eUreka: WEB-BASED TOOL FOR COLLABORATIVE PROBLEM SOLVING AND PROJECT WORK – DOCUMENTATION OF KNOWLEDGE CREATION AND DISCOVERY

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Abstract
eUreka is an institutional web-based management system for project work and knowledge management. It facilitates knowledge creation and provides for learning via experiential knowledge derivation and sharing of institutional knowledge assets. It enables self and world discovery and group synergistic experience beyond the boundaries of physical classrooms and laboratories.

At NTU, usage of eUreka has extended to group-based case studies, problem based learning at the under-graduate level, and to the mentoring/supervision of under-graduate and post-graduate projects at Masters and doctorate levels. It is being explored to support continuing education

Introduction

Project work has long been established as an important learning activity for engineering students. Its many forms include, notably, the final year project (or FYP) that is a major course component and key highlight in the undergraduate program. Other varied forms include term or mini-projects, group project work. In eLearning work, the instructor assimilates knowledge, and together with his experience and expertise, transfers that knowledge through the information communication technological (ICT) media or in the traditional instructor-led teaching model. In contrast, students in project work apply their baseline knowledge and understanding, and use that to reach some objectives or solve some problems.

At Nanyang Technological University (NTU), as in many institutions of higher education, students are exposed to project work. In the earlier years of their undergraduate programme, they are required to complete minor projects of a few weeks' duration to a semester. The nature of such project work might be investigative, analytical, problem based, case study, or information gathering. In addition, in the third year (of a four-year programme), students from some programs spend up to 6 months in industry as interns. Some students choose to

participate in the Global Immersion Program (GIP), an exchange programme with another university abroad.

The project work progress is typically tracked by formal and informal communication channels such as e-mails and face-to-face meetings between (team) student(s) and staff project supervisors. Students usually keep a logbook or journal to record their plans, execution and development with milestones, activities and tasks. Supervisors review this typically hand written logbook to regularly monitor regular progress, as well as assess the student's general performance. The project outcomes and output are often evaluated subsequently with a project presentation and demonstration.

The processes recognizes the lack of a centralized platform to track and record work processes and knowledge assets created by the project students as well the lack of appropriate documentation – typically in the log books only - of the project discovery processes, dialogues, discussions, failed experiments, alternative paths considered that could have taken place in the project work flow process. As knowledge assets discovery and documentation are critical to the project work-flow and intellectual property processes, it is advantageous that good documentation capture is in place; innovative ideas, inventions, theories, principles, models, experimental data, experiments that have failed and discourses, debate, etc can now become part of the institutional intellectual property.

The University has extended eLearning as a means of knowledge transfer and delivery coupled with pedagogy to knowledge creation and discovery on an automated online system. eUreka is an institutional web-based management system for project work and knowledge management. It facilitates knowledge creation and provides for learning via experiential knowledge derivation and sharing of institutional knowledge assets. It enables self and world discovery and group synergistic experience beyond the boundaries of physical classrooms and laboratories. The usage of eUreka has extended to group-based case studies, problem based learning at the under-graduate level, and to the mentoring/supervision of post-graduate projects at Masters and doctorate levels.

Project-based Learning in Continuing Education

Notably absent in continuing education is this conative domain as part of the holistic learning outcomes. While education has focused on the cognitive (like knowledge, comprehension, application, analysis, synthesis, evaluation, etc) domain, there is now increasing expectations from employers of such attributes and qualities like motivation, drive, effort, communication, creativity, innovation, etc.

Project-based Learning (PjBL)[1] is a constructivist pedagogy with the intent to encourage deep learning by allowing the students to adopt an inquiry based approach in dealing with issues and questions/problems that are real and relevant in their learning and own lives. Students are required to be independent, and sometimes inter-dependent and accountable for their contribution and effort. They manage, set goals, and strive to meet project expectations, using either skill sets they already have, or struggle to develop them while doing the project (very much like a chicken pushing its way out of its shell).

Project work is designed for complex authentic issues that would require students to investigate and explore possibilities in order to better understand the problem presented to them. These can be an individual or a team project. It is also less structured than a traditional teacher-led classroom approach and in most cases, the students need to organize their work and manage their own time. The learning/discovery activities and effort, as such,

1: http://en.wikipedia.org/wiki/Project-based_Learning

are long-term, usually multi-disciplinary and student-centred and student-driven.

With Web2.0 applications, students are expected to use technology in meaningful ways to facilitate their investigation process or to present their project outcome. Project-based Learning is designed to encourage students to be independent workers, critical thinkers and lifelong learners. It provides an in-depth investigation of real-world issues that could well be relevant to the students in their own lives.

Problem-based Learning

Problem-based Learning (PBL)[2] is an instructional strategy of 'active learning' and students are encouraged to take responsibility for their group to organize and manage their learning process, with support from a tutor or instructor. Advocates of PBL have claimed that this approach can be used to enhance content knowledge and foster the development of communication, problem-solving and self-directed learning skill.

The expert-novice approach advocated by Merill (2002) would mean presenting simplified versions of real work problems with guidance by the tutor or instructor and then the guidance will progressively fade as the students build up their confidence and expertise in handling the problem or issue on hand. The progression and fading will motivate the students as they gain the expertise and take ownership of their learning.

In problem-solving situations (applicable to project work as well), students assume increasing responsibility for their learning while the instructor takes on the role of modelling different kinds of problem-solving strategies. PBL thus fosters active learning, supports knowledge construction and integrates learning with real-life situations. Problem-based approaches structure students' activities by getting them to solve specific open-ended problems rather than relying on the students to define their own problems in the course of completing a project, as in Project-based Learning.

eUreka – NTU's Web-based Project Work Management System

There are readily available tools for effective use in the management of projects. However, such tools cater more to the context of commercial and industrial projects. In the educational environment, there is a need to provide useful features to enhance the documentation of knowledge creation and learning experiences that are unique to the students' involvement in project work. Such a system should also tap on information and communication technology to incorporate extended features to better cater to group work and online collaboration, facilitating support for reflection and providing authentic assessment of project work management. On the other hand, the system should not be so overwhelming to the students, who look at such project work management systems merely as a tool.

Adopting an approach of 'less is more' in the design of eUreka, established project work management tools, such as Microsoft Project, eRoom, BaseCamp, Teamspace, Task Manager, eProject and @Task, related to the project work-flow process have been taken into consideration. These tools focus more on resource and timeline management and might be overly complex for the student/learning environment. They do not integrate a document repository or a project log to better cater to the learning experiences and knowledge discovery that could be evident in the project work duration within the educational context.

2: http://en.wikipedia.org/wiki/problem-based_learning

Unlike learning management systems such as Blackboard and Moodle, which handle learning and content management for knowledge transfer and sharing, eUreka is targeted at knowledge discovery and management

Laffey *et al*. (1998) advocated that the design of project-based learning support systems needs to consider the instructional and learning processes. The instructional processes include scaffolding and coaching, while learning processes cover planning and resourcefulness, knowledge representation, communication, collaboration and reflection.

Scaffolding provides step-by-step support to guide students in performing tasks required in the project work management process. While the interaction of students with their project supervisor represents the explicit form of scaffolding, procedure and task facilitation implicit to the design of an interface are also effective forms of scaffolding. Coaching covers activities in modelling, providing appropriate and timely feedback, structuring the way things should be done, demonstrating good techniques as well as providing prompts, encouragement, thinking-learning opportunities and support (Laffey *et al*., 1998).

Project work can be a long-term activity that involves interdisciplinary knowledge. Learning-support tools such as a project work portal could provide a one-stop service for the process of collaborative project work, covering project planning and scheduling, documentation of resources and findings, report writing, and reflections on learning experiences in the project work duration (Tan *et al*., 2004).

For reasons of a lack of an easy-to-use project work management tool, an initiative by NTU was started to develop an online web-based version of the project work process. This project work portal can also function as a productivity and collaboration tool that will enhance the efficiency of project coordination and management by supervisors and the university administration.

The use of such computer-mediated systems will enable the supervisor to review project status at any time, anywhere, and provide timely feedback to students on their progress of work done, rather than the regular weekly or monthly face-to-face meetings. This is similar to e-mail enhancing communication frequency, ease and updating status; it does not replace the need for other modes of communication, like face-to-face meetings. As such, this portal aims to complement and enhance the face-to-face sessions between and among project students and supervisors.

eUreka (after Archimedes' "*I have found it!*") is aptly named, depicting the adventurous spirit with its passion for and pursuit of new horizons, knowledge and innovations. It was developed to create an automated web-based system to manage, document and monitor the project work process.

eUreka's utility is not restricted solely to academic projects. Staff and students can use eUreka to manage their collaboration with external organisations. Such projects can be academic (*e.g.*, research collaboration), industrial (*e.g.*, joint industrial developmental projects and collaborations), and informal and nonacademic (*e.g.*, committee work, events, conferences, student activities, *etc.*). In the latter example, minutes, meeting notes and other documents can be placed in the document repository. Progress on the project can be monitored and shared online by committee members with ease. eUreka, thus provides a one-stop resource repository and work flow process system that facilitates students in applying their project management skills, albeit in real-world projects.

eUreka is designed with ease of use in mind and has a gentle learning curve. Thus, students who are unfamiliar with the tenets of project management should not find eUreka overwhelming to cope and use. The system provides user-friendly tools for project work

planning and management to supplement the expected face-to-face contact between students (undergraduates and postgraduates) and their project supervisors.

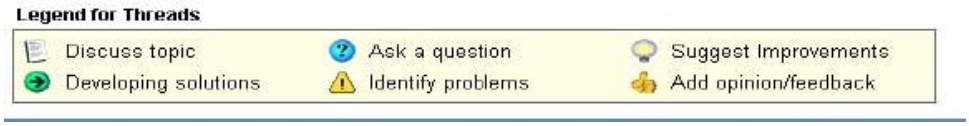
Features in eUreka

	Menu Tab	Description
1	Information	A summarised overview of the selected project site. The user will be able to access the latest announcements, project files uploaded and updates to work flow process for the project.
2	Announcements	This section provides announcements, news and administrative updates. It can also double up as a form of reminder for the project members.
3	Activities	Users can create milestones, activities and tasks to monitor and manage the work flow processes and development for the project. The Gantt Chart generated will provide a graphical representation of the overall plan and work flow processes. Version tracking is available to keep history of the project work flow process (milestones and tasks).
4	Project Files	This is the file repository in the system. It includes a customizable document structure which allows uploaded files to be stored under multiple folders. The user can upload files to the repository, for the documentation of the project work flow process.
5	Discussion Forum	The online forum facilities group project discussion. While it has limited benefit for individual projects, for group project, members and supervisors can raise issues for discussion.
6	Members	This section contains contact details of the team members and the supervisors in the project. It serves as a good reference for communication link (using e-mail or phone).
7	Weblog	Weblog is the online journal or diary to record individual member's progress, observations, thoughts, insights, responses, learning experiences, etc. It acts like the physical log-book for students to document their work. The members can share and allow others access to their weblogs.
8	Links	A repository of useful web links for reference in the project work. The user can create his/her own folders for better management of their project useful links
9	Assessment (for Project Supervisors only)	This section provides tools for assessment rubric creation and customizable assessment templates by project supervisors. Scores can be weighted, updated and eventually exported out to other systems (such as, in NTU, the Marks Entry Systems).

What was previously documented using a project log book and discussed face-to-face during student-supervisor sessions, have resulted in an online version in which the supervisor is able to keep timely track of the student's (or many of his group of students at various levels – Final Year, post graduate PhD - doing multiple projects) progress anytime and anywhere there is an Internet connection. That eUreka is web-based and online allows such supervision to be done; staff and students can be physically remote and linked on the Internet, and eUreka will afford timely supervision. Communication tools using discussion forums, or direct comments in the student's weblog or VOIP tools like Skype or instant messaging tools will provide warmer mentorship.

To enhance its collaborative value, the Discussion Forum tool in eUreka incorporates a scaffolding structure (Figure 1), where classification of postings will facilitate the flow of discussion and guide group members towards resolving conflicts and moving towards a solution of the project's goal. To enhance its use, multimedia elements can be embedded within forum postings. Documents can also be attached to individual postings. To aid viewing, filter tools are available to view postings based on time windows. Individual postings can also be selected and aggregated as a document for further use (*e.g.*, part of a report or an archive for reference in a meeting).

Figure 1 Scaffolding aids to make discussion more effective



eUreka's core element is the Weblog tool. This is a strong example of the useful application of blogs in education. Most people will define 'weblog' as a "frequently updated website consisting of dated entries arranged in reverse chronological order" (Walker, 2003). A blog is also likened to an online personal journal or web page and it provides a "hierarchy of text, images, media objects and data, arranged chronologically, that can be viewed in an html browser" (Winer, 2003). The moments of shared experience can be powerful connectors to further collaboration. The weblogs provide the framework for the students to build their social networks through the documents they have created, and such distributed 'conversations' could begin online and be solidified in the real world (Hourihan, 2002).

Through eUreka, relevant and useful documents can be deposited in the Project Files repository. Having such documents online makes digital reports, presentations or references easier to manage and disseminate. Unlike printed media, these reports do not get lost or become messy, tattered and torn with use. Project members can also incrementally contribute to this collection as part of their work, and include progress reports, presentation slides, project publications at conferences or in journals, notes, *etc*. Documents stored in a project repository provide convenience for group project members to share their own collection as well.

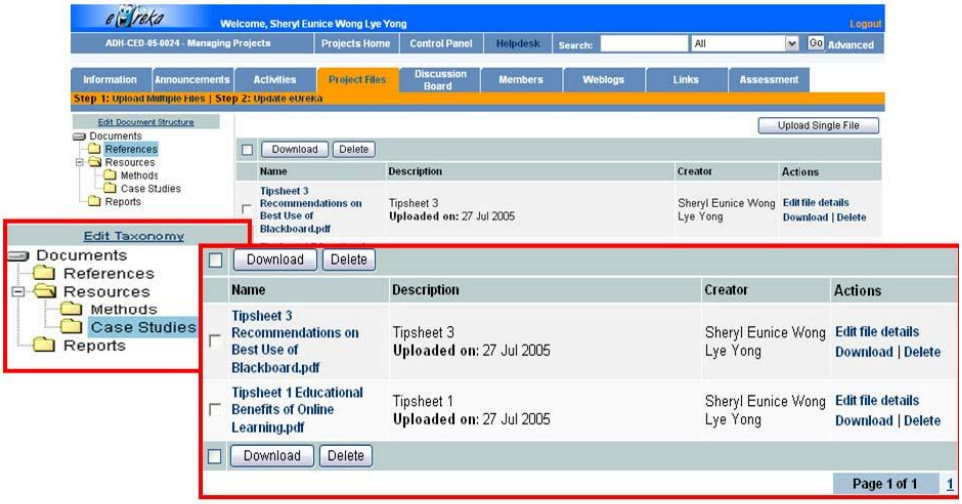
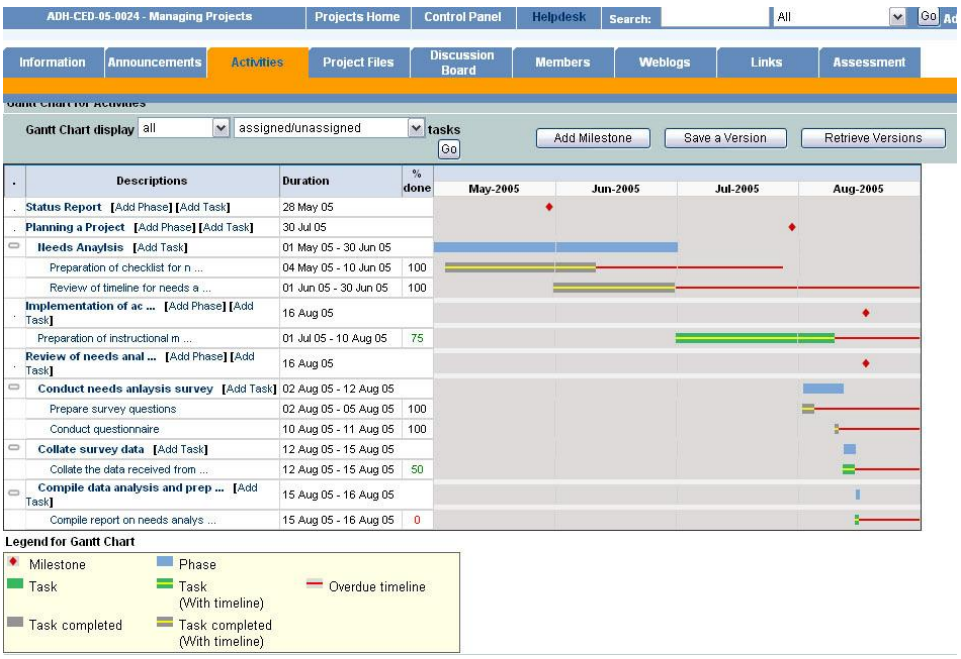


Figure 2 File Repository for documentation and reference

After establishing the project's objectives and requirements, project members can formulate a 'plan of attack'. The creation of milestones, activities and tasks allows the project members to better manage the deliverables, progress rate and time-lines. The availability of a monitoring process for milestones and tasks provided operational and visual representation of project progress and this, in turn, would enhance the efficiency in achieving the project goals.

Figure 3 Project outline using a Gantt Chart



Using eUreka for problem-based learning and project work

While eLearning can be seen as an effective tool for knowledge transfer, eUreka has facilitated a platform for group collaboration and discovery learning. Such learning context will facilitate the learning process as defined in problem-based approach. The students are now the centre of the learning process. Instead of going through a learning pathway to attain competency, in the eUreka project work management system, the student using material provided by the professor as a mentor or supervisor, determines, plans and design the process of discovery, experimentation, analysis, implementation and project completion.

The instructor will now assume the role as Facilitator-Mentor and would provide the learning support to enhance the learning process by posing metacognitive questions (such as “How do you know?” or “What assumptions have you made?”). Such questions could cover areas like the planning process; the assumptions made on the premises for the problem; the process for negotiations, discourse and resolving conflicts; and the derivation of possible alternative solutions for consideration as a group. The students are also provided with opportunities to role-model for one another the different problem-solving strategies.

eUreka serves as the platform for knowledge discovery in which students, through case studies, project work, PBL, and authentic real-world learning scenarios, will (individually or in a group) apply knowledge and understanding through trial and error to conclude their work. Although project objectives might be similar, in some cases project groups might achieve different solutions and approaches that will meet the project objectives through this experiential learning of debate, discussion, and risk taking (*e.g.*, building a bridge to link two communities on opposite sides of a river).

How eUreka has served the needs in project work management at NTU

Since the launch of the system in September 2004, there has been steady growing increase in numbers and usage. The number of formal projects created for year Apr 2007 till to-date (eg. FYPs) is 2,292 and active project sites total 412

	FYP Projects							
	Year 2004/2005		Year 2005/2006		Year 2006/2007		Year 2007 (Apr onwards)	
	Total	Active	Total	Active	Total	Active	Total	Active
	3376	865	2113	1152	1588	212	2292	412

The number of ad-hoc project sites for Year 2007 April total 919 sites, of which 77% are active sites (707 sites). Active sites refer to those sites where there had been creation of announcements, upload of documents or creation of milestones and tasks etc.

Ad-Hoc Projects							
Year 2004/2005		Year 2005/2006		Year 2006/2007		Year 2007 (Apr onwards)	
Total	Active	Total	Active	Total	Active	Total	Active
276	25	525	266	393	246	919	707

The total number of project files created has hit 8,302 as of present status:

Project Files Created			
Year 2004/2005	**Year 2005/2006**	**Year 2006/2007**	**Year 2007 (Apr onwards)**
501	**3681**	**6801**	**8302**

Weblogs have also seen an increase in adoption, from just 61 weblogs in year 2004 to 2005, there are to-date 1,980 weblogs created representing an increase of 32.45%.

Weblogs Created			
Year 2004/2005	**Year 2005/2006**	**Year 2006/2007**	**Year 2007 (Apr onwards)**
61	**103**	**407**	**1980**

For discussion forums, the increase in forums created has 9.325 times and growing to-date.

Discussion Boards Created			
Year 2004/2005	**Year 2005/2006**	**Year 2006/2007**	**Year 2007 (Apr onwards)**
40	**163**	**116**	**373**

From the pattern of usage since its maiden implementation in September 2004, users have viewed eUreka as a useful repository for the resource upload and process documentation. It can be seen that there has been rising trend on the use of the repository since its launch, with an increase in files upload from 501 (September 2004 to April 2005) to 3681 (June 2005 to May 2006) to 6659 (June 2006 to-date March 2007).

Conclusion

Universities are recognized in society for their key role in teaching of advanced knowledge to its students who would become future participants of the economy.

eUreka offers an institution like the university a uniform campus-wide system to curate its institutional memory. It offers a centralized platform to manage the internal quality processes of invention and innovation in the future. This includes the creating, sharing, retaining, storing, using, updating and retiring knowledge. Its use can also be extended to research labs, institutions and other organizations involved in cross cultural and cross boundary collaborative work.

The system was built and enhanced with feedback from the student and professor user communities, and it can be regarded as one that is “built by the users and for the users”. The learning design consideration in the system vis-à-vis the weblog, reflections and forums cater to the users’ scaffolding environment for the knowledge creation and discovery learning journeys.

(3,403 words)

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