

# Building a Virtual University for Orthopaedics

Grainne Conole<sup>1</sup>, Gary Wills<sup>2</sup>, Leslie Carr<sup>2</sup>, Lucile Vadcard<sup>3</sup>, Wendy Hall<sup>2</sup>, Simon Grange<sup>4</sup>

1. Research and Graduate School of Education, University of Southampton, United Kingdom
2. Electronics and Computer Science, University of Southampton, United Kingdom
3. Université Joseph Fourier, Grenoble, France .
4. Royal College of Surgeons of England, London, United Kingdom

## Abstract

The development of a Virtual Orthopaedic University is underpinned by a pedagogical approach built on current education research in terms of learning being situated and authentic; with learners adopting an active and constructive approach. An aim of the project is to maximise the relationship between different pedagogical approaches, tools and resources in a novel learning environment, while providing support for the decision making using a toolkit approach. The Virtual Orthopaedic University architecture can be used in a variety of different ways to support different types and levels of users and different syllabi. This paper describes the rationale behind the development of the system, the overall architecture, and the relationship between the architecture and the adopted pedagogical strategy.

## 1. Introduction

This paper reports on a project which has developed a virtual university for orthopaedics. The Virtual Orthopaedic University (VOU) provides an infrastructure for clinicians to use computer assisted surgical tools with dedicated interactive media, which links the educational environment of the Web Based Training (WBT) scheme to resources and to clinical data collection from ongoing trials in orthopaedics. Continuing Professional Development (CPD) is an essential part of the healthcare professions and the use of ICT provides an opportunity to improve the efficiency of both the teaching and the learning in the context of lifelong learners.

Furthermore, surgeons are mobile well-educated individuals whose work demands excellent availability of educational material that is up to date and focused to their particular learning situation. With the advent of virtual infrastructures, there is the potential to manage most of the administrative, research and educational workload of the university within the digital domain. This has potentially huge benefits for surgeons by providing greater access to information without the friction associated with traditional infrastructures. However, in reality the situation is more complex. Although technologically this is possible there are still huge barriers in terms of effective implementation, and in particular there is a need to understand the associated cultural and pedagogical aspects.

This paper addresses these aspects by reporting on the pedagogical strategy adopted within the VOU project and its relationship to the developed architecture. The system design needed to take account of the fact that the content for this area is constantly changing, giving rise to the need for dynamic and interactive systems, which allows for new and updated materials to be included, as well as the 'just in case' archives. This paper describes the rationale behind the development of the system as well as a description of the overall architecture.

## 2. VOU Implementation

VOU provide a working environment to help with familiarisation of new surgical procedures and the management of clinical case audit. The implementation enables users to communicate using material mediated for their specific needs allowing presentation of media to be adaptive to the user experience and knowledge base. This combines declarative (factual) content with feedback from a clinical (procedural) case-based training and evaluation environment.

The Orthopaedic Syllabus for training Higher Surgical Trainees (HST) is arranged by sub-specialty, the current version of the syllabus is a static entity [7]. It has no relationship to the learner's previous experience, beyond tacit acknowledgement of the fact that the trainees must have attained entry-level knowledge to attend the courses. The learning agreements allow the trainee and the tutor to agree the plan for the clinical experience and select suitable posts of a level of experience for the trainee to use for structured training purposes. The individual contract must be specific for the clinical post and the template can be used only as a recommendation. It is not prescriptive.

To ensure enhanced interoperability the construction of the metadata standards for the core components within the system confer to approved standards such as the Dublin core, Learning Object Metadata and Information Management System (IMS) [14]. Applicability (the ability to apply the technologies for other applications), and expandability [16, 18] are vital characteristics of components in VOEU. There are three underlying characteristics of the training needs of orthopaedics which need to be accounted for in the system developed:

1. There is a need for constant updating of the knowledge base for both procedural and declarative learning.
2. The learners typically have limited user time and computing expertise.
3. The specialist knowledge base varies according to experience and application.

Specialist knowledge includes both essential and important knowledge. The essential knowledge includes the part of the core curriculum relating to safety issues and with respect to this every trainee must be evaluated and demonstrate passable skills on every occasion. Important knowledge is also part of the core curriculum, although time is not formally available to test this, it will be included within the questions of the core modules. Important knowledge is that required to achieve a high quality of service, such as knowing a wide range of detail regarding conditions. The varying ability to pass this will constitute the grade of performance. The system developed to meet these requirements included the following components.

- *Multimedia Educational Modules*, which provide the declarative (factual) base of material for the education of the users.
- A *Virtual Classroom* environment for exchange of views, and monitoring of progress.
- A *Virtual Observatory* for the collection of data from simulation systems and the actual intra-operative data collection
- A *Dynamic Review Journal (DRJ)* is a web-based archive of medical and technical material, which is peer reviewed. The DRJ will allow students and tutors to analyse data from existing journals, investigate hypotheses, comment on reviewed articles, and even prepare and submit articles for review. In addition, tutors will be able capitalise on these reviews to include the corresponding declarative and procedural knowledge in the educational modules.
- Novel Modalities of *Simulation* [5,6] for the emulation of surgical procedures for training and experimentation focusing upon micro-surgery.

Combining the above disciplines within one working environment, the virtual university infrastructure [8] aims to meet the needs of clinicians to combining clinical, educational and research duties. VOU is an integrated digital educational and working environment for the training of orthopaedic surgeons. This includes the concept of the digital personal profile of the trainees, this is formalised as a surgical educational ontology, which is part of the learning agreement. There is a core of documents and components linked into the VOU surgical educational learning agreement, this will continue to be refined as part of the VOU pedagogy.

### **3. Pedagogy**

The aim of the project was to create a novel learning environment which tries to maximise the relationship between different pedagogical approaches used to support learning, and the associated tools and resources available to support them (see Figure 1). The project builds on current thinking in educational research upon pedagogy in terms of learning being situated and authentic; with learners adopting an active and constructive approach. In particular it builds on the problem-based learning literature [10], constructivism [12, 13], communities of practice [17], situated learning [1, 15, 9] and activity theory [4]. The pedagogical strategy aims to create an environment, which allows the different benefits of each of these pedagogical approaches to be made explicit. Guidance and exemplars of how, for example, problem-based learning can be used in conjunction with collaborative learning, through the use of the case based learning (case scenarios), the *Dynamic Review Journal (DRJ)* and the communication environment, will be included as part of the learning environment.

The guidelines and exemplars will be developed and stored in a pedagogical 'toolkit'. This builds on our previous research on using toolkits to provide guidance and support, which are developed through a process of co-participation with relevant stakeholders. 'Toolkits' provide a pragmatically-based approach to applying theory to practice' and can be used to support decision-making. We have developed a framework for integrating learning technologies into courses which builds on Laurillard's 'conversational' framework [3]. The framework is designed



2. Identification of appropriate teaching and learning methods.
3. Evaluation and selection of appropriate resources
4. Identification and integration of resources and tools
5. Delivery, evaluation, and refinement.

**Figure 2** outlines the overall process showing the relationship between each of the stages. It is anticipated that these steps will be completely interactive.

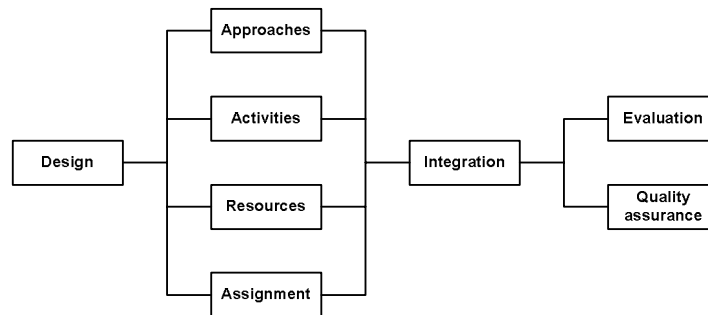


Figure 2 Educational Tool Development Process

#### 4. The On-Line VOU Syllabus for Orthopaedics

The VOU architecture can be used in a variety of different ways to support different types and levels of users and different syllabi. The project also includes some specific courses and specific routes through the system, but can also be used flexibly by the user. An educational contract is drawn up to bring the educational syllabus and the learning agreements together. These provide a two-way proposal for the tutor and trainee to agree initially and then review as the clinical post progresses. The aim of the contract is to identify areas of overlap between the trainees's learning needs, the tutor's ability to focus upon specific clinical areas, the resources of the clinical department and case mix to provide relevant learning material and clinical experience. It maps on to the personal profile of the individual and can be used as the basis of providing a personalised route through the VOU system in accordance with their clinical role.

The benchmark for the syllabus and the learning agreements is the requirement for individuals to pass the Certificate of Completion of Specialist Training (CCST) exam. This will enable;

1. Preparation of an *outline course infrastructure* for educators – such as course convenors or instructors and the tutors of individual trainees for specific courses or periods of in-house training (posts of usually 6 months duration).
2. *Curriculum* development is dynamically built, with units that can be combined and decomposed in meaningful ways. These will be mapped onto the syllabus and structured to suit the individual learner's needs.
3. Documenting and recognizing the completion of existing or new *learning and performance objectives* developed as part of VOU.
4. Education, training, and learning organizations involved in VOU, to *monitor an individual's progress* as related to covering the syllabus.
5. The necessary *security and authentication* procedures (including non-repudiation) for the distribution and use of Learning Agreements in particular – in accordance with the data protection act and the laws of consent regarding patient information.

#### 5. Surgical Ontology and the Learning Agreement

Within the VOU system, a surgical educational ontology is used as the basis for the learning agreements, this is coupled with the need for VOU to accommodate the organisational approaches of different individuals. By formalising the process, the VOU Learning Agreement ontology provides part of the pedagogical framework for the development of courses so that these may be integrated with the trainee's specific needs and the trainer's (clinical tutor's) ability to accommodate the specialised learning needs of the individual within the context of the

most suitable caseload and experience within the setting of the clinical post. This contributes to the VOU philosophy of embracing all possible learning models by providing learning object metadata, which allows course convenors to build their own course structures, whilst focusing upon the problem-based learning model to allow multiple modalities to be presented to the trainee.

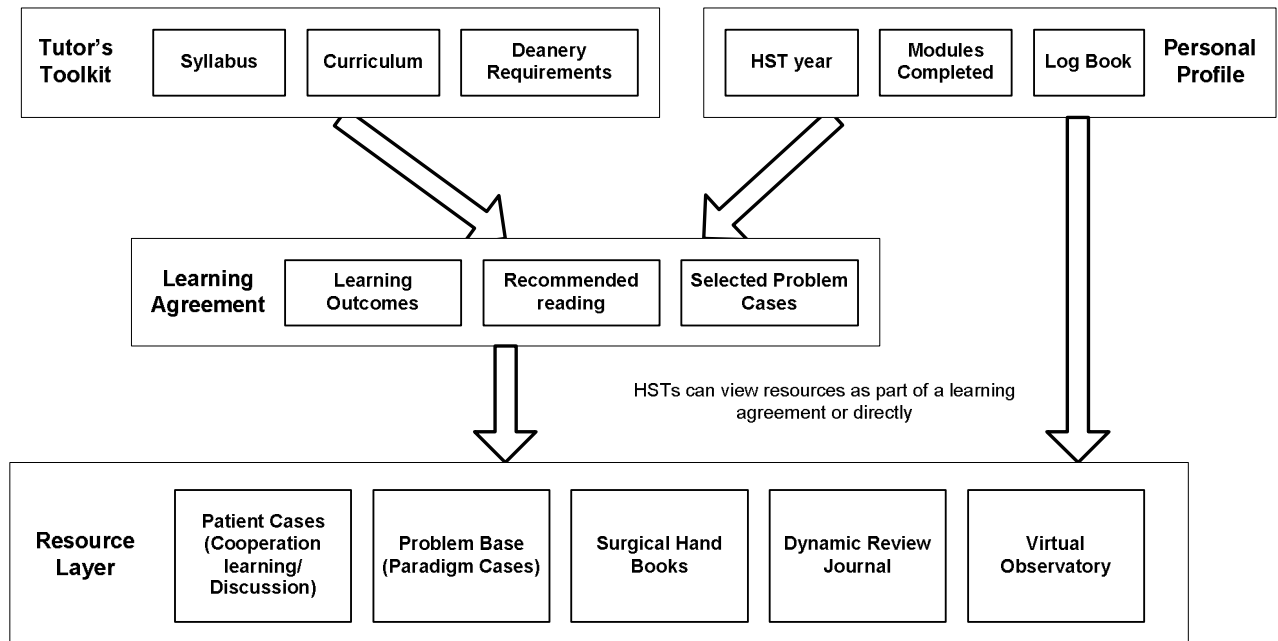


Figure 3 - Electronic Higher Surgical Training Infrastructure

## 6. Conclusions and Future work

Surgeons are mobile well-educated individuals whose work demands excellent availability of educational material that is up to date and focused to their particular learning situation. This reflects the need for life long learning material as well as the 'just in case' archives. New material is being collected constantly and this needs to be properly evaluated and integrated into the learning infrastructure appropriately. Part of the educational strategy employed relies upon the evolving university concept to allow for the updating and upgrading of educational material in light of new results, using analysis of incoming data from ongoing clinical trials for the evidence base. This acknowledges that a virtual university is a living infrastructure that evolves with time, due to changes both in its underlying philosophy and staff. To navigate the CPD requirements, new emerging and constantly changing medical world of the modern surgical professional, a cultural, technological, and social paradigm shift is occurring in orthopaedic surgical training within the UK. Technological solutions such as the VOU framework presented here have the potential to offer cost effective and timely solutions if used appropriately.

The development of a Virtual Orthopaedic University described in this paper is underpinned by a pedagogical approach built on current education research. Using a toolkit approach allows us to maximise the relationship between different pedagogical approaches, tools and resources in a novel learning environment, while providing support for the decision making. The tools and resources are designed to be flexible to enable their use at a number of levels, from major pedagogical re-engineering of courses through to enrichment of aspects of the learning process with engaging and illustrative resources. To ensure that the different requirements from the stakeholders can be met, the Virtual Orthopaedic University architecture was designed to be flexible, that is, it can be used in a variety of different ways to support different types and levels of users and different syllabi. The Virtual Orthopaedic University has been developed in a consortium consisting of orthopaedic surgeons, educationalists and computer scientists, and has undergone expert review at several stages in its development. However, the financial implications of developing and using these types of systems, in a clinical environment, are not well understood and further investigation is required. The next phase is to conduct user evaluations of the VOU system; this will also include a multi-centre clinical trial using the dynamic review journal.

## 7. Acknowledgements

Part of this work was funded by The European Commission under Project Virtual Orthopaedic European University, IST-1999-13079, Information Society Technology Program. The authors offer gratitude to the Raven Department of Education at the Royal College of Surgeons of England for their guidance and advice while developing the system.

## 8. References

1. Brown, J. S., L. Collins, et al. (1989). "Situated learning and the culture of learning." Educational Researcher **18**(1): 32-42.
2. Conole, G., E. Crewe, et al. (2001). "A toolkit for supporting evaluation." ALT-J **9**(1): 38-49.
3. Conole, G. and M. Oliver (1998). "A pedagogical framework for embedding C and IT into the curriculum." ALT-J **6**(2): 4-16.
4. Engestrom, Y., R. Miettinen, et al., Eds. (1999). Perspectives on activity theory. Learning in doing: social, cognitive and computational perspectives. Cambridge, Cambridge University Press.
5. Grange S., Bunker T., Cooper J. Networking virtual reality for shoulder arthroscopy. British Journal of Healthcare Computing 13[10], 26-28. 1996.
6. Grange S., Bunker T., Cooper J. Exeter Virtual Worlds Shoulder Arthroscopy Simulator. London: Brunel Univ Press, 1997.
7. Gregg PJ, Sher JL, Allum RL, Banks AJ, Clarke NMP, Bentley G, Calvert PT, Hobby JL, Phillips H, Ross AC. Guide to Core Education for Higher Surgical Training Programmes in Trauma and Orthopaedic Surgery. British Orthopaedic Association, November 1999.
8. Hazemi R, Hailes S. Reinventing the Academy. In: Wilbur S, Hazemi R, Hailes S, editors. The Digital University. London: Springer, 1998: 7-24.
9. Lave, J. and E. Wenger (1990). Situated Learning: Legitimate Peripheral Participation. Cambridge, Cambridge University Press.
10. O'Dowd JK, Spencer JD. An audit of university education in trauma and orthopaedic surgery in Great Britain. J R Soc Med 1992; 85(4):211-213.
11. Oliver, M. and G. Conole (2000). "Assessing and enhancing quality using toolkits." Quality Assurance in Education **8**(1): 32-37.
12. Papert, S. (1980). Mindstorm. New York, Basic books.
13. Piaget, J. (1954). The construction of reality in the child. New York, Basic Books.
14. Smythe C, Shepherd E, Brewer L, and Lay S IMS Question & Test Interoperability: An Overview *Date*: 11 February 2002 online at <http://www.imsglobal.org/>
15. Suchman, L. (1988). Plans and Situated Actions: The Problem of Human/Machine Communication. Cambridge, Cambridge University Press.
16. Wactlar H.D., Christel M.G., Gong Y., Hauptmann A.G. Lessons Learned from Building a Terabyte Digital Video Server. Computer 82[2], 66-73. 1999.
17. Wenger, E. (1998). Communities of practice - learning, meaning and identity. Cambridge, Cambridge University Press.
18. Witten W.I., Mc Nah R.J., Jones S., Apperley M., Bainbridge D., Cunningham S.J. Managing Complexity in a Distributed Digital Library. Computer 32[2], 74-79. 1999.