Embedding an Integrated Learning Environment and Digital Repository: Lessons Learned

Caroline Breslin[1], David Nicol[2], Hilary Grierson[2] and Andrew Wodehouse[3]

[1]Learning Services, [2]Centre for Academic Practice and Learning Enhancement and
[3]Department of Design, Manufacture and Engineering Management
University of Strathclyde, 16 Richmond Street, GLASGOW G1 1XQ
caroline.breslin@strath.ac.uk

Abstract. This paper describes how a system comprising a learning environment and digital repository is being embedded into the Design Engineering teaching and learning. It then maps out the issues that have been encountered, how these have been overcome and how they will affect other departments or institutions as such tools are scaled up and rolled out. These issues are categorised as technological, pedagogical and cultural and include the adequate provision of support, creating a critical mass of resources, ensuring quality and integration with other technologies. Successful embedding and sustainability requires that senior managers reflect on these key issues at a departmental and/or institutional level before implementation.

Keywords: e-learning, transformational change, wiki, information literacy, sustainability, digital library, digital repository, learning environment, design engineering.

1 Introduction

In tertiary education there has been a rapid increase in the use of electronic tools such as shared workspaces and digital repositories to support the management of digital content. The vision is that students and academics utilising these advanced information systems will be better able to access, create, store, share and reuse content. From an educational perspective, having tools to ease the burden of managing digital content is potentially beneficial. For example, more attention can be focused on learning processes rather than delivery of content. Also, economies of scale are possible with resources shared and reused across courses and programmes and even improved by new users. However, the increasing application of tools to manage digital content in university courses and programmes raises wider issues about how their use is embedded within institutional systems and cultures and about the sustainability of these approaches when they are scaled up from the localised context of their, often pilot, implementations. This paper examines technological, pedagogical and cultural issues related to use of a shared workspace and a digital repository within the Distributed, Innovative Design, Education and Teamwork (DIDET) project.

2 Overview of the DIDET project

The DIDET project is one of four UK-USA collaborations in JISC and NSF's *Digital Libraries in the Classroom* Programme. The aim of DIDET is to enhance the learning experience of Design Engineering students at the University of Strathclyde (Glasgow, UK), Stanford University (CA, USA) and Olin College (MA, USA).[1] Projects are now entering the fourth year of this five-year programme.

This paper will discuss the DIDET project at Strathclyde where the teaching and learning in the Department of Design, Manufacture and Engineering Management (DMEM) is underpinned by an information system developed as part of the project. This system, named 'LauLima', was based on open source 'wiki' technology (Tikiwiki) which was extensively customised and enhanced to meet project requirements. The LauLima system comprises a shared workspace and a digital repository. Figure 1 shows how classroom teaching and learning is supported by these two inter-linked components of the system – the LauLima Learning Environment (LLE) and the LauLima Digital Library (LDL).

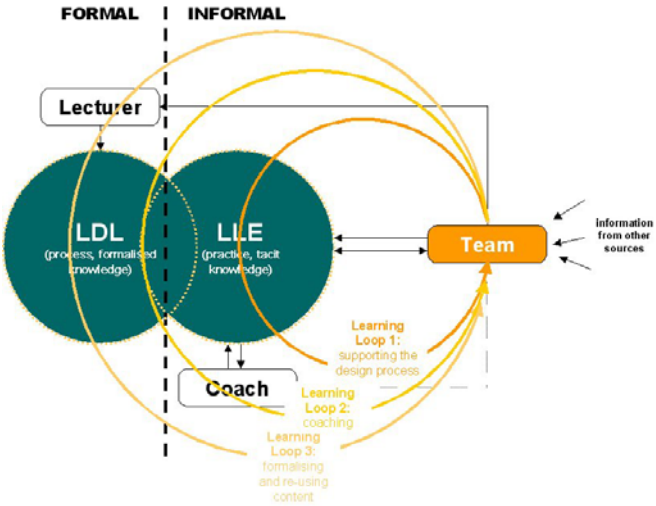

Fig. 1. LauLima system supporting teaching and learning.

The LauLima Learning environment (LLE) is a dynamic shared workspace designed to support collaborative learning during product design as shown in *Learning Loop 1* in Figure 1. In contrast to the central institutional VLE at Strathclyde, the LLE is focused on students creating, storing and sharing content rather than accessing content supplied by teaching staff. In DMEM, students work in design teams on projects and use the LLE to create, store, access, manage and share digital resources. The LLE has a file storage area and allows the creation of dynamic wiki pages with which student teams can map their design process from beginning to

[1] For further information, see the DIDET Project Website http://www.didet.ac.uk

end. The LLE offers great flexibility during group working as students can access and manage resources online at any time from any location and can collaboratively manage their learning and workflow.

Learning Loop 2 illustrates how student teams are supported by a 'coach' who guides and facilitates their design processes. The coaching process involves interactions with both the LLE and LauLima Digital Library (LDL) components of the system.

The (LDL), in contrast to the LLE, is a formal and more permanent repository where resources relating to Design Engineering education are built up over time to be reused as depicted by *Learning Loop 3*. Externally created resources or references to them can be stored in the LDL. However, an important focus of the DIDET project is that *student-created* resources are stored for reuse by future students and staff in the department. Staff and students in the department can browse or search the LDL, making use of the rich metadata to retrieve quality resources relating to Design Engineering in general or relating to a specific class or project.

Although the LLE and the LDL components can be considered discrete elements of LauLima, they are designed to be interdependent and a workflow procedure has been developed that inter-links them. Staff in the academic department harvest the most useful resources from students' LLE workspaces and submit these for inclusion in the LDL: 'usefulness' in this context refers to 'potential for reuse'. This selection is subject to a final approval stage where an information specialist checks the resources for quality and legality and adds additional metadata. In turn, resources also move from the LDL to the LLE when students retrieve them to inform their design projects. This creates a workflow 'loop' of creation, use, storage and reuse.

The LLE provides an additional layer of support as a communication tool and can be used by the coaches of student teams to monitor work on an ongoing basis; providing support and advice throughout the lifecycle of the project and not only at the final assessment stage. The LLE is also used by staff to distribute class materials and information.

3 Embedding the DIDET Project Tools

This section discusses ways in which the DIDET technology and the teaching and learning that it supports are embedded at Strathclyde.

3.1 The LauLima Learning Environment (LLE)

The Department of Design, Manufacture and Engineering Management (DMEM) has piloted the LLE in a small number of classes and refined its design based on ongoing evaluation. In engineering design classes where LauLima supports learning, students receive an induction in the use of the LLE including its technical features. They then engage in a team design project and use the LLE to store resources and links to resources that have been created or discovered as part of the design process. Other functionality within the LLE helps students to keep track of different versions

of documents created collectively by members of the team and to collectively manage the team workflow.

When they start their design, the student teams are required to create concept maps to help structure their thinking about the scope of the design project. During the development of the design the teams use interlinked wiki pages comprising resources (e.g. diagrams, descriptive text) and links to resources to map out the design process. At different points in the design process, students use the LLE and the inter-linked wiki pages to deliver presentations to staff and peers for feedback. These presentations outline the thinking behind the design concept and its development. Throughout the design project students also create blogs that reflect back on the design project, its progress and its outcomes. In effect, the concept maps, inter-linked wiki pages and the blogs all help to capture the students' tacit and developing understanding of the design process.

The classroom activities described above are all designed to encourage students to engage in deep analysis and reflection on their own understanding and to help them create new and more elaborate knowledge structures [1]. It can be argued that the classroom teaching and learning and the technology are tightly integrated and embedded at a curricular level within DMEM Firstly, significant use of the LLE is required in order to complete the learning tasks, hence it is cannot be seen as an add on. Secondly, the use of the LLE is planned in at the course design stage. The LLE permits learning activities that would be difficult to achieve by other means; for example, it easier for teams to keep all their project related resources in one place and access and share them as required and to document the design process. Previous research [2] has shown that when the use of technology is designed in this way students are very positive about its use.

3.2 The LauLima Digital Library

The LauLima Digital Library (LDL) is a digital repository accessible to students on Design Engineering courses at Strathclyde and all members of staff involved in the teaching of these courses. Student created resources are fully indexed then stored in the LDL with metadata attached (see below). Students and staff can then use the LDL's powerful search and browse facilities to retrieve quality resources for reuse in design projects or for other teaching and learning needs. As part of teaching in relevant classes, students are given a demonstration of how the LDL is used and taught how to browse and search for relevant resources. This demonstration not only prepares students for the use of the LDL as a retrieval tool, but also makes it clear to them the purpose and importance of the metadata associated with resources in the LLE.

The digital library element of the LauLima system has not been fully embedded in the Design Engineering courses at Strathclyde for a number of reasons. Firstly, the LDL technology has taken longer to develop than the LLE and has not been fully tested across different contexts. Secondly, there are, as yet, only a limited number of resources in the LDL, hence searching for resources is not currently guaranteed to be a productive activity. Thirdly, there is a danger that commitment to use the LDL

within the department will be less if the LDL is promoted when there are insufficient high quality resources. Work is currently underway to increase the number of resources from approximately fifty to at least several hundred. This is the 'critical mass' that will allow its use to become more widespread and, in turn, initiate more resources to be submitted by active users.

At this stage in the project, significant effort is being expended to develop a workflow to enable the efficient transfer of resources from the LLE to the LDL [3].

4 Overcoming Issues

The project team has identified a number of factors that are enabling the application of LauLima for teaching and learning to become embedded within DMEM at the University of Strathclyde. This section outlines the technological, pedagogical and cultural issues faced by the DIDET project and the potential impact should the project tools be scaled up or rolled out to other academic departments or institutions.

4.1 Technological Issues

Technical Support. Currently, technical support for the LauLima system resides within DMEM where one member of staff is employed with this as his main remit. Also, in the department, the software development has been dynamic and ongoing with new features to support pedagogical needs added when requested by academic staff. However, it is clear that if other departments were to use this system they would require training, documentation for the software and technical support to troubleshoot problems. So far DMEM have produced some documentation for the system and some new user departments have their own technical staff to support LauLima. However if each department were able to follow the DMEM approach and adapt the software to fit their own needs this would raise further issues regarding embedding and sustainability, given that the result would be a number of different versions of the software.

One solution to this problem would be that the system be managed and supported by central university services. For this to happen a business plan would have to be drawn up and potential usage across the institution evaluated to gauge the potential return on investment.

Integration. The LauLima system running in DMEM has been developed to authenticate users against the central directory service at Strathclyde and is integrated with the central student and staff portal system. The central VLE, however, is a proprietary software package and has not yet been integrated with LauLima.

The IT Services department at Strathclyde are able to provide support to resolve integration issues. Successful integration in other departments and institutions will depend on the technologies in use and the level of support and expertise available.

At the University of Strathclyde, the central VLE and the LLE constitute two complementary learning environments that will eventually be integrated. However at

other departments or institutions there may be issues relating to whether more than one learning environment is advisable.

Availability of Hardware and Peripheral Resources and Services. Student teams at Strathclyde using LauLima had a pool of laptops available for use during dedicated group working time as well as having access to a scanner and digital cameras. The accommodation available to students for group working also gave access to the university's wireless network. This made use of the LauLima system easier for students as they did not have to provide their own hardware and could, for example, quickly take digital photos of sketches to be uploaded to the LLE. If users in other departments or institutions were to use the system in teaching and learning, students would require computer equipment and network access during class time to allow them to make best use of the tools.

4.2 Pedagogical Issues

Pedagogy Led Project. Many studies of e-learning have shown that projects such as DIDET must be led by pedagogy and not by technology [4], [5]. The LauLima system has been designed to support project-based learning as used in Design Engineering education. The need to capture tacit knowledge was identified, alongside the Design Engineering requirement to support teamwork by enabling the storage and sharing of resources. It is also being used to capture tacit knowledge generated when students engage in the design process. For example, the way in which wiki pages are structured and linked, and the descriptive metadata information provided by students that is associated with files gives an insight into the design process and how designs have evolved over time. Hence this system provides added value to the learning process in that capturing tacit knowledge is more problematic in traditional teaching and learning contexts.

The issue here for other departments or institutions is that it is not sufficient to simply make tools such as LauLima available to users; the system and its use must be embedded into the curriculum from the outset.

Pedagogical Transfer. LauLima has been developed to support team learning in Design Engineering, based on the requirements of the subject's teaching and learning. However if it were used in other departments, especially those in non cognate disciplines, for example Social Sciences, then this would require that staff in these departments engaged in some of the same scoping and developmental testing that occurred in DMEM. This would ensure that these other departments make good pedagogical use of the LLE.

Training and Support: Information Literacy. Students using LauLima are given an induction into its use. Students are also given an induction into information literacy through learning tasks and demonstrations. For example, students searched for resources, input descriptive metadata, created concept maps within wiki sites and built structured file galleries. All this training was initially provided by the learning

technologist and was integrated into the teaching of Design Engineering at Strathclyde. This approach raises issues about who should provide this training in information literacy in the long term. In DIDET academic staff did not initially have the knowledge or experience to provide this training. Sustainability would therefore require that academic staff received preparation so that they can provide information literacy training to student. Alternatively, departments using these tools would each have to employ an information literacy specialist. However, there is a strong argument that all staff in future should have these skills.

Evaluation Loop. Another major factor in the success of DIDET has been the iterative loop of evaluation and development. The project team has regularly analysed student feedback which is periodically input back into development work to improve both the design of teaching and learning and refinements to the LauLima system each academic year.

Quality. Critical to the success of the LauLima Digital Library (LDL) will be the provision of suitable resources for students and staff. The DIDET team is addressing this by aiming to provide a set of unique resources that will be unobtainable elsewhere, namely *student-created* resources for reuse in courses at Strathclyde's Department of DMEM. Furthermore, Design Engineering students have already been surveyed to investigate which type of resources will be of most use. For the department of DMEM, a large percentage of students have specifically requested exemplars of previous students' work so that they know what is expected in assessed work. Other departments or institutions would have to carry out their own analysis of what types of resources would be most suitable for their staff and students, and also consider whether they can actually provide a unique set of resources as it would be ineffective to provide resources that are readily available elsewhere.

It is not only the quality of the resources that must be considered, but also the quality of the metadata attached to them. The LLE automatically adds limited metadata to uploaded files and prompts the user to add more. At the LDL submission stage, however, metadata must be of high quality so that resources are appropriately indexed and will be effectively retrieved by LDL users. When a member of staff submits an item to the LDL, there are additional metadata fields to be filled in. When the item is then transferred for final approval by an information specialist, further metadata is added again. The metadata schema for resources is based on Dublin Core and was developed by Digital Librarians and a learning technologist who had previously worked as a librarian and had experience in cataloguing digital resources. A decision was made to purchase an engineering thesaurus so that standard terms would be used.

A number of issues are raised by this model. Firstly, the descriptions input by students are of variable quality. Secondly, expertise is required to input metadata for the LDL. This suggests the need for a permanent librarian or information specialist for this task. This has implications for the roles and responsibilities of staffing in departments. Lastly the input of metadata is time consuming and therefore staff can be resistant. At Strathclyde, much work has been done to establish a workflow which balances the need for sufficient metadata with the time taken to create it. The system itself has been enhanced to cater for this.

Also scaling this model up to the institutional level adds further complexity. To be sustainable metadata creation would have to become an integral part of the institutional information strategy [6]. The solution recommended by Jones and Beazleigh [6] from the Open University is that there is shared ownership of metadata creation across staff and those with digital librarian skills.

Resources and Their Use. Currently many of the resources in the LDL have been harvested from the LLE with additional metadata attached. Other resources have been created by teaching staff and drawn from external sources and there are also pointers to resources in other repositories. However, while these resources can be easily reused across different cohorts of students within DMEM, they are of much less value to other departments, that is their value decreases as the subject content moves further away from Design Engineering.

Another issue raised by the DIDET project has been the time to create sufficient resources for use by a single department. This suggests that a similar timescale would be required for other departments to benefit from resources in the LDL. Various solutions to these problems are possible. One is to accept that the LDL is a departmental or faculty resource where sharing is more likely. This has been the approach taken in the DIDET project, where the LDL is a departmental resource. Another solution may be to build the LDL up into an institutional repository. The resolution will be very much dependent on the type and size of institution and what repositories already exist there and why they want to use a repository.

4.3 Cultural Issues

Funding Arrangement. JISC/NSF provided financial support for only the first 3 years of each 5-year project. This ensured institutional commitment beyond the funding stream. Three years was also a reasonable timescale to embed the project tools and technologies into classroom practice. Another advantage of the funding was the opportunity to develop 'proof of concept before rolling these tools across the department, faculty and institution.

Senior Buy-In. The DIDET project has benefited greatly from senior buy-in. This has been identified in many different areas of research as critical to achieve cultural change [5]. The Head of Department of DMEM and the Dean of Engineering have been key members of the core project team and developed the initial project proposal. There has therefore always been a strong commitment and understanding of the project at senior level.

Cross Discipline Team. The DIDET project was carried out by a cross-disciplinary team consisting of teaching staff, a systems developer, educational development and evaluation experts, an information specialist and a digital librarian. These staff are based in various departments across the university; DMEM, Learning Services, the Centre for Academic Practice and Learning Enhancement and the Centre for Digital Library Research. This range of backgrounds provided the project with a wide and

complementary range of skills, knowledge and experience. It also meant the project has a higher profile and greater reach across the institution and in the wider academic community.

However, despite the necessity of a cross-disciplinary team, this proved to be a major challenge within the project at least initially. Each stakeholder brought a different vision to the project and their own disciplinary discourses and understandings. This hampered communication at the beginning and pointed out a need for a strong leadership for the project. This was resolved by a core member of the project team taking responsibility for day to day management of the project in order to focus the efforts of the team.

Course Team Approach. A team approach has also underpinned teaching and learning in the classroom with students being coached by a multi-disciplinary coaching team, including staff not traditionally involved in teaching. This included the systems developer and learning technologist being directly involved in the classroom. The course team approach adopted successfully broadened the experience of both the students and staff and created new links and synergies across departments. This sharing of teaching across the team is highly supportive of sustainability. If one or two members of staff were to leave the department, the coherence of the course would not be undermined. This approach, if it were to be replicated elsewhere, would raise issues related to roles and responsibilities of staff, which may be at odds with traditional or expected tasks.

Uptake and Acceptance. As with any system, there is a learning curve associated with learning to use LauLima. Although the system has been regularly updated based on user feedback to improve its functionality and usability, becoming familiar and at ease with the tools can be difficult when not using it on a daily basis. It is important to create a culture of use in a department, faculty or institution. In DMEM, students' use of the tool and their system outputs were not only an assessed element of the class, but were part of regular course work. Hence the students were compelled to use LauLima on a regular basis. They were also supported during class time by team coaches who had experience of using the system. To encourage use of the LDL by staff and other students in the department, access will be made available to the LDL without the need to login and authenticate to the whole LauLima system. This has proved to be a barrier to the use of this system.

6 Conclusions

The experience of Design Engineering students at Strathclyde has been enhanced by the DIDET technology which supports teaching and learning. Our evaluation and research has shown the learning environment (LLE) element of the LauLima system technology to be embedded within the Department of Design, Manufacture and Engineering Management (DMEM) at the University of Strathclyde and work is now underway to embed the digital library (LDL) and its use into new and existing classes.

Embedding eLearning tools requires that the institution address many sustainability issues. These issues will change as the use of eLearning is scaled up from departmental to institutional level or rolled out to other departments or institutions.

It is easy to envisage the technological embedding of the LLE and the LDL in departments or institutions provided they have the technical skills and funding. However, pedagogical integration is more problematic. The LLE could be used to support group working in any class within any discipline to a greater or lesser extent. Embedding here requires that learning tasks call for its use and it provides added value. The LDL could in principle be used in any discipline. However, its integrated use with the LLE in this project while adding significant value also complicates the picture. The main reason for this is that many of the issues regarding embedding relate to the resources themselves rather than to the tool. The resources created by students in the LLE and transferred to the LDL are reusable for staff and students in DMEM but it is harder to envisage their value to other departments and institutions that did not run courses and programmes incorporating similar learning tasks. Finally, there are cultural issues to be addressed in the embedding of the LLE and LDL. These include concerns about changing roles and responsibilities, issues in relation to support and training and gaining senior buy-in and the acceptance of staff and students in academic departments and the institution as a whole.

Acknowledgments. The authors would like to acknowledge all work carried out by the DIDET team, including William J Ion, Neal Juster and Andrew Lynn. The DIDET project would not have been possible without funding from JISC and NSF.

References

1. McGill, L., Nicol, D., Littlejohn, A., Grierson, H., Juster, N. and Ion, W (2005). Creating an information rich environment to enhance design learning: challenges and approaches, British Journal of Educational Technology, 36(4), 629-641.
2. Nicol, D., Littlejohn, A. and Grierson, H. (2005). The importance of structuring information and resources within shared workspaces during collaborative design learning. Open Learning, 20(1), 31-49
3. Grierson, H., Wodehouse, A., Breslin, C., Ion, W. and Juster, N. Building A Design Engineering Digital Library: The Workflow Issues. Engineering and Product Design Education Conference. 7-8 September 2006, Salzburg University of Applied Sciences, Salzburg, Austria.
4. Twigg, C. (2003). Improving learning and reducing costs: New models for online learning. EDUCAUSE Review, 38(5), 28-38.
5. Bates, T. (2000). Managing technological change. San Francisco: Jossey-Bass Publishers.
6. Foster-Jones, J. and Beazleigh, H. (2002), Metadata in the changing learning environment: developing skills to achieve the blue skies, Association for Learning Technology Journal, Vol 10(1), pp52-59.