contributions can further benefit the students. The students can also participate in community-based post-publication reviews and online discussions to benefit from the collective wisdom of the community.

Since the EM in the OCC Website have open licenses, with the proper attribution, instructors can simply pick and mix whatever they want in order to custom built their own courseware flexibly. Furthermore, they can also use the OCC site as a tool for assignments and require students to create projects, contribute to them, participate in review, etc. Instructors can of course contribute to projects themselves too.

3.3 Related Works

Figure 2 coarsely depicts the relationship between EM, courseware and their relationship. EM is the basic component for building courseware. Courseware may interact and/or use each other for enhanced reusability and interoperability.

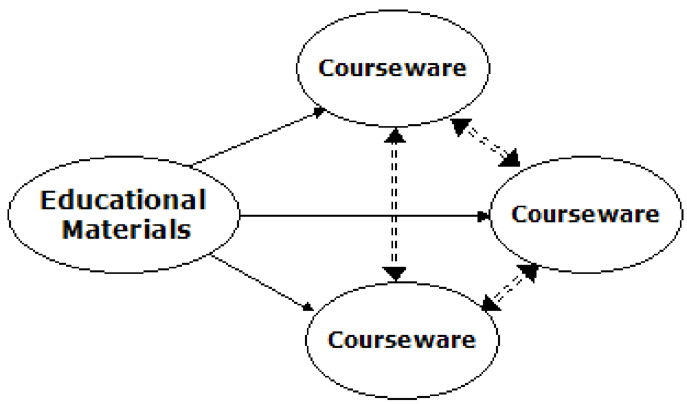

Figure 2. Relationship Between EM and Courseware

Our project focuses on collaborative development of EM, not courseware construction. To provide our project a suitable context, we briefly discuss recent activities in courseware here.

There are intensive ongoing researches and commercial activities in the construction and management of courseware. *Course Management Systems (CMS)*, such as WebCT and Blackboard, are software used to design, develop and deliver courseware. *Courseware standards* are used for promoting reusability and interoperability of learning objects and courseware. Important examples are *Open Knowledge Initiative* (OKI) [OKI 2004] and *Sharable Content Object Reference Model* (SCORM) [SCORM 2004]. These standards provide interoperability between different CMS and courseware. Since the goal of OCC is to develop EM, and *not* courseware, it is designed to be *neutral* to both CMS software and courseware standards. An OCC workgroup can select any appropriate courseware standards to adhere to. An instructor may also use any CMS to integrate EM selected from OCC.

Open CourseWare (OCW) is another important related area. The two major projects focusing on developing and hosting OCW are the MIT *OpenCourseWare* (*MIT OCW*) [MIT 2004] and Rice's *Connexions* project [Rice 2004]. *MIT OCW*, a highly visible and influential project, will eventually provide the public open access to *all* of a total of about 2000 MIT courses by 2007. Unlike our project, it does not attempt to create a collaborative community for content development.

Connexions is the sole major project in building a community for OCW. Content developers can develop modules using a set of predefined tools in the site. Modules are stored in custom designed XML format and they can be selected to construct courses *hosted* by the *Connexions* site.

Both *Connexions* and *MIT OCW* focus on the development and hosting of courseware. Their direct targets are thus instructors for hosting and/or using courseware for their students. For examples, in *Connexions*, modules are the basic units and there is no standalone KU. To provide for courseware consistency, a custom-designed XML language, *CNXML*, is used for capturing all modules. Although this is a reasonable approach for constructing courseware, it limits the flexibility of the workgroups and increases the size of the learning objects, thus raising the cost of entry for contributors. For examples, to contribute, a developer needs to develop the full module using the *CNXML* tool provided by the *Connexions* site. If an instructor, or even a student, has an excellent case study in Words format, for example, he cannot simply contribute it to *Connexions*. This is because the case study is not a full module by itself and conversion to CNXML is also needed. In OCC, this is possible, resulting in higher degree of collaboration and increased richness of EM.

In fact, the OCC approach of developing EM is complementary to current OCW projects. For example, EM developed in *OCC* can be used to construct modules and courses in *Connexions* since both have similar open licenses.

Besides OCW, there are also many Websites that annotate and rate EM. A popular example is *MERLOT* [MERLOT 2004], which annotates and rates external EM resources for higher education. However, annotations and ratings are usually submitted in an unstructured manner and there is thus no mechanism to ensure the resources for a given subject to be comprehensive and rich. Furthermore, although the annotations and reviews themselves usually have an open copyright license, the *actual* external resources they are referring to may *not*.

4. Experience and Capability of the Principal Investigators

The PI, *Dr. Kwok-Bun Yue,* is an Associate Professor of Computer Science (CS) and the chairperson of the Computer Information Systems (CIS) program at UHCL. He is the recipient of the 2002 UHCL Faculty Fellowship Award, the 1993 UHCL Distinguished Teaching Award, and the 1994 UHCL nominee and a seven-time finalist for the Texas State Piper Faculty Teaching Award. He has received a NSF CSEMS award, three NSF CCLI awards, and a DOD curriculum development award. He is also currently working on an OSS project on software metric for XML Schema [McDowell 2004]. Together with the other PIs, they have a total of more than 20 years of experience in Internet development and have published numerous papers in CS education.

Dr. Toneluh A. Yang, an Associate Professor of CS at UHCL, has years of experiences in computer science education, especially in the area of computer security education. He teaches graduate level computer security course (CSCI5233), and has designed and taught a new course on Web security (CSCI5931). He also designed and taught a new undergraduate computer security course, CSCI4931, in spring 2004. In addition to conducting research in wireless networking and Web based application development, he has sponsored independent studies in various security areas, including Wireless Security, Wireless Application Protocols (WAP), Database Security, and Web Security.

Ms. Wei Ding is a lecturer of CS and CIS at UHCL. She has seven years of experiences in industrial Web application development, including working at Verisign. She has taught undergraduate courses at UHCL for three years on Internet application development [Yue 2004d] and other core computer science courses. She will teach a new course on E-commerce development in Fall 2004, which is an advanced Web development course. She is a recipient of 2004 UHCL Faculty Development Award. She is currently working on her Ph.D. degree on Computer Science.

Dr. *Ping Chen* is an Assistant Professor in Computer Science program at UHD. His research is mainly in Data Mining, Software Engineering and Computer Security education. He created two new courses, Data Mining and Computer Security for CS program in UHD. He has over ten years software development experience. He is a recipient of 2002, 2003 and 2004 UHD Faculty Development Award, and the 2002 and 2003 UHD Organized Research Award.

5. Evaluation Plan

Both formative and summative evaluations will be collected on two issues: (1) the OCC model's effectiveness in creating high quality EM, and (2) the OCC site's effectiveness in fostering OCEM projects.

The OCC site will keep traffic statistics of individual projects, modules and KUs. It will include surveys for volunteering developers, instructors, students and workgroups to complete for assisting the site to improve its effectiveness. During the fall semester of 2005, about 60 students taking CSCI 4230 Internet Application Development (IAD) will be assigned to develop EM using the OCC site. A third of these students will be selected as the control group where they will develop similar EM using their own methodologies instead of OCC. Both groups will provide formative and summative evaluations. Ding and Yue, the PI of this proposal, and the current and past instructors of IAD, will also develop a significant part of its courseware using OCC. Students will be surveyed on each courseware component so that comparisons can be made between those developed using and not using OCC.

Collaborators/developers will be sent custom-designed questionnaires before the conclusion of the project in December 2005. External collaborators, such as Dr. Nasir Memon of the Polytechnic University, will be invited to evaluate the OCC site at the conclusion of the project. Detailed design of survey questionnaire and sampling approach will be developed during the design and implementation phases according to the professional development modules of Online Evaluation Resource Library [OERL 2004].

6. Dissemination Plan

We have already published papers on OCC, OCW and OSS in conferences for Web communities, computer science education, and software engineering [Yue 2004a, Yue 2004b, McDowell 2004]. Because of the general nature of the project, the results should be of interest to very broad areas of audiences, including courseware development, higher education, STEM education, open source development, etc. Publication sources can be as diverse as: SIGCSE conference and conferences of the Consortium of Computing in Colleges, which focus on computer science education; various open source conferences, such as Open Source Content Management Conference and O'Reilly Open Source Convention; and referred e-Journal, such as First Monday [FirstMonday 2004], which has already published several popular papers on OCW. We have already presented technical presentations on OCC model at conferences for Web communities [Yue 2004a,] and at universities [Yue 2003b, Yue 2004c]. The research team will continue to do so. The OCC site will collect documents, papers and white papers pertaining to the OCC experiment. Upon the completion of the project, we intend to develop a full development proposal to fully implement the OCC model. This will include a significant faculty workshop. The OCC site will adhere to the Dublin Core and other appropriate standards. Efforts will be made to promote the site to other repositories and search engines.