BUILDING A DESIGN ENGINEERING DIGITAL LIBRARY: THE WORKFLOW ISSUES

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ABSTRACT

Over the past 2 years the Design Manufacturing and Engineering Management Department at the University of Strathclyde has been developing a digital library to support student design learning in global team-based design engineering projects through the DIDET project [1]. Previous studies in the classroom have identified the need for the development of two parallel systems – a shared workspace, the LauLima Learning Environment (LLE) and a digital library, the LauLima Digital Library (LDL) [2]. These two elements are encapsulated within LauLima, developed from the open-sourced groupware Tikiwiki. This paper will look at the workflow in relation to populating the digital library, discuss the issues as they are experienced by staff and students, e.g. the application of metadata (keywords and descriptions); harvesting of resources; reuse in classes; granularity; intellectual property rights and digital rights management (IPR and DRM), and make suggestions for improvement.

Keywords: design engineering, digital libraries, workflow, reusable resources, wikis

1 INTRODUCTION

One of the primary goals of the DIDET project is to integrate digital libraries into the classroom, thereby providing learning opportunities for students in team based design process skills, augmented by information archiving and retrieval skills. DIDET aims to develop systems whereby each year design teams add to an evolving digital library. Resources created by students and initially stored in the more informal shared workspace, LLE, during their design projects provide a rich record of the design process and of students' knowledge structures through archived files, interlinked wiki pages, concept maps, and reflective logs. Teaching staff are currently harvesting these rich resources from the shared workspace to benefit future cohorts of students and storing these in the newly developed searchable and browsable formal digital library, the LDL. The LDL differs from existing resource collections in two ways. It captures specific project related 'hard to access' formal information and knowledge (e.g. standards, patents, company reports) which can often take considerable time to source, but focuses more on capturing the unique informal information and knowledge created during the design process (e.g. concept sketches, ideas, decisions); and the re-use of these collections by academic staff and students to enhance learning. Secondly, its content is mainly generated or sourced by students themselves. There are few studies on the creation of resources with metadata by students although there is some research on teachers' experiences of creating metadata [3]. Students will not rely solely on the LDL contents. The LDL will supplement and compliment what exists elsewhere.

2 WORKFLOW MODEL

Effective reuse of resources in the LDL requires that they are organised and managed in a formal repository with quality-controlled metadata based on standards. In contrast, the shared workspace is an appropriate environment for storing and sharing resources that are continually being developed as ideas and representations of the design problem change and new resources are accessed and generated. This suggests that whilst a dynamic and informal shared workspace could help support the design process, it might be much less helpful as an environment for collecting together resources that can be reused with cohorts of students. Earlier studies identified the need for 2 parallel systems and raised issues about how the resources are moved from one (LLE) to the other (LDL) [2]. To this end a workflow model was developed (see fig. 1).

Stage 1 involves the students (and staff) uploading and using content as part of a learning activity. At this point, some metadata is automatically applied (e.g. date, file format, depositor identity) and some optionally by the depositor (e.g. file title, author, citation, description). Stage 2 requires the teaching team to flag content for inclusion in the LDL and potentially add more metadata e.g. further subject keywords and most importantly educational context information and suggested use. Finally, Stage 3 acknowledges the need for a librarian/information specialist (LIS) to formally approve information into the LDL. This arose because of metadata issues; the decision to use a controlled vocabulary in the LDL (Inspec Thesaurus) to ensure consistency of approach; and, the need to take IPR and DRM properly into account. There is also evidence to suggest that metadata produced by both academic and LIS result in improved retrieval [4].

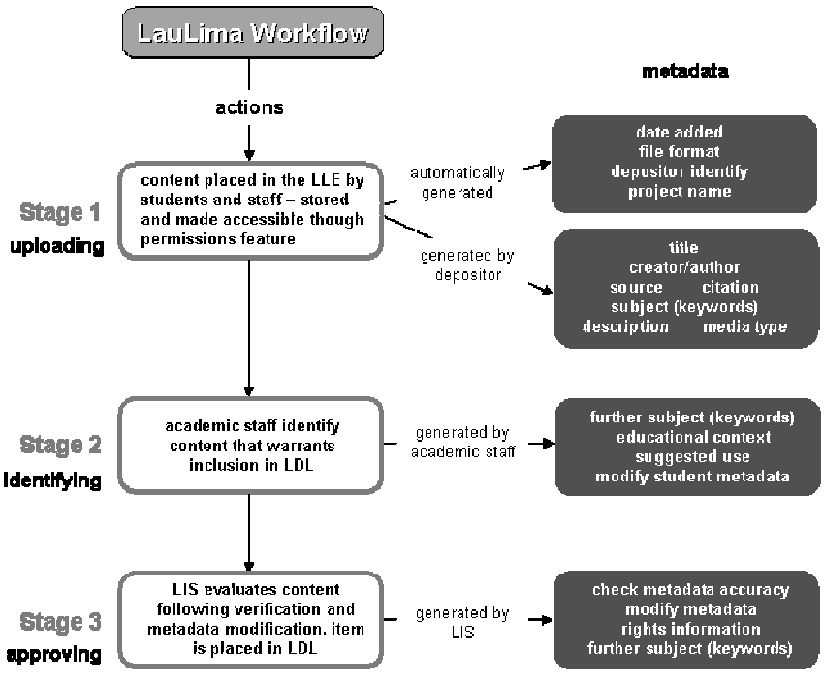

Figure 1. LauLima Workflow Model

2.2 Testing of Workflow

Evaluation was conducted for the 3 stages using a variety of methods. At Stage 1 students were observed in class and at presentations; focus groups were held and reaction cards issued. Objective data was provided through weekly analysis of teams' shared workspaces. This provided information about how students had interacted with the resources, what metadata they had created, what they experienced, etc. At Stage 2 focus groups and interviews were held with staff who had been involved in selecting and uploading resources for inclusion in the digital library; and at Stage 3 the information specialist was interviewed with regards to approving resources in the digital library. The information specialist was also present at the focus groups for Stage 2.

3. IDENTIFYING THE ISSUES

The issues identified at the upload stages At each of the upload stages several issues were identified. These are described below and summarised in Table 1.

3.1 Stage 1: Students uploading to LLE

Students uploading information and resources to the LLE during design project work are required to enter certain metadata including a title, creator, keywords and descriptions for each file. Early studies (reported elsewhere [5]) showed students strongly resisting inputting large amounts of metadata. Student metadata attached to uploaded files was inadequate, misleading or incomplete. Analysis of each team's files early on revealed that only 50% of teams had supplied keywords and descriptions (metadata) when uploading resources. Students reported the use of metadata difficult for several reasons. It was confusing; they didn't know how to use keywords; they didn't realise their purpose; their value hadn't been made clear and it took too long to input keywords and descriptions. Analysis of the keywords supplied revealed that students tended to use terms supplied by academic staff for each project topic to be investigated rather than their own. Reaction cards highlighted several factors determining student choice of keywords, e.g. content of resource file (80%); summary of resource file; obvious and relevant description; file type. 25% of students selected keywords based on sharing resources, thinking of the words others might use when searching. Analysis of description metadata showed three categories of information had been provided: descriptions of the type of information supplied (e.g. image, sketch), descriptions of the source of the information (e.g. government publications, standards) and descriptions of the content in terms of subject matter (e.g. data about forces, mechanisms). The most common descriptive category was about content. Teaching staff acknowledged that insufficient preparation had been given to students in the creation of keyword and descriptive metadata.

Significant changes were made in relation to information literacy instruction and support in subsequent classes. A learning technologist provided sessions at the beginning of design projects on planning information searching, identifying search terms, using appropriate sources, modifying searches, evaluating resources, copyright issues, organising information, assimilating found information into their own design concepts and referencing. Information literacy is now embedded in classes. Concept mapping was the mechanism used to develop these activities. Students responded positively to this support as evidenced in project logs where the students described their experiences. They also reported the value of being able to access and contribute to the development of resources at any time from any location. Students agreed that applying

keywords and descriptions to resources made them stop and reflect on the information they were uploading. However they also noted this took considerable additional time.

3.2 Stage 2: Staff uploading to the digital library (LDL) approval gallery

Academic staff identify items for inclusion in the LDL by reviewing the class project team wiki sites and file galleries populated by the students during their design projects. Staff relied on their knowledge of the engineering design process and students' needs to pick out the most appropriate. Items selected covered a range of potential applications including good examples of brainstorming, concept sketches; photographs and videos of prototype development, each with design rationale and decisions taken, as well as useful external resources. Most teams had at least a few resources (up to 5) which would be of use to future cohorts, although the better teams tended to have more. On average, around 5% of the material from a class has been submitted to the approval gallery.

Staff often found that file names had to be altered and descriptions improved before submitting to the approval gallery due to the existing poor quality metadata, especially descriptions for files, input by students at Stage 1. Importantly, in addition to a description, a field on educational use had to be completed. Staff could identify the educational significance of a resource and indicate how it could potentially be used to improve student learning. Harvesting of reusable resources originally took place during academics' preparation for class each term however, the assessment process has now been identified as a more appropriate time to harvest items for the LDL. A greater number of staff can be involved (both academics and design project coaches) and good resources can be simultaneously tagged as the team wiki sites are being reviewed for credit and feedback. Tagged resources are then able to be compared and the best selected resulting in robust high quality reusable learning objects. Academic staff reported that inputting metadata to resources was time consuming but they valued this process in terms of the added educational value and reusability in future classes.

3.3 Stage 3: Approving LDL resources

A librarian/information specialist (LIS) worked with the team to formulate an agreed controlled metadata vocabulary suited to the types of resources used in design engineering education which would support effective information retrieval from the digital library. To address sustainability and interoperability issues, the metadata schema developed for the LauLima digital library was based on standards established by the Dublin Core Metadata Initiative (6). Although the main issue for uploading resources is the effort required to add quality metadata, a high quality useful resource will not be retrieved and effectively re-used unless it is well indexed. Resources are submitted to the digital library and are indexed by the LIS according to subject area using Inspec thesaurus terms but can also be classified by class project, year and resource type e.g. case studies, graphs, sketches, reports. The LIS found many resources with insufficient or poor quality metadata and lack of referencing had to be rejected. Submitters can review the rejection message and re-submit later if desired, after improving the quality of the submission. Legality and quality remain important issues for the approval stage. If copyright clearance cannot be obtained for an external resource then users must store a reference to the resource rather than a copy of the resource itself. Student permission is sought at the beginning of each class so that their work can be uploaded and legally stored in the digital library and reused. Resources

which have breached copyright legislation have also been rejected, as are resources which have limited educational value.

Table 1. Summary of upload issues at each stage

Students	Academic staff	LIS
Stage 1	Stage 2	Stage 3
Insufficient/poor metadata. Poor resources. Time consuming. Interruption of design process. Information literacy training is crucial. Keyword application increases interaction with information and encourages reflection.	Time consuming. Granularity - unable to upload linked information. Long term reduction in preparation of class materials. Maintenance.	Rejection of resources. Time taken to track down references. Intellectual Property Right (IPR) and Digital Rights Management (DRM). Maintenance.

4. DISCUSSION

4.1 Time

Currently the time taken to select, add metadata and upload these valuable resources is one of the greatest barriers to the successful adoption of the system. The inputting of metadata at Stage 1 (mainly students) needs to be kept to a minimum in order not to interrupt the natural flow of the design process. As much as possible needs to be captured automatically; even an increased use of drop down menus reduces time taken. Other methods such as 'drag and drop' are being investigated. At assessment staff found it useful to harvest resources but welcomed a tagging facility along with the ability to add quick notes which would allow them to identify resources and return to them after the initial selection to input metadata, thereby not interrupting the assessment process. Such a system allows flexibility and supports different marking styles. Guidelines are also currently being drawn up to support staff in the selection of high quality resources in order to reduce selection time.

4.2 Quality

The DIDET project aims to produce resources of high quality. Ways of ensuring this now include the education of students in information literacy, metadata input and referencing by class academics at the start of projects and by academic staff during the project in addition to sessions by librarians; the use of copyright-cleared content; and the creation of our own content, most of which cannot be found elsewhere. Many high quality small resources have been entered into the digital library but academics have reported the value of the interlinked wiki pages (editable web pages) in terms of added context; making relationships between resources; and student knowledge structuring. Since the issue of granularity is also important mechanisms to capture linked wiki pages are now being explored. These types of resources are promising to link declarative information with the more informal procedural and organizational information which captures context, ideas, rationale, and processes and are of great value to learners.

4.3 Maintenance

Initial discussions around maintenance of resources have identified the need to have the support of both a LIS and a systems developer in addition to teaching staff. The extent

of this involvement is currently being examined, alongside issues such as the time stamping of resources; the scalability and size of collections and updating of resources.

4.4 Student Learning

Research suggests that constructing resource collections in shared workspaces can benefit learning especially when students are required to analyse, organise, reflect on, and interact with, the information and resources they upload [7], [8]. Through continually improving learning activities within the design projects we are encouraging greater interaction and reflection on the information students find and generate during design projects. Concept mapping has proved in past projects to aid the creation of keywords specific to classes and to help students create knowledge structures around the information they work with. Integrated instruction in information literacy, supported by academics and design project coaches, is also crucial to student learning.

5. FUTURE WORK

The use of the LauLima system is embedded in team based design engineering projects at DMEM due to positive student feedback, a committed project team and robust technical support. Evaluation of its use in a few other classes within the department and other departments is taking place and the intention is to roll-out to wider user groups. The DIDET team is now also focusing on the use of the shared workspace and the digital library in global team design environments with the development of a new joint class project with Stanford University and Olin College.

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