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HORUS e-Learning Management (HeLM)

FINAL REPORT

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1. Executive Summary

Aims and objectives
The HORUS e-Learning Management (HeLM) project aimed to research requirements and design a system for supporting workplace learning in healthcare disciplines. The objectives were to provide reusable specifications for software supporting:

- in-depth reflective learning (student portfolio)
- teacher development and teaching administration (teacher portfolio)
- learning opportunities management in the workplace
- the presentation of assessment data to students and teachers

Overall approach
The project focused on workplace learning and adopted a pedagogic approach based on experience-based learning and directed self-assessment. Qualitative research was undertaken to establish requirements in the areas of student and teacher portfolio systems, learning opportunities management, and presentation of assessment data. A formal systems analysis methodology was used to collect and analyse user requirements and to specify discrete functionality (services) that could be implemented independently. One service (Topcat teaching loads database) was implemented in the Schools of Medicine and Dentistry, to investigate the implications of using the formal design as a basis for development in different environments, using emergent technologies.

Findings

- Reflective discussions, supported by peer facilitators, provide benefits to workplace learners when compared with reflective essays.
- Requirements were established for a teacher portfolio system for staff development and teaching administration, and for a learning opportunities management system founded in experience-based self-directed assessment.
- A novel methodology for measuring the quality of workplace learning providers using student feedback was validated in hospitals.
- Presentations of aggregated assessment data for comparing the individual with the cohort, demonstrated benefits to students and staff.
- Recommendations are made regarding transferability of the HeLM approach and services to other organisational environments.

Achievements
HeLM provides a reusable platform-independent design, with supporting recommendations, for software services for workplace learning in healthcare disciplines. Specifications for e-portfolios, learning opportunities management and reflective discussions are in the submissions process for the JISC e-Framework on-line repository, with a view to making them available to the community.

Conclusions
The project makes significant contributions to the e-learning community through its transferable design for software recognising the very different learning circumstances of workplace learners, in which learning opportunities are somewhat opportunistic and spare time is short. The design is supported by recommendations on using emergent technologies and on implementation of the model in new environments.

2. Background

2.1 Workplace learning and HORUS

Undergraduate learning in health sciences includes substantial periods on placement in the workplace (hospitals etc). At postgraduate practitioner level, learning may be almost exclusively work-based, as in Medicine. Workplace learning brings particular challenges. Much of the learning is difficult to specify, being dependent on the availability of patients and circumstances being presented. It is therefore essential that students develop strategies for opportunities for self-directed learning to ensure curriculum coverage, and also that workplace teacher development supports this. Administrative processes should support a common learning experience distributed across multiple providers.

The HeLM project is founded on the HORUS family of learning management technologies, which focus on e-tools for learner-centred work-based lifelong learning. HORUS is based on a pedagogic model of "Experience-based learning"[1] whose generalisability increases the likelihood that HORUS will transfer to other fields of study. The HORUS suite has benefited from previous JISC-funded development. It includes services supporting undergraduate medical education (HORUS-UG), early postgraduate education (HORUS-FP), specialist medical postgraduate education (HORUS-ST), the in-service training of diabetes health care professionals (HORUS-Diabetes) and basic nurse education (ULYSSES).

Up to the start of the project, HORUS had focused primarily on supporting learners' attainment of the intended learning outcomes of objective-based curricula. It had not defined in any detail how HORUS could instil a capacity for reflective learning, which is essential for people to become lifelong learners. The potential for HORUS to link workplace learning to assessment, and to support teaching quality management had not been explored; nor had the potential of HORUS to help course administrators and managers manage the complexities of flexible workplace programmes delivered across multiple sites. Finally, HORUS was restricted to Medicine and Nursing, and how and whether it could be generalised to other healthcare disciplines was not clear.

2.2 Systems analysis and service-oriented architecture (SOA)

There was a need to link these different aspects of the project into a unified whole, integrated with existing HORUS services. To achieve this, HeLM chose to use an approach being used in stakeholder-driven professional software development. The formal system analysis approach is based on early capture of stakeholder requirements, and aims to ensure that the developed software fulfils its promise of meeting stakeholder needs.

Systems analysis also brings important additional benefits. The holistic approach of looking at the whole system during the design phase promotes efficient design, through being able to generalise similar concepts. The close examination of the true meaning of the underlying concepts aids generalisation of the software to other organisational and educational environments. Accordingly, the HeLM project adopted a systems analysis approach leading to formal specification of user requirements and a model of the captured requirements in Unified Modelling Language (UML)[2].

HeLM also opted to use a Service-Oriented Architecture (SOA) approach[3] to software design and development. In SOA, discrete reusable modules ('services') are specified,

which interact through interfaces. Such services can be potentially reused by others in the e-learning community in a 'plug and play' manner. At the same time, JISC was setting up the e-Framework repository of material conforming to the SOA specification, to which HeLM would contribute as part of its dissemination strategy.

Adoption of the systems analysis approach changed the emphasis of the project from software development to systems analysis and modelling, which was felt to give more value to the e-learning community in terms of generalising the results of the HeLM project. It was important that the impact of the HeLM approach on the full software development lifecycle be explored, in order to make recommendations to the community on both technical and human/organisational issues to support transferability of HeLM to new environments.

2.3 Project themes

To address all these issues, this report follows three major themes.

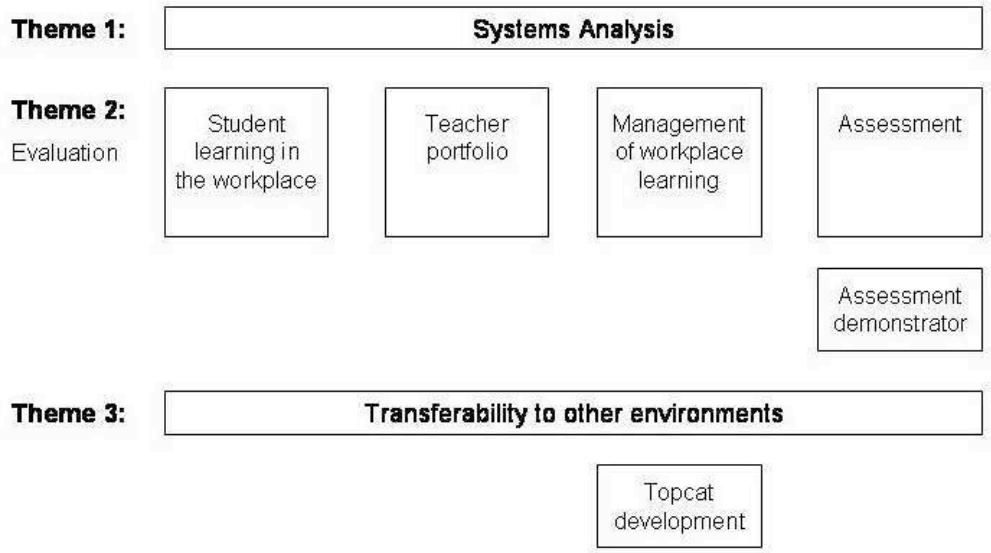


Figure 1: HeLM themes

Theme 1 – Systems analysis:

The HeLM project would gather user requirements and develop a validated model in UML of the Manchester medical education world ('HeLMworld'), including service specifications. HeLM would provide material for the e-Framework.

Theme 2 – Evaluation and research:

The HeLM project would undertake supporting evaluation and research in the areas of:

- student learning in the workplace
- teacher portfolio
- management of workplace learning
- assessment integration

in order to inform the user requirements for new or enhanced HORUS services and/or improvements to University processes.

Theme 3 – Recommendations to the community to support transferability of HeLM to new environments

HeLM would evaluate the technical and human/organisational aspects of the HeLM approach to the software development lifecycle, with a view to making recommendations to the e-learning community concerning transferability to new environments. HeLM would achieve this through development of sample services developed as part of the 'Topcat' teaching loads system, and examination of their transferability beyond Medicine.

2.4 Related projects in Manchester Medical School

The HeLM project operates alongside five others in the Technology Enhanced Workplace Learning area. Figure 2 shows the set of functional areas (pink) that are of interest and their set of underpinning technologies (green). In the centre sit 5 relevant and related projects (selected from the group's current project set) mapped to their functional areas and underpinning technologies. Technology here is used in the most general sense to include method, process and architecture as well as operational software.

It may be seen from this that HeLM supports four functional areas: self-directed learning, learner and teacher portfolio, learning opportunities management and supporting workplace learning. It has been part of the development of three underpinning technologies: educational process models, software service development process and learning and teaching systems architecture.

HeLM shares this space with five related projects: HeLMET[4], CRAMPON[5], InnovationBase[6], LTfLL[59] and ARC[7], of which the first three are funded by JISC. The diagram shows which functional areas each project supports and in which underpinning technologies each is involved. The InnovationBase will (when it becomes a JISC service) provide a means by which all six projects' outputs in this landscape context, along with any other relevant contributions from the sector, can be shared with the JISC e-Framework community and with the sector as a whole.

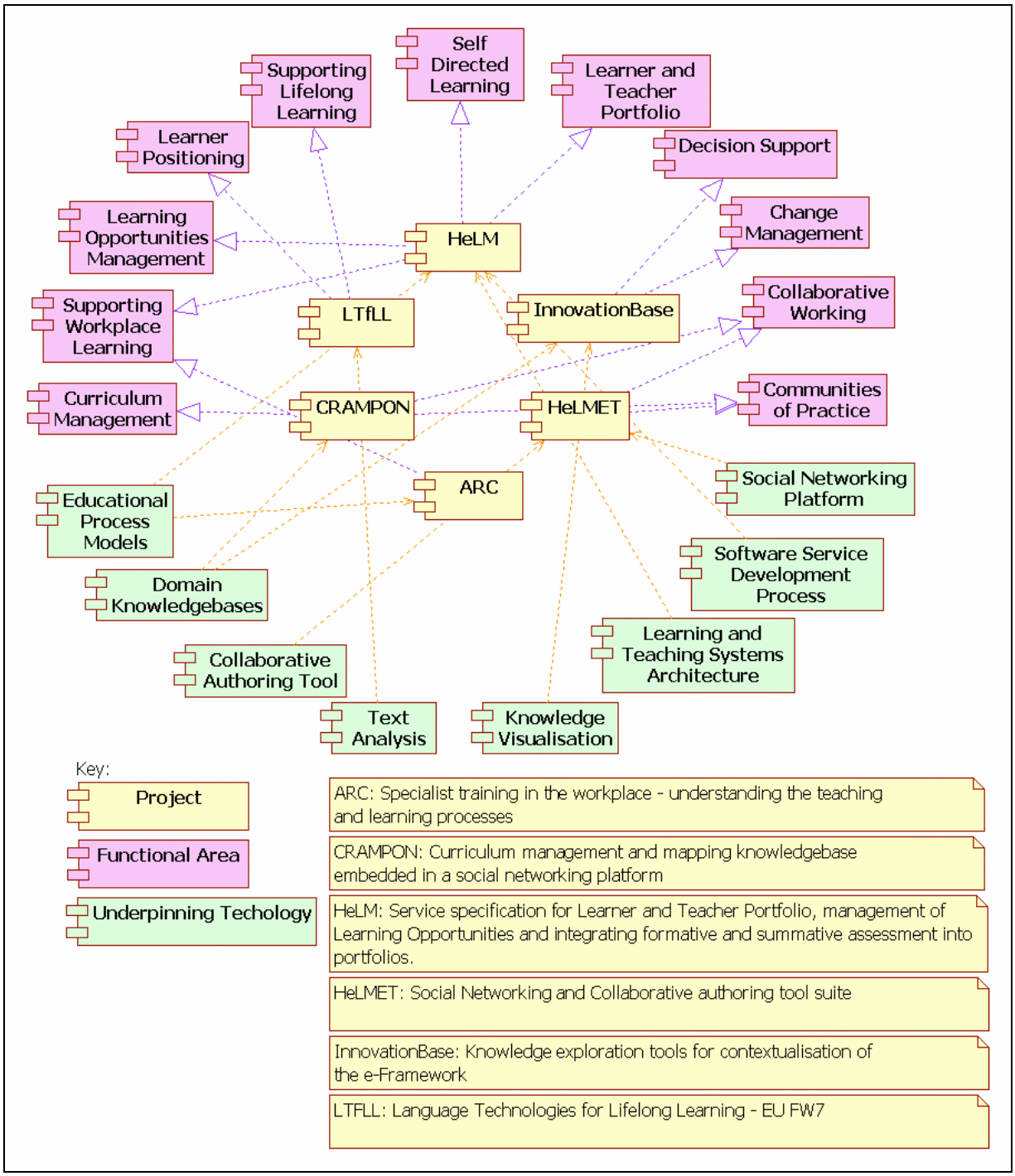


Figure 2: Related projects in Manchester Medical School

3. Aims and Objectives

3.1 Aims agreed at the start of the project

The HORUS e-Learning Management (HeLM) project aims to extend the earlier JISC-funded HORUS learning management services to a wider range of applications, institutions, and stages in the lifelong learning continuum and link them to other JISC-funded projects.

3.2 Objectives agreed at the start of the project

In summary, the original objectives were to extend HORUS services to:

- support in-depth reflective learning
- support teachers' learning from students' evaluations of their teaching
- establish pedagogic and technical means of linking e-learning to assessment
- support learning management in the workplace
- extend the implementation of HeLM services within and beyond Medicine

***Reflective learning*:** develop portfolio services within HORUS-UG to support the in-depth reflective learning of all two thousand undergraduates in the University of Manchester medical curriculum and map their learning to an exemplar metadata system, the General Medical Council (GMC) domains of learning[8].

***Teacher development*:** develop services within HORUS-UG to reuse students' evaluations of their learning to help their teachers provide a more learner-centred education.

***Assessment*:** prototype a link between HORUS and UMAP/UKCDR data so that students can learn reflectively from assessment activities and teachers are engaged into assessment activity.

***Learning management in workplaces*:** develop services within HORUS-UG to support administrators and managers in providing cross-institutional workplace learning according to learning need.

***Transfer*:** Develop a design specification for the transfer of HORUS services to workplace learning of two other health professions (Dentistry and Pharmacy) and identify the potential to meet HE/FE user requirements identified in the JISC-funded MANSLE project.

***Project management and capacity building*:** work within the stable, long-standing partnerships:

- between the University of Manchester and three large NHS organisations, which educate its students and employ them as graduates;
- between different health professions in the Faculty of Medical and Health Sciences;
- increase the partnership between the HORUS and MANSLE collaborations

to build collaborations that have learners and their learning experiences at the centre.

3.3 Changes during the project

The following changes of direction have taken place since the start of the project:

1. **Systems analysis model and e-Framework:** To join the different strands of the project and to integrate them with the existing MedLea-HORUS implementation, an over-arching new objective was agreed:

   HeLM will deliver a validated formal systems analysis model and service specification comprising new and existing functionality and will contribute services to the e-Framework.

2. **Software development lifecycle**: Adoption of the modelling approach changed the emphasis of the HeLM project from software development to software design. Nevertheless, it was important to determine the implications of the HeLM approach for transferability of the model into production in different environments. A development within the HeLM teacher portfolio (the Topcat teaching loads database) was selected to examine the HeLM approach from inception to wide scale roll-out. A further objective was specified:

   HeLM would evaluate the technical and human/organisational aspects of the HeLM approach to the software development lifecycle, with a view to making recommendations to the e-learning community concerning transferability to new environments.

3. **Links with other JISC projects:** For reasons discussed later, the proposed links with other JISC projects (MANSLE[9] and UMAP/UKCDR) were not realisable. This was reported to the JISC project manager, who agreed that these elements of the original aim and objectives be dropped. Work on presentation of summative assessment continued in two separate collaborations: between UMAP and its associated universities, and between HeLM and the School of Medicine Examinations Office. Work on reflective directed self-assessment took place within the HeLM consortium.

4. Methodology

4.1 Pedagogic basis

The pedagogic basis of the HeLM services is Dornan's experience-based learning model, which incorporates the concept of directed self-assessment [1,10]. This is a cycle in which students select experiences, evaluate and reflect upon them, and then determine the next steps to take to meet their learning objectives.

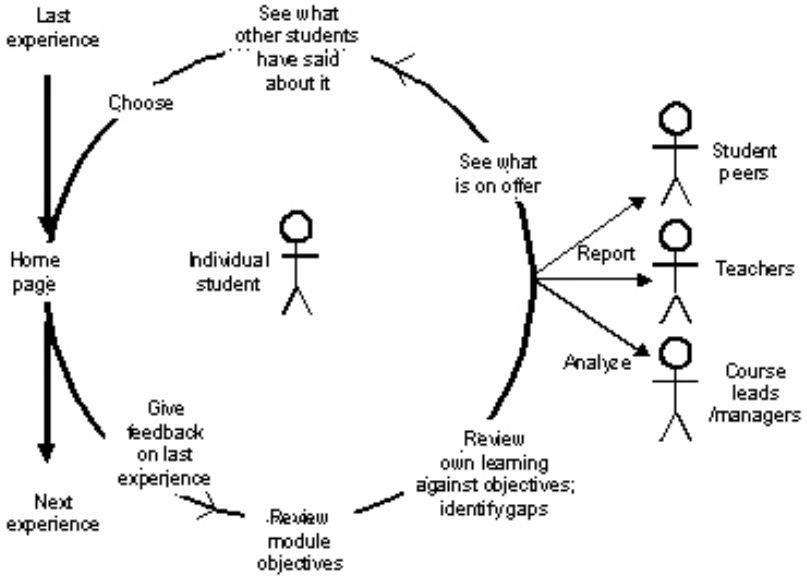


Figure 3: Experience-based self-directed learning

4.2 The HeLM Approach

The building blocks at the start of the project were:

- existing HORUS software, which had been incorporated into the undergraduate virtual learning environment, MedLea-HORUS
- new and emerging requirements for enhanced HORUS functionality.

The overall **HeLM approach** comprised:

1. user requirements gathering, encompassing proposed new functionality and existing HORUS functionality, and their capture in a UML model
2. development of an ontology to clarify understanding
3. identification of services
4. validation of the UML model and service specification
5. development of sample services (Topcat and assessment demonstrator)
6. roll-out and change management (Topcat)
7. stakeholder evaluation of new and existing MedLea-HORUS functionality
8. iterative refinement of the systems analysis model and service specification
9. preparation of contributions to the e-Framework
10. evaluation of the HeLM approach

4.2.1 User requirements gathering and capture

The HeLM project adopted a stakeholder-driven approach to systems analysis, beginning with the identification of domain experts. These were primarily teachers and managers at this stage, students being involved later in iterative refinement of the requirements. The domain experts' vision for a system and their knowledge of the workings of that system were captured in a set of requirements expressed as Unified Modelling Language (UML) Use Cases and domain information models. The domain experts were introduced to the ideas of formal system analysis and modelling through workshops based on what were termed "the 5 key questions" about the system under development. These questions defined the scope of the project as follows:

Q1	Where am I?	The boundaries of our area of concern ('HeLMworld')
Q2	Who is here?	The actors in our system and the roles they undertake
Q3	How do we all carry out our responsibilities?	The function, process and activities taking place within the system
Q4	What things are there?	The concrete things: artefacts, resources and deliverables
Q5	What supports our work?	What infrastructure needs to be in place?

4.2.2 Development of an ontology to clarify understanding

The domain experts differed in their location of work, and this led to local differences in terminology for the same concepts, and some terms having different meanings in different locations. There was a need to reach consensus between the domain experts on a working (evolving) vocabulary to describe the domain. While this could have been addressed using a glossary, a decision was made to develop an ontology of HeLMworld[34] using the standard ontology tool Protégé-OWL. This allowed the team to map HeLMworld as a set of business entities and associated relationships, for example:

Student (*entity*) IS REGISTERED ON (*relationship*) Programme (*entity*)

Programme (*entity*) CONTAINS (*relationship*) Course unit (*entity*)

As well as concepts and relationships, examples of concepts were entered into the ontology to probe whether the meaning and relationships have been fully expressed.

4.2.3 Identification of services

Following the capture of requirements in the UML model, requirements were then analysed using object oriented modelling into discrete high level services components each offering a range of services. The high level service components include:

1. Membership Services – provides services to support groups, users, roles, organisational structures
2. Portfolio Services– provides core portfolio services
3. Programme and Curriculum Services
4. Problem Based Learning Services
5. Collaboration Services – Included forums
6. Learning Opportunity Management Services
7. Teaching Management Services

8. Assessment Integration Services

4.2.4 Validation of the UML model and service specification

The two aspects of the model that were evaluated (the set of business entities and the mapping of Use cases to services) were chosen as the most likely to yield insight into the overall usefulness of the HeLM model. They also provide a starting point for a team wishing to develop a system (or parts of the system) to support the areas of work involved.

Validation of the set of HeLM entities:

The ontology was used as a checklist against the requirements document by making use of a qualitative analysis tool[11] to mark up the text of the requirements document against the ontology expressed as the set of nodes (nVivo themes). Any missing entities or redundancy in definitions could be identified in this way leading to an evaluation of the coverage of all the requirements by the identified set of core business entities (UML Classes).

Use Case traceability to Service Interfaces

By reviewing the UML model it was possible to map the Use Cases to the operations on service interfaces. These mappings were tabulated. Any missing specification or redundancy in specification could be identified in this way, leading to an evaluation of the coverage of all Use Cases by Service specifications.

4.2.5 Development of sample services (Topcat and assessment demonstrator)

Technical approach

Development within Topcat followed a Model-Driven Architecture (MDA) approach. This allowed changes in the UML model to be propagated to the database underpinning the software. This improved reliability by reducing the opportunities for differences to arise between the UML model and its physical expression within the database.

The following key tools, frameworks and components were used in the development process.

AndroMDA[12]: AndroMDA is an MDA tool that can generate code from UML models. It provides a UML profile that is used in defining a platform independent model. The parts of the HeLM model related to teaching load management were extracted from the base model and extended to include UML stereotypes known to the AndroMDA tool. The stereotypes enabled the identification of UML objects as Domain Entities, Enumerations, Services, and Value Objects.

Microsoft Visual Studio .NET 2005: AndroMDA was used to generate code in the C# language. The service implementations and user interface were then written using the Microsoft Visual Studio .NET development environment.

Microsoft SQL Server 2000: AndroMDA is also capable of generating data definition statements in SQL for any database. The Topcat project used the Microsoft SQL Server 2000 database to persist the data.

Microsoft Internet Information Services (IIS): Microsoft IIS was used to host the live application with the university's central server infrastructure.

On the other hand, the assessment demonstrator used a similar MDA tool named **Sculptor**[13]**,** which was in turn based on the **openArchitectureWare**[14] framework. Sculptor provides a Domain Specific Language (DSL) with has a textual syntax in which the UML model is expressed. The parts of the HeLM model related to assessment presentation was extracted and easily expressed in the DSL. A more detailed report of this implementation is shown in HeLM deliverable D5.5[15].

Like AndroMDA, Sculptor is able to take the textual representation of the UML model and generate JAVA code through a series of model transformations. This did not only ease the development burden but also improved maintainability given that changes in the model can be easily propagated to code without difficulty.

Topcat was developed from the start as an enterprise system, being sited in the University's server farm from early in the project, thus benefiting from enterprise sizing of networked resources and server management. Topcat was integrated with enterprise systems including the University's user authentication and student records systems, the Manchester Medical School virtual learning environment and the University data warehouse based on Oracle Discoverer. The URL https://topcat.manchester.ac.uk and the user support email address topcat@manchester.ac.uk were allocated early on.

User-centred iterative development

In the Topcat development, HeLM adopted a user-centred iterative development approach to the user interface design. This comprised fast development of a prototype system based on the initial requirements gathering. The prototype formed the basis for combined evaluation / change management activities, in which users were introduced to the system through a series of demonstrations with associated discussions. These, in association with weekly meetings with the Head of Manchester Medical School as decision maker, led to iterative refinement of the design.

4.2.6 Change management and roll-out (Topcat)

Change management began as soon as the project started, with potential users being consulted on the tariff table mapping teaching activities to a nominal number of hours. The system was demonstrated widely during development to committees and groups of staff. An important part of these demonstrations was the associated discussion, in which staff were invited to comment on the system.

Following user-testing, roll-out was effected for each group of staff by provision of a training session. User support was provided electronically, by telephone and by provision of a user guide.

4.2.7 Stakeholder evaluation of new and existing MedLea-HORUS functionality

Software corresponding to the HeLM areas of focus (student and teacher portfolios, learning management in the workplace, assessment) were evaluated using the JISC Six Steps to Evaluation[16] approach, though with some difficulties with staff engagement owing to the extensive nature of the stakeholder evaluations logically required from this method.

The main approaches to evaluation within this methodology comprised qualitative think-aloud activities, focus groups and interviews. The major criteria for evaluation were pedagogic/andragogic effectiveness and usability. Although originally planned, questionnaires were not used owing to concerns over the number of questionnaires students are expected to complete at a time when students are widely viewed as subject to excessive numbers of questionnaires. The qualitative approach yielded rich data in which the factors contributing to the views on criteria could be explored, and this to some extent made up for the wider coverage of questionnaires.

In one case, a demonstrator system was developed (the 'assessment demonstrator') to probe student and staff reactions to the presentation of assessment data.

4.2.8 Iterative refinement of the systems analysis model and service specification

Results from the stakeholder evaluations informed refinement of the systems analysis artefacts.

4.2.9 Preparation of contributions to the e-Framework

The HeLM project has submitted two service genres and six service usage models to the e-Framework. There was a significant reuse of service genres from the e-Framework.

4.2.10 Evaluation of the HeLM approach

The HeLM systems analysis approach was evaluated through stakeholder interviews probing:

- the domain expert view of the user requirements gathering
- the developer view of the UML and MDA approaches
- the Topcat senior manager's view of the software development lifecycle.

5. Implementation

5.1 Introduction

Work took place in three thematic areas:

Theme 1: Systems Analysis

Systems analysis activities took place as outlined in the Methodologies section, resulting in a User Requirements document[22], UML model[23] and ontology[34]. HeLM worked with feedback from CETIS to prepare Service Usage Models (SUMs)[27,28,29,30,31,32] and Service Genres[25,26] for the e-Framework. At the time of writing, these were in the e-Framework submissions process.

Theme 2: Research and evaluation

Theme 2 concerns the research and evaluation activities in which the value to stakeholders of the developed software corresponding to the UML model was assessed. The purpose of these activities was to inform iterative improvements to the HeLM user requirements and model. This theme comprises a number of sub-themes, described below.

Theme 3: Impact of the HeLM approach

This theme concerns the evaluation of the impact of the HeLM approach on the software development lifecycle, including organisational aspects and generalisation of service. Theme 3.1 describes transferability and Theme 3.2 evaluates the HeLM approach. This theme comprises a number of sub-themes, described below.

5.2 Theme 2 - Research and evaluation

5.2.1 Theme 2.1 - Student learning in the workplace

The student portfolio in MedLea-HORUS, developed outside the HeLM project, is based on the Experience Based Learning through Directed Self-Assessment cycle[1].

In accordance with the model, the student portfolio comprises the following functionality:

- Selection of optional clinical learning opportunities (“signups”)
- Providing feedback to the teacher following attendance at the signup
- Reviewing intended learning outcomes, reviewing learning against these objectives and identifying the gaps in learning (‘ILO browser’)
- Selecting further learning opportunities
- Optionally completing a full ‘long’ reflection based on an extended template (“what went well”, “what went not so well”, “action plan” etc; and tagging the reflection with the relevant section(s) of the Good Medical Practice guidelines[8].

Provided separately in WebCT, though accessed through MedLea-HORUS, are student reflective discussion forums, in which students are asked to discuss “what makes a good doctor?” and “safe prescribing”.

Student evaluations of this functionality took place as described in Table 1.

Functionality	Criteria	Number	Type of students	Method
Workplace learning (general) [38,39]	Student requirements	7 students	Years 3 & 4	Focus group
Directed self-assessment cycle[39]	Usability and utility	3 students 3x 8 students 3x 8 students	Year 3 Year 3 Year 3	Think-aloud Focus group Questionnaire
Reviewing objectives and identifying gaps in learning ('ILO browser')[37]	Usage	All students in year	Years 3 & 4	Automated system report
Reflective discussions[37]	Usage	All students in year	Years 3 & 4	Automated system report
	Student learning; Community of Enquiry model[17]	Discussion threads from 20 randomly selected groups	Year 3	Analysis of discussion threads
	Student experiences	287 students	Year 3	Questionnaire
		24 student interviews	Year 3	Semi-structured interviews
		4 focus groups	Year 3	Focus groups; nominal group techniques[18]

Table 1: Evaluations of student learning in the workplace

5.2.2 Theme 2.2 – Teacher Portfolio

The key elements of functionality specified in the HeLM teacher portfolio are:

1. Browsing information on timetable, PBL groups, intended learning outcomes and announcements (available in MedLea-HORUS)
2. Viewing student assessment data (see Theme 2.4)
3. Reviewing student feedback on teaching activities, for teachers to reflect on the quality of their teaching (student feedback available in MedLea-HORUS; teacher reflective portfolio not yet implemented)
4. Recording and viewing the profile of their teaching, in terms of numbers of hours expended on each type of teaching activity (Topcat development)

Evaluation took place as shown in Table 2.

Functionality	Criteria	Number	Type	Method
MedLea-HORUS facilities for teachers[19]	Utility	19	Hospital consultants	Semi-structured interviews
Topcat[20]	Usability and effectiveness	293	Academic staff inc. consultants	Informal evaluation and help desk queries

Table 2: Evaluation of teacher portfolio

5.2.3 Theme 2.3 – Management of workplace learning

This theme concerns evaluation of the developed elements of the HeLM model associated with:

- the administration of the signups process, including making signups available and attendance management (available in MedLea-HORUS)
- teaching quality management (paper pilots in one of the hospitals)

The teaching quality management specification within the model is based on aggregated quantitative feedback data from student end-of-module questionnaires. Learners use Likert items with 1-7 scales to rate the conditions, processes and outcomes of their workplace learning. They are invited to add free text comments reporting positive features of their experiences and ways in which their experiences could be improved upon. Detailed statistical analysis is used to reduce the total number of items (47) to a more limited set of key performance indicators (KPIs) representing their ratings in a way that allows comparison between placements (clinical 'firms') and hospitals.

HeLM has undertaken initial steps towards providing a demonstrator system presenting teaching quality management data in graphical form, though this work is incomplete.

Evaluation took place as shown in Table 3:

Functionality	Criteria	Number	Type	Method
Signups administration[38]	Utility	1	Tutor	Interviews
		2	Hospital-based undergraduate administrators	
		1	University academic manager	

Table 3: Evaluation of management of workplace learning

5.2.4 Theme 2.4 – Assessment

This theme concerns the presentation of student summative assessment data from the undergraduate progress test in Medicine to students and staff, to:

- obtain student and teacher opinions on various options for data presentation
- evaluate ease of navigation/use and integration with other areas of system
- evaluate impact on teachers and students

The project originally intended to take a data stream from the UMAP database, the user interface being provided by a HeLM demonstrator that could be evaluated. UMAP is a consortium of medical schools who share a question bank for the undergraduate progress test.

When early proof of concept of UMAP/HeLM integration was demonstrated to stakeholders, great concern was raised about taking data from a secondary source, i.e. UMAP. An analysis of the progress test process showed that the progress test is automatically marked by the School of Medicine Examinations Office, who return results data to UMAP. A decision was taken that any future large scale implementation in Manchester should take data direct from its primary source. HeLM later developed the relationship with the Examinations Office and provided a demonstrator based on Examinations Office data.

In recognition that other institutions might not share Manchester's concerns regarding data source, the UMAP management continued to evaluate alternative presentation formats with its partners in other medical schools as well as Manchester. The data presented in the 'Outputs and Results' section of this report comprises data from several medical schools.

Functionality	Criteria	Number	Type	Method
Presentation of summative assessment data	Functionality to be included, ease of navigation, impact	74 students from three medical schools in the UMAP consortium	Students	On-line survey
		7 tutors	Tutors	Workshop

Table 4: Evaluation of presentations of assessment

5.3 Theme 3

5.3.1 Theme 3.1 – Transferability

Topcat development

An urgent need arose in the Faculty of Medical and Human Sciences to develop an aspect of the teacher portfolio design falling under the 'learning management in workplaces' strand of the project. This concerned the recording and reporting on teaching loads for staff development and resource management purposes. This provided an opportunity to test the organisational aspects of the HeLM model and change management in Dentistry as well as Medicine. This development was run as a discrete project within HeLM, named Topcat, in order to probe how the HeLM approach would work in a 'green field' situation.

The development and change management methodologies are outlined in the Methodologies section of this report, sub-sections 5 and 6, and are available in full in HeLM deliverable AD10[20].

An important part of the generalisation of Topcat to Dentistry, following its implementation in Medicine, is to understand the organisational differences between the Schools. This was achieved initially by providing access to Topcat to a nominated user in Dentistry, who was asked to 'play with the system'. The user was interviewed to determine key differences

between the Schools. This information informed a later meeting with the Head of the School of Dentistry and the senior administrator in that School.

MANSLE

The project originally intended to investigate possibilities for generalising HeLM to the Further Education sector, through links to the MANSLE project, which had reportedly used HORUS. A meeting took place with the MANSLE project manager, which identified that the project could not deliver to HeLM any user requirements; there was also some uncertainty regarding the use of HORUS in MANSLE. As the MANSLE project was close to completion, HeLM was unable to take this further.

5.3.2 Theme 3.2 – Evaluation of the approach

The HeLM approach was evaluated as follows:

Functionality	Criteria	Number	Type	Method
The systems analysis approach (user requirements gathering, use of UML)[21]	Utility, stakeholder experiences	2 3 1	Systems analysts Domain experts Business analyst	Combined focus group
Using UML, SOA, MDA and rapid application software development[21]	Stakeholder experiences	1	Topcat developer	Questionnaire
Senior management perspective on the HeLM approach to Topcat development, change management and roll-out[21]	Stakeholder experiences	1	Topcat senior manager	Semi-structured interview

Table 5: Evaluation of the HeLM approach

6. Outputs and Results

6.1 Theme 1 – Systems Analysis

6.1.1 Outputs

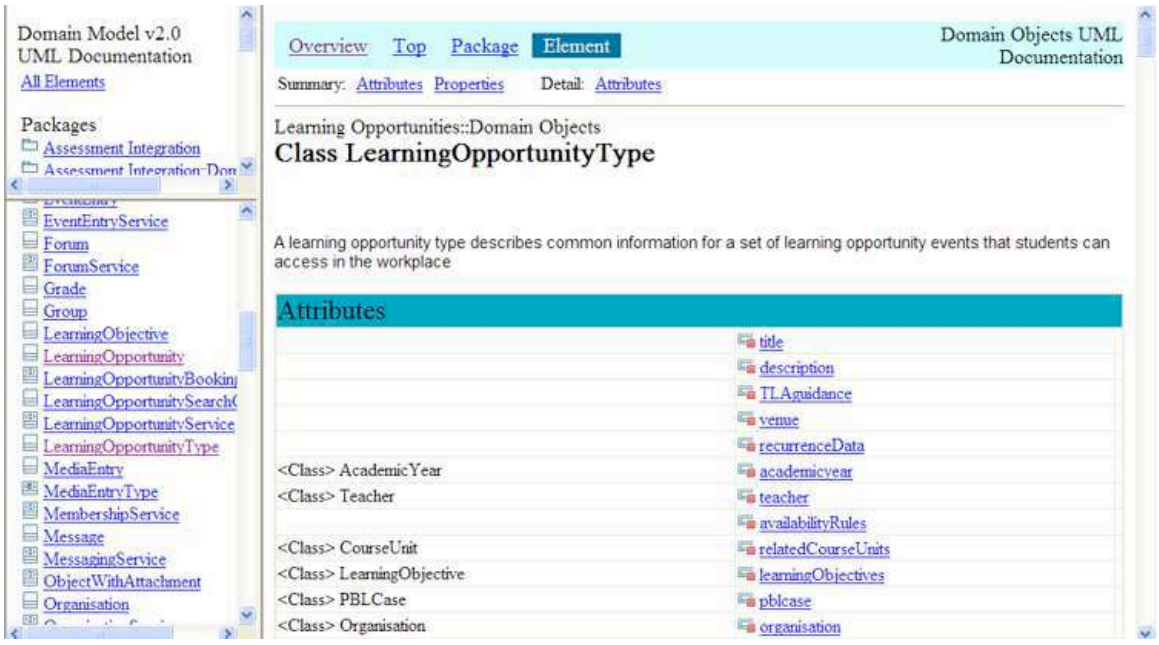
The outputs of the systems analysis work comprise:

- a set of user requirements[22] covering enhancements to MedLea-HORUS in the areas of student learning in the workplace, teacher portfolio, learning management and assessment;
- a UML model and service specification[23];
- data from validation of the HeLM model and service specification against the user requirements[24]
- an ontology of the organisation and management of medical education;
- the following submissions to the e-Framework:

1. Service Genres
    a. Manage ePortfolios[25]
    b. Manage learning opportunities[26]
2. Service Usage Models
    a. Learning Opportunity Management[27]
    b. Reflective Discussion Forum[28]
    c. Student ePortfolio[29]
    d. Reflective teacher ePortfolio system[30]
    e. Formative Assessment[31]
    f. Reflective learning journal[32]

A website located at http://www.medicine.manchester.ac.uk/helm/aboutus/deliverables/AD2 provides browsable access to the UML context and domain models and use cases.

Figure 4: Website showing domain model excerpt for learning opportunity type



6.1.2 Implications of the findings for portfolio design

Reflection on the modelling work revealed that:

- the HeLM model was applicable to undergraduate education in the Schools of Dentistry and Pharmacy[22]. Although there were a number of superficial differences, these could be handled with user-configurable parameters. The model was generalised to include a bank of user-configurable parameters.
- the student and teacher portfolios as simple repositories of work conform to an identical design, differing only in the titles of the different areas of the portfolio and in the additional facilities provided within the portfolio;
- student and teacher portfolio systems are linked by two-way exchange of feedback data and shared interest in assessment data and timetabling/attendance information[33].

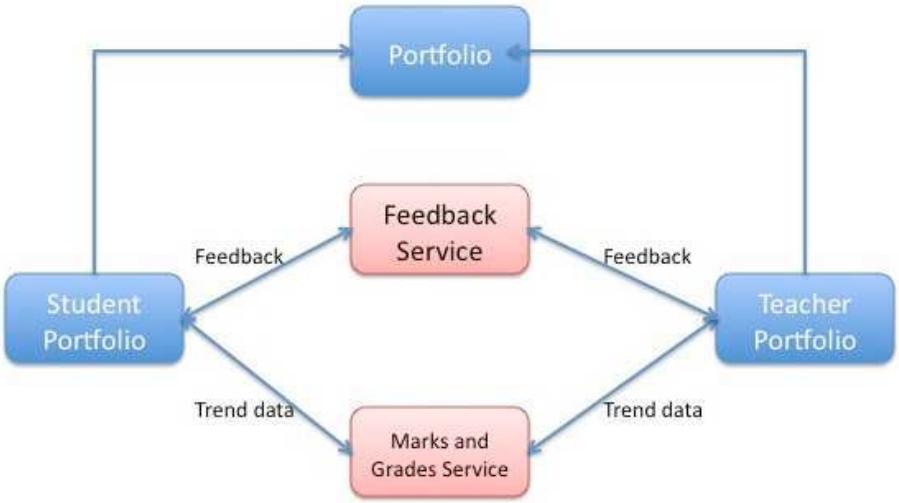


Figure 5: Model of interactions between student and teacher portfolios

6.1.3 Ontology

The HeLM ontology[34] describes concepts and interrelationships in the organisation and management of UK medical education. Although subject-related ontologies, including SNOMED CT[35] (clinical terms) and TIME-ITEM[36] (medical curriculum) exist, the HeLM ontology differs from these in its focus on the organisation and management of medical education, rather than the content. HeLM therefore supplements existing ontologies in the medical domain.

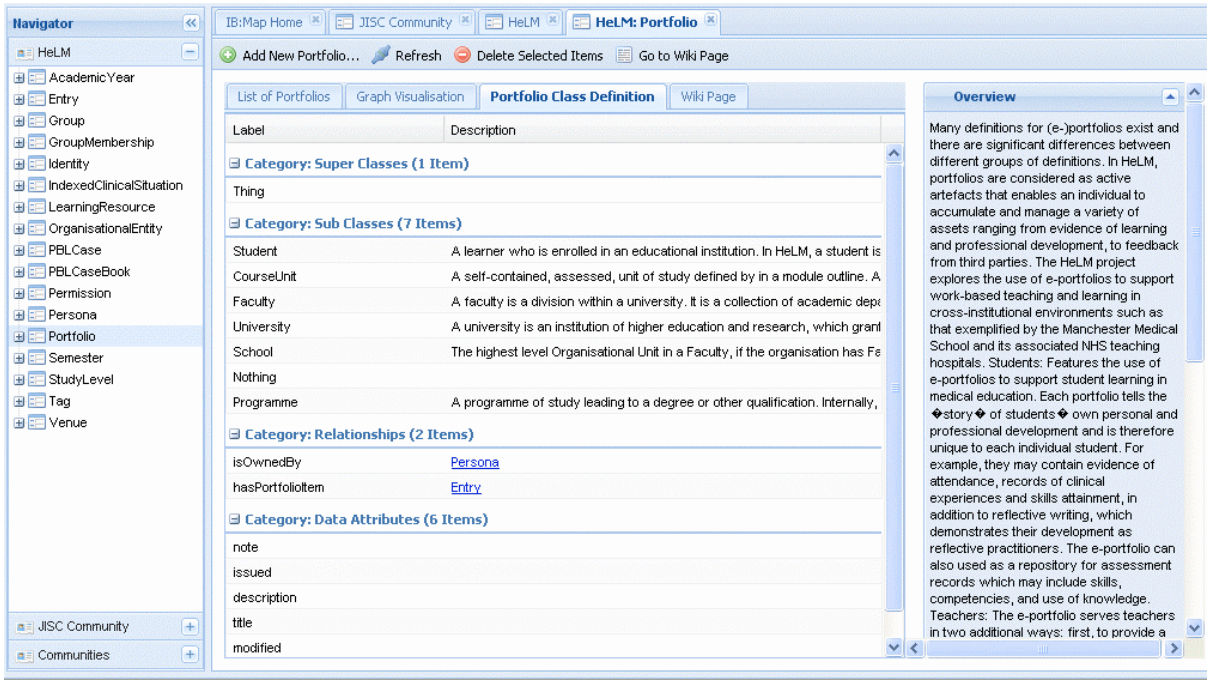


Figure 6: The HeLM Ontology viewed through the JISC Innovation Base

6.2 Theme 2.1: Student Learning in the Workplace

The HeLM approach to student learning in the workplace comprises functionality related to experience-based self-directed learning and reflective activities. Details of findings are presented in HeLM deliverable reports[37,38,39]. This section presents the most significant findings.

6.2.1 Experience-based learning in the workplace

A detailed study[38] was undertaken at Salford Hope Hospital of student experiences of the MedLea-HORUS functionality for the Directed Self-Assessment cycle. Using an action research methodology, the services were introduced to 24 learners in three cycles, and their experiences of using them were evaluated in depth. A large body of data has been collected and has not yet been fully analysed. However, the pilot provides proof of concept and detailed information about how the services can be improved in a more comprehensive implementation. The pilot noted the need for improved training to embed this approach in the student body. It also found that:

- it was acceptable to students to evaluate learning events in considerable detail. However, they identified some redundancy in the present evaluation fields that should be modified in a revised version of the technology.
- students rated highly the provision of a list of intended learning outcomes (ILOs) against which to map the outcomes of their informal workplace learning. They made useful suggestions for improvement to the existing categories.
- likewise, respondents gave positive feedback about the capacity to assess their skills performance but would have found the facility more useful if more guidance had been given about expected levels of performance.
- Respondents gave mixed evaluation of the requirement to evaluate workplace experiences, particularly if it duplicated their existing way of keeping records of experience; for some, this function would be valuable, for others of little value.

- although the system helps learners compare their own learning with that of their peers, the system was not sufficiently populated by peer evaluations. Also, students were not well enough trained for any useful evaluation data to be forthcoming; however, respondents were positive about the principle.

The review of the Salford Hope pilot revealed that initial training in *MedLea* in general, and the ILO browser in particular, was insufficient. Students therefore needed continuous supervision and mentoring in the use of these services during the pilot.

Other evaluations indicate:

1. high enthusiasm for the facility for booking optional clinical learning opportunities (signups); many students consider this a very valuable part of the system.

   "Signups are useful for indicating what is expected to be covered in a topic".

2. a clash of cultures between the 'reactive' reflective learning components of the pedagogic approach and the 'proactive' choice of learning outcomes based on directed self-assessment. That raised two related challenges; to shift the culture of the programme to give equal emphasis to both and to provide induction and training to the services that gives both elements due emphasis. Whilst the former could not be within the scope of HeLM, the changes that took place within the action learning approach were insufficient in scale to get the directed self-assessment approach well embedded in the learning behaviour of the student body. Therefore a major challenge in the project's implementation context compromised its success and illustrates that the best specified e-portfolio for reflective workplace learning will only be as successful as the context in which it is implemented permits. That insight, we believe, explains the following observations:

- a random review of individual student accounts in MedLea-HORUS revealed that many students did not avail themselves of the signup option during the 2007/08 academic year.
- very low usage of the ILO browser.

In addition, a technical issue beyond the influence of HeLM influenced success:
- substantial feedback on signups when the feedback was made available to other students, but very low amounts of feedback following a bug in which feedback was not made available to students

6.2.2 Usage of Web-based reflective discussions

Data was collected from a 24 hour period, selected at random during March 2007. The results were collected directly from WebCT and indicated that some students were participating in the discussions for all but 2 hours of the 24 hour period, indicating that one of the strengths of online learning is that students can use this facility when convenient to them.

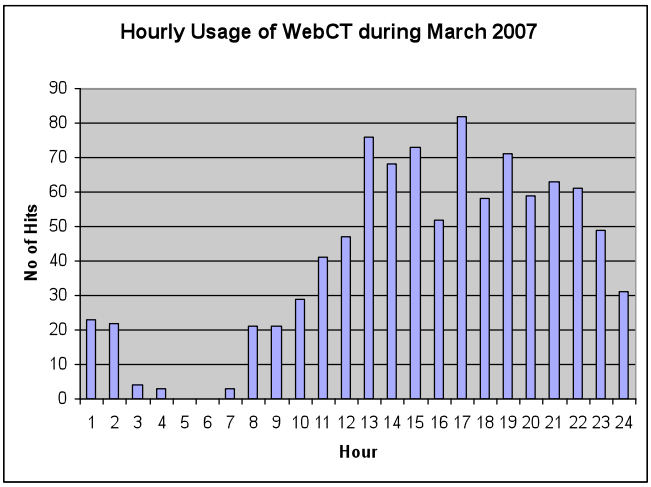


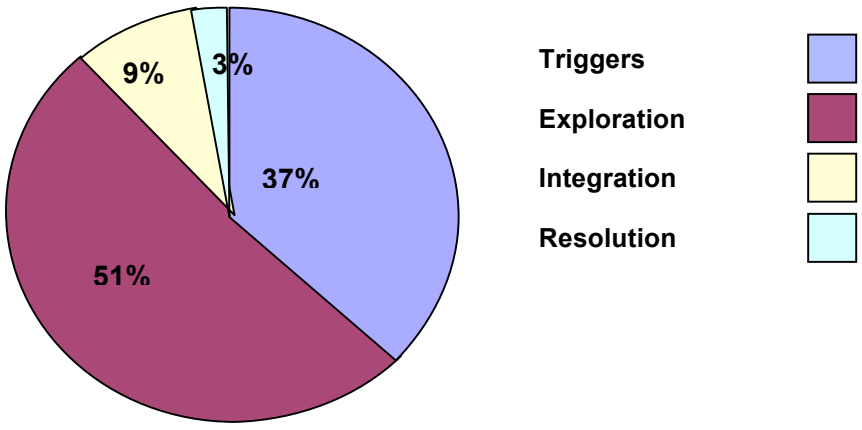
Figure 7: Hourly usage of Web based discussions in the Medlea HORUS portfolio

6.2.3 Analysis of online text discussions using the Community of Inquiry Model

Twenty (five from each of the four major hospital sites) of the sixty three discussion groups were selected at random. Text threads were analysed by the Community of Inquiry model for messages containing semantic indicators of increasing levels of cognitive presence as follows

Triggers	Lowest level – basic questioning
Exploration	Second level – further enquiry and clarification
Integration	Third level – integrating observations, learning with own experiences
Resolution	Highest Level - putting together ideas from discussions leading to further analysis

Figure 8: Analysis of Cognitive Presence

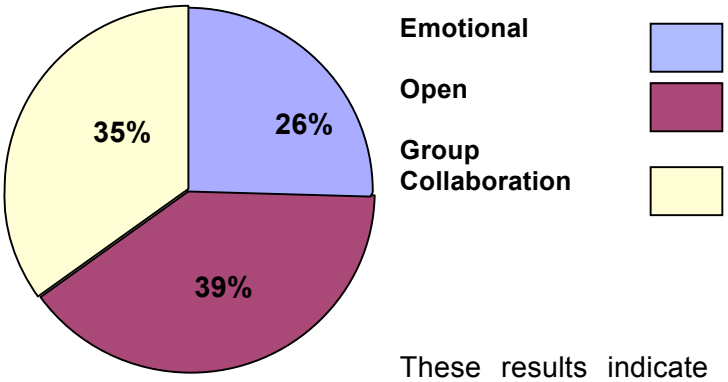


These data indicate that although most messages were at the lowest levels cognitive presence, 12% of messages were at the highest two levels with clear evidence of critical thinking.

These text messages were also analysed for semantic indicators of social presence as follows:

Emotional	Lowest level – able to express emotions in group discussions
Open	Higher level – open to ideas and vies of others
Group collaboration	Highest level – integrating overall views but also able to accept differences

Figure 9: Analysis of Social presence



These results indicate that the three levels of social presence were evenly spread throughout the text messages and that over a third had reached the highest level of social presence.

It is noteworthy that the highest levels of cognitive and social presence display a degree of overlap, which is important for the development of the online discussion group as a community of reflective learners. Furthermore, the higher levels became evident as discussions progressed over time.

6.2.4 Students' views on online reflective discussions – in their own words

Extensive data has been collected from questionnaires, structured interviews and focus groups, which is still in the process of analysis. We have included an example of a student's views shown below:

I think is good and anything that encourages people to write more I think is good, and I think that you can use it anytime, anywhere is definitely a benefit, and especially if you've got a busy timetable, it's much easier to fit in fifteen minutes of an evening to write a reply to someone than it is to try and meet up with someone and so, yeah, I think it should continue

This indicates the way in which the asynchronous on-line discussions have overcome timetabling obstacles and enabled the student to devote some time to reflective writing, while in a busy workplace learning environment.

6.2.5 Students' views on extended reflections

Qualitative data suggests that very few students are using the extended reflection element of the MedLea-HORUS portfolio regularly. In a focus group of seven students[38, 39], only one student said that he had used the MedLea-HORUS portfolio extended reflection. While he found it useful, he said it was too time-consuming. In a separate study with three students,

two students said they had only once made a reflection voluntarily, when an event of emotive value had arisen concerning their future career paths. This is at odds with system usage data[37], which suggests large numbers of visits to the portfolio reflective page, but does not record whether any data was entered.

6.3 Theme 2.2 – Teacher Portfolio

6.3.1 Student feedback to staff for appraisal purposes

MedLea-HORUS does not deliver on-line student feedback to staff. However, an earlier system at one of the hospitals provided feedback on signup sessions, and staff could include a copy of their aggregated feedback in their personal portfolios and discuss this at their personal development reviews.

In summer 2007, a survey[19] of 19 consultants at the hospital was undertaken, based around the open question "how can the MedLea-HORUS system help you, now or in the future?". Consultants were not prompted regarding topic, but all 19 expressed a desire for student feedback to be available to them. As well as commenting on its value for self-improvement, staff also said it was highly motivational, for example:

> *"(The feedback system is) an excellent mechanism, with students being perhaps more forthcoming than they would be face to face. Student feedback is an excellent morale-booster for staff".*

In addition to feedback on signups (already in MedLea), consultants would like to receive on-line feedback from students at the end of placements, end of PBL Groups, end of self-selected components (projects), and sometimes on individual ward rounds. An interest was also expressed in being able to analyse feedback by type of procedure, e.g. endoscopy.

Consultants differed regarding who should see feedback items. One felt that feedback should be private to the individual concerned, whereas others were keen to see feedback at individual and hospital firm (specialist group to which students are attached) level, including comparisons between firms.

A means of delivering targeted feedback to junior doctors is needed, as these doctors are on short term appointments and generally do not have logins to MedLea-HORUS.

6.3.2 Other teacher portfolio facilities

The same study indicated that the following are important components of the teacher portfolio:

The ability to manage learning opportunities (signups)

Consultants would like to know which students are intending to attend sessions, so that students can be contacted if the session has to be cancelled. The following facilities were requested:

- the ability to see on screen who will be attending, and/or an email informing consultants (or their secretaries) of attending students;
- the ability to change the timing of an event or delete it;
- the ability to perform a group emailing to all students registered as attending, in case a session needs to be cancelled or changed.

Consultants would like to see a description of what students can expect to learn during a learning experience, so they can propose cases of particular relevance to the students attending. It would also help in keeping descriptions up to date. It would also be useful to be able to review the text periodically and edit it.

A number of consultants commented on the need to restrict bookings to particular "groups", where a group might be:

- students in a particular year
- students in their firm
- students in particular PBL group(s)
- junior hospital doctors

A number of consultants expressed concern about students booking signups and not attending, effectively denying the opportunity to other students. Historically, there was a problem with keen students booking so many signups that none remained for other students. This could be addressed by limiting signups to particular student groups. Also, a proposal was made that students could not book further signups until they had provided feedback from the previous one.

Consultants also talked about phasing release of signups to the different groups in a priority order, and about releasing all remaining signups to all remaining students a short time (e.g. 24 hours) before the event.

There may be different types of signups with different priority orders. For example, 'major A&E signups' are only available to students on the A&E firm. 'Minor A&E signups' can be offered to students in the year group as a whole.

As well as students evaluating signups, it was proposed that staff should be able to rate students' performance at signups or when undertaking SSCs on the wards.

Teaching loads recording and reporting

Consultants would like MedLea/HeLM to log teaching loads to provide evidence of teaching for their own portfolios and appraisals. They would like data in tables and graphs at individual, firm and department levels. The information would also allow firm leads to review teaching commitments across the firm. (This was later implemented as the Topcat project).

Integration of personal timetables

MedLea/HORUS only includes a member of staff's teaching timetable, their hospital duties being on a separate timetable. Firms and departments may have their own timetable(s). Consultants would like integration of their various personal timetables, possibly within Outlook.

It would be useful for the consultant's secretary to be able to enter timetable details. They are employed by the hospital rather than the University, and would not normally have access to MedLea/HORUS.

It would be useful to be able to view individual student timetables in order to track down students.

On-line student performance monitoring forms

Hospital staff receive a number of paper forms to comment on student performance, which are currently printed and circulated by administrators, for completion and return by consultants. These include:

- End of firm attendance / monitoring sheets
- PBL group assessment / feedback forms
- SSC evaluations

Many consultants would like to complete the forms on-line, and commented on the value of the student's photo appearing on the form. However, one said that he would prefer to print his forms as a batch because he discusses these forms with the students concerned, and both parties have to sign the forms, so would prefer to use paper-based forms; also, there is no PC where he works for viewing his comments on screen.

6.3.3 Topcat implementation

The Topcat teaching loads database software was evaluated informally by verbal feedback in meetings and by observation of help desk calls. The user guide[40] was very highly regarded, which contributed to the fact that there were very few calls regarding how to use the software. Users found the screens intuitive and of professional appearance.

> *[Interviewer] What went well? (with the Topcat implementation)*
>
> *{Senior manager] The technical solution is very good – there have been lots of positive comments. There have been very few responses around the front end. People have liked the usability.*

2007-2008: School of Medicine

Undergrad, Teaching : Category

Activity	Unit	Hours
PBL tutor Phase 1	Semester	36
PBL tutor Phase 2	Group per Week	4
Y5 Group Tutor	Y5 Block	32
Portfolio Tutor	Semester	20
Clinical Teaching	Session	2
Seminar/Lecture	Session	4
Radiology/Pathology Tutorial	Session	2
Community Tutor	Session	4
Communication Skills Tutor	Session	4
PO Supervisor	Student	40

Figure 10: Extract from Topcat tariff table for the School of Medicine

Almost all the help desk calls concerned the underlying tariff table, which mapped the teaching activity on to a nominal number of hours (see figure 10). The nominal hours comprised preparation time, contact hours and follow-up.

The diversity of teaching activities over the multiple university and hospital sites and specialties has led to a highly iterative approach to refining the tariff table in close

consultation with teaching staff. Achieving a fair number of hours for each activity has been by far the greatest issue for the Topcat implementation.

6.4 Theme 2.3 – Learning management in the workplace

6.4.1 Administration of the signups process

Interviews[38] with students, a hospital-based tutor, two hospital undergraduate administration managers and a University-based academic manager indicated that while the signups functionality in MedLea-HORUS was working well technically, there remain many human aspects affecting the success of the service.

This has led to the following recommendations:

- Maintenance of an adequate bank of learning opportunities is resource-intensive and it is easy for published information on signups to become out of date. The operation of signups needs to be a dynamic process; that is, once a bank of signups has been devised, the organisation needs continuously to adapt and refine them according to stakeholder feedback;
- In some clinical environments (e.g. in the cancer specialties), there are insufficient signups to meet student demand. The solution has been to provide heavily managed signups in the local specialist cancer hospital. This has necessitated signups being made compulsory, with the further caveat that students must undertake their signups within a defined time period.
- Managers should be aware that the necessity within hospital sectors for signup tutors and students to operate on two separate networks (the NHS network for clinical work and the University network for education) makes routine access to and use of University-based administration systems problematic.

The evaluation also demonstrated a cross-institutional issue: that for successful roll-out of systems across multiple hospitals, Manchester Medical School was reliant on the sector-based undergraduate hospital dean/tutor and undergraduate administrator to sell initiatives to hospital staff who will be delivering the teaching.

6.4.2 Teaching quality management

Interviews[19] with hospital consultants indicated the desirability of using student quantitative evaluation data in order to compare the student experience of different organisational units. Consultants asked for graphs and pie charts for presenting comparisons of the performance of their firms against other firms, and also against the Trust as a whole and against other sectors.

Data from the end of module questionnaires was split into categories, e.g. communication. When such data for all students on clinical firms is collated, the relative skills in eg communication of each firm can be compared and any weaknesses addressed. This is important groundwork for enabling key performance indicators (KPIs) of teaching quality to be set and measured.

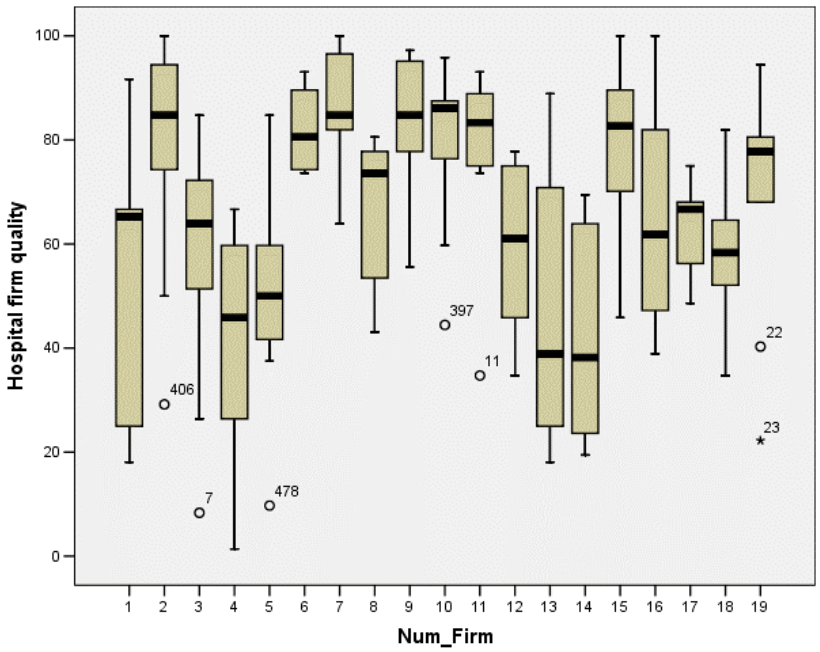


Figure 11: Comparison of different hospital clinical 'firms' (specialisms) based on student end-of-module data

A further in-depth evaluation[41] provides evidence that conditions, processes, and outcomes of learning are measurable and able to detect differences. There are greater differences between individual firms (provider units) within individual hospitals than there are between hospitals. Those differences between firms show there is scope for quality improvement and suggest the measures produced by this exercise represent valid KPIs.

6.5 Theme 2.4 – Assessment

A number of surveys[42] took place to probe the presentation of student summative assessment data from the undergraduate progress test in Medicine to students and staff.

Data from students at three medical schools was accrued (see figures 12 and 13). Students most often selected 'my grade and score', and 'grade and score boundaries', followed by 'my module performance' as the type of information they would 'need to see'. Students selected 'tables showing summary information about the exam' and 'graphs showing how you performed compared to year group' as the features they would most 'need to see'. Overall, the proposal of a traffic light feature to show how well or badly a student is performing was the most controversial, with a large proportion of students rating this as something they 'would be interested to see' and a smaller, but significant proportion of students rating this as something they 'do not wish to see'.

Interestingly, when students were asked for their opinion on allowing access to this same type of information to tutors the response was 'great'.

Data from the tutor workshop revealed that tutors would like to see a range of non-sensitive data per examination such as means, inter-quartile ranges and standard deviations. There would also be a need to 'drill down' into different sub-sections of performance per curriculum themes and learning objectives. Participants were in agreement that there should be different amounts of information made available to different members of staff. For instance

tutors with responsibility for pastoral care should see individual student results in order to provide support. Other members of staff with senior management responsibilities might wish to see more detailed aggregate information for use internally but also for educational research purposes.

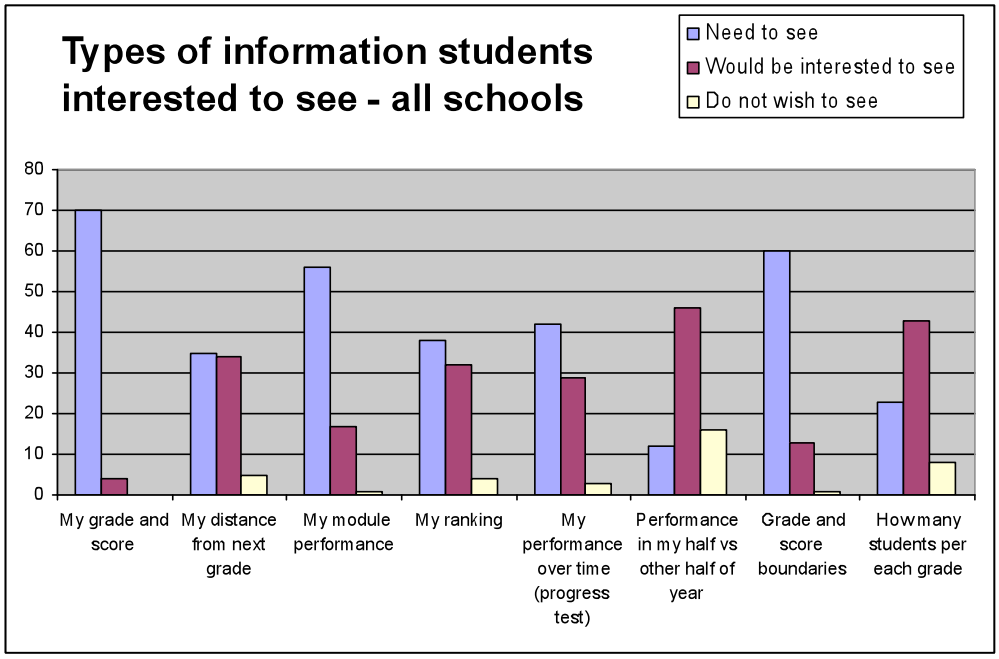


Figure 12: Types of information students wish to see

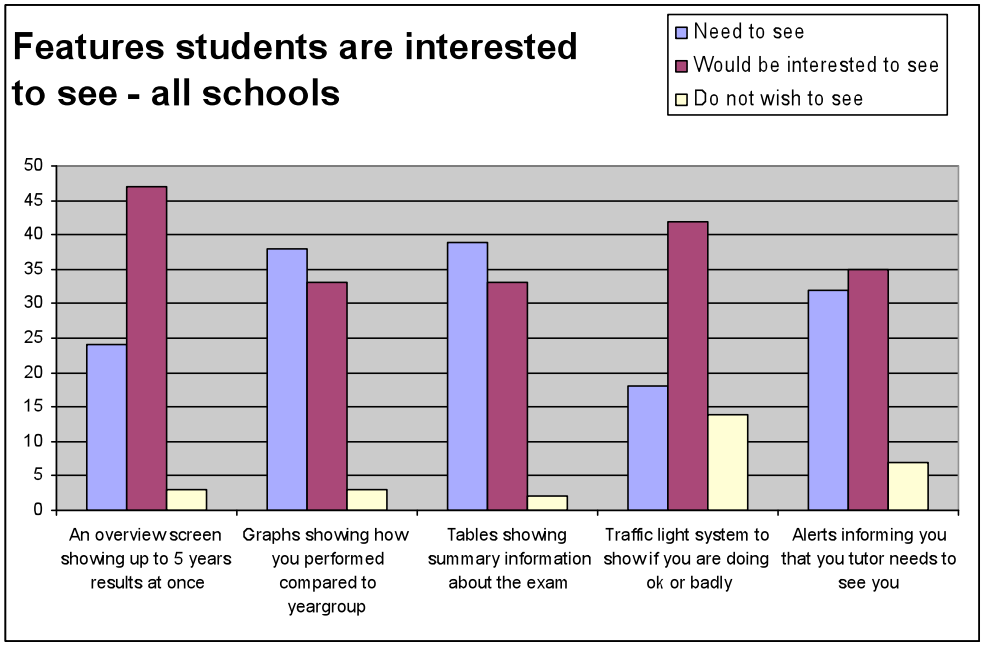


Figure 13: Features students are interested to see

Demonstrator screens

The work led to the following screens being specified for the demonstrator (figures 14 and 15).

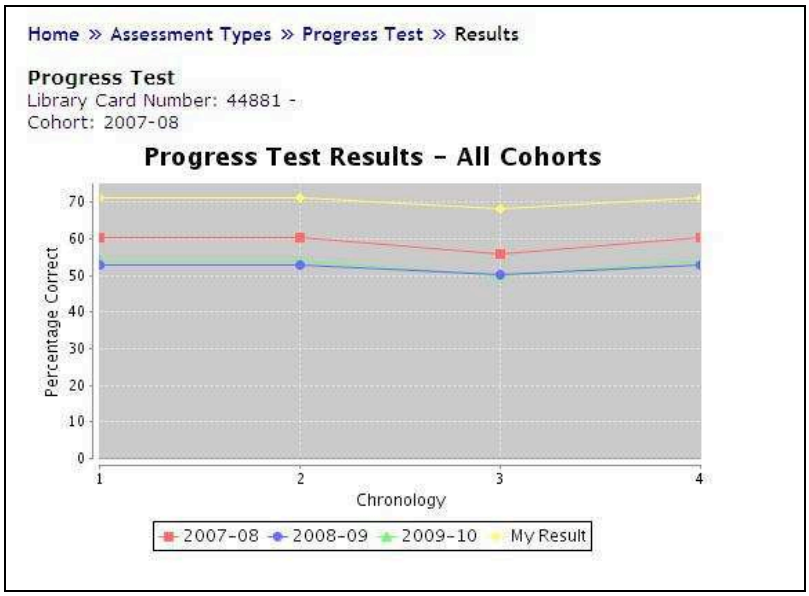


Figure 14: Screen showing student's result for the first four progress tests, compared with previous cohorts

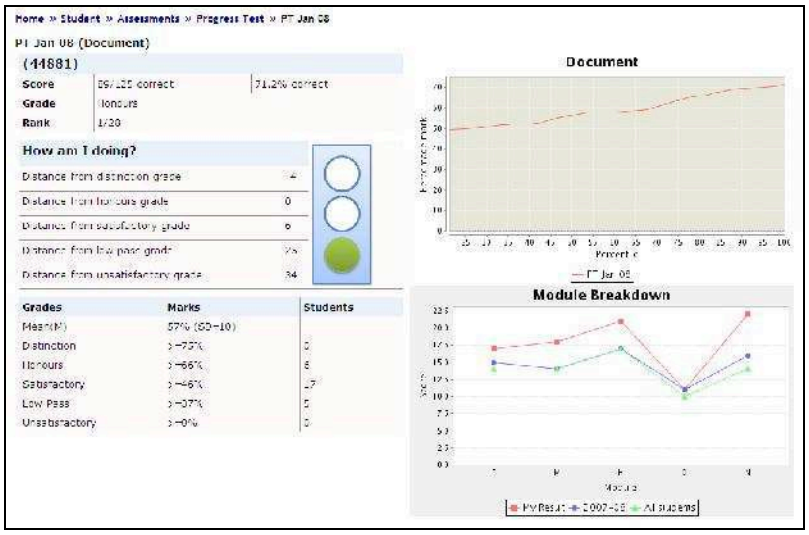


Figure 15: Screen showing 'traffic lights', marks breakdown and graph of position in cohort

Impact

Students were asked 'what level of impact would access to this information bring?' They were asked to rate the impact as either 'no impact', 'low impact', 'medium impact' or 'high impact'. There was also a 'no opinion' option. 50% rated as medium impact, 50% as high impact.

Tutors were asked 'In terms of your role, what impact on teaching, learning and assessment, would access to this information bring?'. Responses revealed that one third of tutors felt

access would have a medium impact, but that two thirds felt access would bring a high impact.

As a further investigation of perceived impact students and tutors were each asked if they would like to see the package in use in their own medical schools. Over 80% of tutors responded 'yes' as did 100% of students.

6.6 Theme 3.1 – Topcat development: generalisation of service

In preparation for the roll-out of Topcat to Dentistry, following its implementation in Medicine, the Head of School and senior School administrator were interviewed to determine the necessary changes to the system. Key changes were as follows:

- Dentistry has a much flatter organisational structure than Medicine, so the number of levels of reporting is less;
- Whereas Medicine attributed teaching loads to individual course units, Dentistry recorded them against individual programmes;
- While teach loads in Medicine were attributed to individual semesters, Dentistry teaching loads were attributed to the academic year;
- Dentistry required extra groupings of teaching loads, to include research teaching, which was not included in Medicine;
- Dentistry required all staff undertaking teaching to be reported, whereas Medicine applied a filter for certain categories of staff;
- The Frequently Asked Questions and User Guide were tailored to Dentistry;
- Data changes included agreement of a tariff table for Dentistry, and loading of Dentistry programmes and staff into the system.

These differences demonstrate the importance of undertaking user requirements gathering exercises before implementing existing software in a new environment, even where the differences are expected to be minor.

6.7 Theme 3.2 – Evaluation of the approach

6.7.1 The systems analysis approach, user requirements gathering, use of UML

To evaluate the systems analysis approach, two activities took place[43]. The senior manager responsible for Topcat development was interviewed. A focus group took place with the business/systems analysts and domain experts who had taken part in user requirements gathering and analysis activities.

Senior manager responsible for Topcat development

The Topcat Senior User was impressed by the professionalism of the systems analysis approach.

> *Working closely with the systems analyst in the design of the software was very valuable…. Systems analysis is a key first area of activity*

Domain experts

Domain experts responded very positively to the systems analysis approach, and felt that they understood more about the organisation, management and processes of the medical education world as a result of the user requirements gathering exercise.

[Question: what went well?]
- *Application of systems analysis to HeLM world – it established clear definitions and interactions.*
- *Awareness of the language used to describe activities and the key players involved in them.*
- *Awareness of who is involved in HeLM world and the beneficiaries from it and they must be included in future HeLM development.*
- *The interdisciplinary working; people's readiness to learn about one another's domains and disciplines. The varied expertise / knowledge / skills of group members.*

[Question: who might benefit from our work in the future?]
- *Anyone else setting up a similar system.*
- *Anyone dealing with complex interactions and responsibilities.*

The domain experts had reservations about the time the process took, and the difficulty in maintaining momentum in areas where development was not taking place.

[Question: what went not so well?]

- *It took up some time to get used to the approach but was very important in the end as a learning process.*
- *Length of time for project understanding to be shared amongst members.*
- *Group dispersed over months after starting very enthusiastically.*

[Recommendations]
- *Try to apply systems analysis to an actual situation.*

Business/systems analysts

The business and systems analysts expressed appreciation of the holistic approach and access to a wide range of staff:

[Question: What went well?]

- *Looking at the HeLM world holistically to see synergies between different parts.*
- *The HeLM community comprising so many senior managers who could facilitate access to others.*
- *The breadth of people we were able to see – UMAP, consultants, key administrators.*

They also commented on the success of the interdisciplinary approach:

[Question: What went well?]

- *Showing domain experts that they can be part of a technical design team – closing the business-IT divide.*
- *User requirements elicitation – domain experts were very cooperative and willing to engage in the process.*

Business/systems analysts also commented on the loss of momentum later in the project, and associated this with the limited development capacity.

[Question: What went not so well?]

- *The project lost energy when we realised we didn't have development capability (in MedLea).*

[Question: If we started again, what would we do differently?]

- *Assure ourselves that the development resource is available (before starting the project).*

Analysts also expressed difficulties achieving appropriate visual feedback to domain experts and developers. Piloting a user interface specification is perceived as desirable for future projects, either as a prototype system/demonstrator or as a paper pilot.

[Question: What went not so well?]

- *Didn't do enough reflecting back to domain experts.*
- *Engaging domain experts with the ontology did not go too well due to lack of user-friendly tools for visualising and navigating ontologies.*
- *No time for full object (instances) population for a walkthrough (of the ontology).*
- *Not doing a user interface specification – made it difficult for developers.*

[Question: If we started again, what would we do differently?]

- *Build into the project plan reflecting back to domain experts.*
- *We would aim to produce a prototype system that could have helped to leave behind a more tangible artefact than an abstract model with lots of documentation. It would also have enhanced the feedback received during the iterative development of the model.*
- *Include a user interface specification.*

The team became aware that early user requirements gathering was predominantly from academic managers, and that involving administrators and students at this stage would be valuable.

[Question: If we started again, what would we do differently?]

- *Include the administrator viewpoint re functionality.*
- *Include students etc.*

6.7.2 Using UML, SOA, MDA and rapid application software development

The HeLM software developer did not have a background in any of the above technologies and approaches. At the conclusion of the project, he completed a questionnaire[21], from which the following comments are reported:

Use cases were overly simplistic and did not have much impact beyond an initial feeling of what the system might be. Detailed descriptions of requirements would have been a better starting point.

Perhaps using activity or sequence diagrams might have made it easier? I think the UI side of the specification was heavily neglected. Major revisions were required none of which made use of UML.

When it comes to interacting with the database (as opposed to setting up) the version of NHibernate we used was a long way short in terms of functionality when compared with writing basic SQL. I spent a lot of time figuring out how to do basic NHibernate tasks which would have been very quick to do with SQL. Eventually I began to use NHibernate to only do very simple tasks and relied on C# code to do things I normally would have done at the database level.

(SOA) *I would not try and specify services at the start of the project, I would develop them as and when required.*

> *The use of UML and MDA via AndroMDA was an excellent learning experience for me. However for a project of this size and even larger I believe there are a wide range of tools which allow you to automate repetitive tasks and reduce errors with much smaller learning curves.*
>
> *However the use of SOA (AndroMDA style) gave clear structure to the application and will reap benefits in maintainability.*
>
> (Rapid application development) *Reasonable success, first few iterations should have been at the screen-shot level, would have saved a lot of time.*

The developer's comments show that, even with careful change management, adoption of UML, SOA and MDA is not intuitive to experienced developers. Even though the longer term efficiencies in maintainability could be seen, these new approaches led to development taking longer than by traditional routes. The developer was regularly asked to set goals for completion of tasks, but both the initial development and the user feedback-driven iterative approach to development took much longer than expected. This suggests that technical managers need to manage developers' expectations of the additional time taken, when implementing these technical approaches for the first time.

6.7.3 Change management and roll-out

The project provides a set of recommendations[20] for the human/organisational aspects of generalising Topcat to new environments.

A key element in the success of the Topcat project was the half-hour weekly meeting between members of the HeLM project team and the senior manager responsible for the business delivery of the project[20,21]. This facilitated the rapid application development as well as opening doors for demonstrations to many of the senior committees in the Faculty. It also enabled rapid responses to emerging problems.

The project team gave around 20 demonstrations with associated discussions of Topcat to committees, groups of users and at awaydays. These were time-consuming but gave a positive impression of professionalism. They also allowed change management issues to emerge and where necessary, be addressed at an early stage. Where possible, a senior manager was asked to chair the sessions. This worked well where, as was usually the case, the manager was committed to the success of the system, but less well if this was not so. The importance of identifying chairs who will be supportive cannot be overestimated.

The project adopted a flexible approach to reporting, through integration of Topcat with the University's data warehouse and the resulting availability of the Oracle Discoverer reporting tool. The data warehouse approach potentially allows non-technical users to design their own reports. This was in response to uncertainties regarding precise specifications of the reports required. It became clear that managers would want a range of reports, many of which could not be specified in advance of the event giving rise to particular needs.

6.7.4 User support

User support has been a concern for much of the project, owing to the requirements to (1) demonstrate that the system was in widescale roll-out and (2) to produce a costed business plan, in order to begin dialogue with the University for its long term support. Work on the business plan is under way.

To minimise support calls, the team adopted a four-part strategy, comprising frequently asked questions, a user guide, a public blog and a dedicated email address. These are described more fully in the user guide[40].

Nearly all the support calls in the early weeks after roll-out concerning the allocation of hours in the tariff table. This was a matter for management to resolve. Such calls were referred to the senior manager responsible for change management. He commented that, although this was time-consuming, it was a vital part of managing change:

> *[Interviewer] You have spent a lot of time responding to emails from staff….*
>
> *[Senior manager] I see this as an important part of managing change. People can be unhappy about different things, and the important thing is not to allow them to coalesce around why they don't want X to happen.*

Users responded enthusiastically to the blog at first, but this dropped away when the help desk did not respond through the blog to user queries. If using this approach, it is important that bloggers should receive feedback from the support team.

7. Dissemination

7.1 Introduction

HeLM's plan for external dissemination provided for:

- input to conferences
- input to JISC events, eg workshops, programme meetings
- (post project) supplying articles to academic journals
- exit and sustainability (internal and external)

A reference list of HeLM dissemination activities is provided in Appendix 2.

It should be noted that the long term impact of the HeLM dissemination activities is difficult to gauge. It is likely that many will be influential in terms of adoption of the approach and elements of the e-Framework, rather than adoption of specific artefacts.

7.2 Input to conferences

The HeLM team gave presentations to the medical education, e-portfolio and systems analysis communities at the following events:

Conference	Main subject of conference	Presentations by HeLM team
AMEE 2007 AMEE 2008	Medical education	• Systems analysis approach[44] • Integration of student and teacher portfolios[45] • HeLM ontology[46] • Reflective learning supported by student facilitators[47]
ASME 2008	Medical education	• Teaching quality management[41]
Manchester Medical Education Conference	Medical education	• On-line access for teachers to aggregated exam results[48]
HEA subject centre (MEDEV) conference	ePortfolios, Identity and Personalised Learning	• Teacher portfolio value[33] • Analysis of on-line reflective learning[49]
ePortfolio 2007	ePortfolios	• On-line reflective learning[50]
Inter/National Coalition for Electronic Portfolio Research	ePortfolios	• Comparison of paper-based and electronic portfolios[51]
WMSCI 2008	Systemics, cybernetics and informatics	• Using an ontology for requirements validation[52]
TENCompetence workshop	Lifelong competence development	• SOA applications development process[53, 54]

Table 6: input to conferences

Materials derived from HeLM were included in a presentation to Peninsula Medical School and, on a separate occasion, in a presentation sponsored by the Combined Universities of Cornwall. It has been demonstrated internationally in presentations at the Universities of Maastricht and Halifax, Nova Scotia.

7.3 Input to JISC events

HeLM members gave a short presentation at a JISC programme meeting on bridging the gap in a cross-institutional project[55] and took part in a JISC 'café' explaining HeLM work on lifelong learning[56].

HeLM is planning to disseminate its results and those of related projects at a JISC CETIS Portfolio Special Interest Group (SIG) in January 2009.

7.4 Academic journals

A HeLM paper was published in *Medical Education*, a major medical education journal, on student-facilitated on-line reflective learning[57]. A paper on the systems analysis approach was published in the *International Journal of Learning Technology*[58]. The HEA subject centre for medicine, dentistry and veterinary medicine (MEDEV) published a peer-reviewed Special Report on e-portfolios, which included two HeLM papers[33,49] on student-facilitated on-line reflective learning, and the design of an integrated student/teacher portfolio system.

Further publications on the application of the systems analysis approach to workplace learning are anticipated beyond the end of the project.

7.5 Dissemination related to exit and sustainability (internal)

The user requirements gathering[22] in HeLM and the Topcat development[20] provided an opportunity to disseminate the systems analysis approach to senior management in the School of Medicine, in other Schools, and at Faculty level. Feedback concerning the value of the approach in achieving understanding of the business requirements was very positive[21], and is expected to be influential in adopting the formal systems analysis approach in the future, not only for bespoke developments but also for evaluating off the shelf solutions.

The HeLM user requirements gathering and evaluation processes were valuable in stimulating debate about improvements to data-related processes. The stakeholder evaluations of HeLM support for self-directed learning provided a focus for discussion concerning how the related business processes can be improved[38]. The work on presentation of aggregated assessment data to students and staff led managers to consider the purposes and optimal presentations for particular purposes[42]. The lessons learnt in HeLM will be influential in process improvements beyond the lifetime of HeLM.

7.6 Dissemination related to exit and sustainability (external)

As noted above, a HeLM workshop at a CETIS SIG has been planned and will cover:

- The holistic view of student and teacher portfolios
- The process of systems analysis in integrating the diverse features of workplace learning
- Student portfolio and language analysis – peer facilitation by students and positioning the learner
- The HeLMET follow-on project, supporting collaborative authoring and communities of interest

The HeLM signup system is being implemented at the Christie specialist cancer hospital, and across a number of small organisations locally, eg pharmacies, opticians, and for autopsies at Manchester Royal Infirmary.

The UMAP consortium of medical schools is interested in adopting visual presentations of student assessment data from the progress test. This work will be taken forward by the UMAP members of the HeLM consortium.

HeLM was demonstrated at the University of Maastricht (Netherlands), which is a world leaders in medical education. To date, our collaboration with them has resulted in the Horus-FP technology (product of a previous JISC-funded project) being adopted nationally in the Netherlands as an e-portfolio for postgraduate work-based learning. An agreement exists in principle to disseminate HeLM to the Netherlands, pending successful acquisition of funding.

8. Outcomes

8.1 Project achievements

8.1.1 Aims and Objectives

The project has achieved its aims and objectives in extending the earlier JISC-funded HORUS learning management services, in the areas of reflective learning, teachers' learning from students' evaluations of their teaching, and supporting learning management in the workplace. It has achieved this through a major contribution to the e-learning sector: a validated systems analysis design for discrete services that can be independently implemented in a plug-and-play way and which form part of the e-Framework.

MedLea-HORUS services have been fully implemented in four teaching hospital trusts to students in the undergraduate clinical years, and SOA-compliant HeLM services (Topcat) have been fully implemented in the five divisions of the School of Medicine and in the School of Dentistry, with further roll-out to the Schools of Pharmacy and Pharmaceutical Sciences, and Psychological Sciences, in Autumn 2008.

However, the linkage to other JISC-funded projects did not materialise. Although dialogue was opened with the MANSLE[9] project, primarily because MANSLE did not provide any user requirements or system design that HeLM could build upon.

In the case of UMAP/UKCDR, the technical feasibility of deriving assessment data from this Consortium was demonstrated; however, the University took the view that such data should be derived directly from its own Examinations Office. UMAP personnel remained members of the HeLM team after this decision, and worked on presentations of their data to students and staff at Consortium medical schools. Meanwhile, the Examinations Office has maintained a keen interest in HeLM's work on presentation of assessment data.

8.2 Project Outcomes

HeLM systems analysis model and contribution to the e-Framework – this is of great value to the e-learning community as a validated, generalised model that is platform-independent and can be used as a basis for future development in other institutions.

HeLM ontology: HeLM has produced an ontology of the organisation and management of UK-based medical education. Although subject-related ontologies, such as SNOMED-CT[35] (clinical terms) and TIME-ITEM[36] (medical curriculum) exist, no other ontology of the organisation and management of medical education is known. This may be of interest not only to those interested in the systems analysis of medical education, but also to workers in the natural language processing community.

HeLM design: HeLM proposes integration of the student and teacher portfolio systems, to provide mutual feedback and to share data, to the benefit of both partners. This concept may be influential in the design of future learning systems.

HeLM approach – recommendations: The project has evaluated the methodologies used within a complete software lifecycle for a project with high institutional buy-in and widescale roll-out. It makes recommendations to the community regarding the human/organisational

factors that will contribute to the success of the similar endeavours that use a systems analysis approach and/or user-centred design and roll-out. It also identifies that more work needs to be done to achieve buy-in from developers without experience of UML, SOA, MDA and rapid application development.

Designs for presentation of examinations data to students and teachers – a set of designs for presenting tabular and graphical summative assessment data to students and teachers has been validated for their utility. These may be adopted as part of UMAP's services to its clients. The designs are of value to other institutions wishing to present such data to its staff and students.

Reflective discussions: Although much analysis remains, early indications are that reflective discussions may be a better way of encouraging work-based learners to reflect on their experiences than the traditional long reflection based on a template. The opportunity to reflect a little or a lot, any time any place, in a social learning environment, is a key finding. Our work has shown that peer facilitation of on-line reflective discussions works well, and has the advantages of reducing staff time and personal development for the facilitators.

Evaluation of the experience-based self-directed learning cycle: The project has undertaken in-depth analyses of stakeholder experiences with the self-directed learning cycle. Recommendations have been made to the sector concerning training, buy-in and organisational issues.

Teaching quality management: The study has identified a methodology for measuring the quality of workplace learning in a way that could be incorporated into a placement quality management system. This approach is generalisable to placements in other subject areas, and provides an important tool for institutions to manage the quality of their placement providers.

Topcat development: the Topcat development is in full-scale roll-out in the Schools of Medicine and Dentistry at Manchester, and roll-out to remaining Schools in the Faculty of Medical and Health Sciences has been agreed.

Institutional perceptions of the HeLM project: HeLM has achieved a very high profile with senior management, committees and staff in the Faculty of Medical and Health Sciences through its work on Topcat, presentation of assessment data and the reflective discussions.

Publications: The HeLM team has had 11 peer-reviewed papers accepted for presentation and four journal papers published (see Appendix 2). It has disseminated its findings within an 'International Coalition for e-Portfolio development', which is an esteem indicator for HeLM, both in its entirety and specifically for the student portfolio. The work on both the e-portfolio and online discussions led the HeLM group to be selected to join this group, which provided an opportunity to disseminate our practice and findings both nationally and internationally.

9. Conclusions

The HeLM project makes significant contributions to the e-learning community through:

- recognising the very different learning circumstances of workplace learners, in which learning opportunities are somewhat opportunistic and spare time is short. It offers a pedagogic approach grounded in experience-based self-directed learning, supported by reflective learning in 'bite-size chunks' through social discussion forums and by two-way feedback between students and staff;
- specifying the requirements for a 'teacher portfolio' system integrated with the student system and supporting staff development and teaching administration;
- providing a validated model and ontology of the medical education world, supporting this pedagogic approach, with supporting recommendations on using emergent technologies and on implementation of the model in new environments;
- its innovative, generalisable approach to management of teaching quality in placement provider organisations.

10. Implications

HeLM systems analysis and associated recommendations for use: HeLM provides a pedagogically-validated platform-independent design that the community can use as a basis for future development of workplace learning systems. It also makes recommendations concerning organisational and human factors that will lead to a successful implementation. However, institutions planning to use the HeLM systems analysis artefacts should note that future developments must be preceded by an alignment of their own user requirements with HeLM's, and the specification of a user interface to meet their own requirements.

Implementation of the complete HeLM design as SOA-compliant services: HeLM was only able to complete one area as a SOA-compliant service, and this led to refinements to the model. For the model to become embedded in the community, it should be validated not only against initial user requirements, but also against emergent user requirements during the course of development in different environments. It would be valuable to track usage of the model and encourage such users to contribute further refinements.

HeLM ontology: Ontologies underpin natural language processing (NLP) techniques, and projects such as the EU Framework 7 'Language Technologies for Lifelong Learning' project[59] make extensive use of ontologies. Completeness of coverage of the medical education world will be important for future NLP developments in intelligent tutoring and support. The HeLM ontology is small and UK-based, and its future may lie in amalgamation into one of the major medical ontologies, and/or an international collaboration to refine it.

Topcat / teaching quality management: the Faculty of Medical and Health Sciences is planning full-scale roll-out of Topcat across the Faculty. They are also planning to build on HeLM's work on use of student feedback for teaching quality management, to build an integrated Topcat teaching loads/teaching quality management system (this is the subject of a recent bid for funding). This will evidence both quantity and quality of teaching for staff personal development reviews, and will also provide management information not previously available. The Topcat design has the potential to be readily extended to include full economic costing of programmes, course units and other units of activity.

Designs for presentation of assessment data to staff and students: both UMAP and Manchester Medical School plan to use these designs as a basis for further development, to enhance the quality of feedback to students and to assist in identifying students who may be at risk. These designs are offered to the community as a basis for further development.

The integrated student/teacher portfolio system: HeLM proposes integration of the student and teacher portfolio systems, to provide mutual feedback and to share data. This concept may be influential in the design of future learning systems, in which students and staff are more equal partners.

11. Recommendations

Using the systems analysis approach with domain experts

To maintain momentum throughout the detailed systems analysis process, it is important that domain experts are assured that resource is available for development and that development should be scheduled as early as possible in the process.

It is important that means are found of reflecting the results of systems analysis back to domain experts, e.g. through storyboarding of the user interface or the use of demonstrator systems.

Using UML, SOA and MDA and rapid application development

This study shows the perceived overhead of using technologies which, while providing a better approach for long term maintenance of the software, take longer to implement during initial development. Careful change management activities need to take place with developers not familiar with working with these technologies, in particular concerning developer expectations of the extended development time.

Future developments are recommended to incorporate paper pilots/demonstrators of the user interface into their rapid application development, to avoid the cost of multiple iterations of the developed user interface.

Implementation of the HeLM design in new environments

The organisational management of roll-out in a new environment follows good management practice for a consultative approach. It is essential to establish the fit of HeLM services to the business at a very early stage, by undertaking a user requirements analysis and aligning the requirements with those described for HeLM.

HeLM benefited greatly from the weekly 30 minute meetings with, and the enthusiasm of, the Topcat senior manager. The willingness of the manager to resolve change management issues with individual staff over a protracted period contributed greatly to a very significant change in staff behaviour, as well as energising the project. Such a relationship should be actively sought, and the expectations for such long term relationships should be clearly enunciated at the beginning of the project.

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[56] Armitt G (2008), "HeLM project – lifelong learning", presented at a JISC programme meeting, Aston, UK, October 2008.

[57] Braidman I, Regan M & Cowie, B (2008), "Online reflective learning supported by student facilitators", Medical Education Volume 42, Issue 5, 528-529.

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Appendix 1: HeLM Deliverables

The HeLM deliverables are available on-line at www.medicine.manchester.ac.uk/helm

	HeLM Workpackage Reports
D2.2	Evaluation of students' experiences of using the MedLea-HORUS prototype e-portfolio
D2.5	Evaluation report analysing ways in which the e-portfolio has been more or less successful in supporting cross-institutional learning and reporting the influence of the technology on learning
D3.4	Evaluation of the impact of the e-portfolio on teachers' development as educators
D4.2	Pilots demonstrating how HeLM can support cross-institutional delivery of workplace clinical learning: evaluation report analysing challenges encountered and success of the project
D5.4	Evaluation of students' and teachers' reactions to presentations of assessment data
D5.5	Combined evaluation report covering: (i) successes and difficulties encountered in interfacing HORUS with UKCDR/UMAP; (ii) evaluation report highlighting implications and challenges of transferring the technology
D5.5A	Assessment demonstrator software (ZIP file)
D5.5B	Installation of the assessment demonstrator software
	Systems Analysis Reports
AD1	Software Requirements Specification and Analysis for HORUS e-Learning Management System (HeLM) Version 2.0
AD2	'HeLM Model 2.0' providing the Context Model, Domain Model and Use Case Model www.medicine.manchester.ac.uk/helm/aboutus/deliverables/AD2
AD2A	Introduction to website deliverable AD2: 'HeLM Model 2.0' providing the Context Model, Domain Model and Use Case Model
AD3	HeLM UML Model and Ontology Evaluation
AD3A	HeLM ontology (.OWL file)
AD4	e-Framework Service Genre: Manage e-Portfolios
AD5	e-Framework Service Genre: Manage Learning Opportunities
AD6	e-Framework Service Usage Model: Learning Opportunities Management
AD7	e-Framework Service Usage Model: Reflective Discussion Forum
AD8	e-Framework Service Usage Model: Student e-Portfolio
AD9	Development Process Using Model-Driven Architecture
AD14	e-Framework Service Usage Model: Reflective Teacher e-Portfolio System
AD15	e-Framework Service Usage Model: Formative Assessment
AD16	e-Framework Service Usage Model: Reflective Learning Journal
	Topcat Teaching Loads Database
AD10	Topcat Teaching Loads Database: Transferability to Different Organisational Environments
AD11	Topcat User Guide
AD12	Topcat software
AD12A	Introduction to the Topcat software
	HeLM Approach
AD13	Evaluations of the HeLM approach

Appendix 2: Publications and Presentations

1. Peer-Reviewed Publications and Presentations

Armitt G, Dexter H, Ukor R and Dornan T (2008) “Can integrating student and teacher portfolio systems provide mutual benefits?”, presented at AMEE, Prague, Czech Republic September 2008.

Armitt G, Ukor R and Dornan T (2008) " Developing teacher portfolio value in a medical school environment", The Higher Education Academy Medicine, Dentistry and Veterinary Medicine, Special Report 10: Conference proceedings: ePortfolios, identity and personalised learning in healthcare education, Newcastle upon Tyne, UK, February 2008, pp 71-77, ISBN 978-1-905788-68-2.

Braidman, I. and Regan, M. (2008), “Online reflective learning supported by student facilitators”, poster presented at AMEE, Prague, Czech Republic, September, 2008.

Braidman I, Regan M & Cowie, B (2008), “Online reflective learning supported by student facilitators”, Medical Education Volume 42, Issue 5, 528-529.

Braidman I, Regan R, Wallis S, Boggis C and Dornan T (2007), “Online Approaches to Reflective Learning – initial studies”, presented at EPortfolio 2007, Maastricht, Netherlands.

Braidman I, Boggis C, Dornan T, Regan R and Wallis S (2008), “Analysis of on-line reflective learning in undergraduate medical students”, The Higher Education Academy Medicine, Dentistry and Veterinary Medicine, Special Report 10: Conference proceedings: ePortfolios, identity and personalised learning in healthcare education, Newcastle upon Tyne, UK, February 2008, pp 16-21, ISBN 978-1-905788-68-2.

Campbell I, Braidman I, Dexter H, Petch J and Dornan T (2007), “A systems analysis approach to workplace portfolio learning”, presented at AMEE, Trondheim, Norway, September 2007.

Dexter, H, Petch, J and Powley, D (2008) “Establishing a development process for composite applications in the work-based learning and competency management domain”, International Journal of Learning Technology, Vol. 3, No.4, 348 – 367.

Dexter H, Petch J and Powley D (2007), “Establishing an SOA composite applications development process for work-based learning and competency progression management”, presented at TENCompetence workshop, Manchester UK, January 2007.

Dornan T, Boggis C, Graham J, Scherpbier AJJA, Boshuizen HP, Muijtjens A (2008), “Learner centred programme evaluation”, presented at the Association for the Study of Medical Education, Leicester, UK, September 2008.

Ukor R and Armitt G (2008) “An ontology of the organisation and management of medical education”, presented at AMEE, Prague, Czech Republic, September 2008.

Ukor R, Armitt G and Dexter H (2008) “A cross-disciplinary approach to early requirements validation in supporting medical education”, Conference proceedings: World Multi-Conference on Systemics, Cybernetics and Informatics, Orlando, USA, July 2008, Volume VI, pp.183-188, ISBN 978-1-934272-36-7.

2. Other presentations

Armitt G (2008), “HeLM project – lifelong learning”, presented at a JISC programme meeting, Aston, UK, October 2008.

Armitt G and Campbell I (2007), “HeLM – bridging the gap in a cross-institutional project”, presented at a JISC programme meeting, Aston, UK, October 2007.

Armitt G, Ukor R, Owen A and Baines D (2008), “Developing online access for teachers to aggregated exam results data”, Manchester Medical Education Conference, March 2008.

Braidman I and Regan M (2007), “How does the transition from a paper based to an electronic portfolio impact on the personal and professional development of undergraduate medical students?”, Inter/National Coalition for Electronic Portfolio Research (Cohort IV), London October 2007.