

# BIO-ALGORITHMS AND MED-SYSTEMS



Vol. 6, No. 11  
2010



Sustainability

Curriculum  
Transformation

Innovation

Social  
Networking

Virtual  
Patients

E-learning

Research

Collaboration

Design

JOURNAL EDITED BY JAGIELLONIAN UNIVERSITY - MEDICAL COLLEGE - KRAKOW - POLAND

<http://www.bams.cm-uj.krakow.pl>

The  
Higher  
Education  
Academy

Medicine,  
Dentistry and  
Veterinary Medicine



St George's  
University of London



# EDITORIAL BOARD

## EDITOR-IN-CHIEF

Professor IRENA ROTERMAN-KONIECZNA  
*Medical College – Jagiellonian University, Krakow, st. Lazarza 16*

## HONORARY ADVISOR

Professor RYSZARD TADEUSIEWICZ  
*AGH – University of Science and Technology*  
Professor JAN TRĄBKA  
*Medical College – Jagiellonian University*

## MANAGING EDITORS

**BIOCYBERNETICS** – Professor PIOTR AUGUSTYNIAK  
*AGH – University of Science and Technology, Krakow, al. Mickiewicza 30*

**BIOLOGICAL DISCIPLINES** – Professor LESZEK KONIECZNY  
*Medical College – Jagiellonian University, Krakow, Kopernika 7*

**MEDICINE** – Professor KALINA KAWECKA-JASZCZ  
*Medical College – Jagiellonian University, Krakow, Pradnicka 80*

**PHARMACOLOGY** – Professor STEFAN CHŁOPICKI  
*Medical College – Jagiellonian University, Krakow, Grzegórzecka 16*

**PHYSICS** – Professor STANISŁAW MICEK  
*Faculty of Physics – Jagiellonian University, Krakow, Reymonta 4*

**MEDICAL INFORMATICS AND COMPUTER SCIENCE** – Professor MAREK OGIELA  
*AGH – University of Science and Technology, Krakow, al. Mickiewicza 30*

**TELEMEDICINE** – Professor ROBERT RUDOWSKI  
*Medical Academy, Warsaw, Banacha 1a*

**LAW** – Dr SYBILLA STANISŁAWSKA-KLOC  
*Law Faculty – Jagiellonian University, Krakow, Kanoniczna 14, Institute of Intellectual Property Law*

## ASSOCIATE EDITORS

*Medical College – Jagiellonian University, Krakow, Kopernika 7e*

**EDITOR-IN-CHARGE** – PIOTR WALECKI  
**E-LEARNING (project-related)** – ANDRZEJ KONONOWICZ  
**E-LEARNING (general)** – WIESŁAW PYRCZAK  
**DISCUSSION FORUMS** – WOJCIECH LASOŃ  
**ENCRYPTION** – KRZYSZTOF SARAPATA

## TECHNICAL SUPPORT

*Medical College – Jagiellonian University, Krakow, st. Lazarza 16*  
ZDZISŁAW WIŚNIEWSKI – in charge  
WOJCIECH ZIAJKA  
ANNA ZAREMBA-ŚMIETAŃSKA

**Polish Ministry of Science and Higher Education journal rating: 4.000**

Sustaining institution: Ministry of Science and Higher Education

Edition: 300 copies

© COPYRIGHT BY INDIVIDUAL AUTHORS AND MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY

ISSN 1895-9091 (print version)  
ISSN 1896-530X (electronic version)

<http://www.bams.cm-uj.krakow.pl>

## OPENING PAPER

- 7 MedBiquitous Europe and its Role in Improving Technology Standards for Medical and Healthcare Education  
Chara Balasubramaniam, Valerie Smothers

## INVITED PAPER

- 9 Repurposing Cardiology to Psychiatry Sessions in a 3D Based Virtual Learning Environment  
Eleni L. Dafli, Kostantinos I. Vegoudakis, Costas Pappas, Panagiotis D. Bamidis

## VIRTUAL PATIENT: RESEARCH AND DESIGN

- 14 Pre-technical Assessment of Virtual Patient Designs  
Janet Tworek, Rachel Ellaway
- 15 Evaluation of Different Designs of Virtual Patients: First Results Using the eViP Evaluation Instruments  
Stephan Oberle, Simone Huber, Ralph Nawrotzki, Cordula Harter, Eva Schönit, Navina Schäfer, Burkhard Tönshoff, Sören Huwendiek
- 20 Assessing Designs for Assessment Virtual Patients – an Evaluation of Prototype Designs  
Jonathan Round, Emily Conradi, Sophie Vaughan, Tristan Bate, Michael Fitzpatrick, Tim Green, Terry Poulton
- 21 Transfer of Manual Dexterity Skills Acquired on the Simodont, a Dental Haptic Trainer with a Virtual Environment, to Reality. A Pilot Study  
Dirk Bakker, Maxim Lagerweij, Paul Wesselink, Marjoke Vervoorn
- 25 Simulation of a Virtual Patient with Cranial Nerve Injury Augments Physician-Learner Concern for Patient Safety  
Aaron Kotranza, Juan Carlos Cendan, Kyle Johnsen, Benjamin Lok

## TECHNICAL INNOVATIONS IN VIRTUAL PATIENTS

- 35 Towards the Development of a Gold Standard for Authoring, Introducing and Sustaining Virtual Patients in Multi-campus Clinical Education Environments  
Daphne Vassiliou, Katarina Arnrup, Olle Broström, M. Evans, M. Ruiz, K. Hagwall, P. Henriksson, M. Sköld, Ronny Sejersen, Nabil Zary
- 39 Standardized and Extensible Javascript-API for Logging Functionality for the MVP Player  
Jörn Heid, Frank Hess, Simone Huber, Martin Haag
- 41 How Dungeons & Dragons Made Us Better VPs: Randomizing Physiological Data to Rapidly Produce 97 Clinically Realistic VPs  
Janet Tworek, Mike Paget, Kevin McLaughlin, Bruce Wright
- 46 Enhancing Clinical Reasoning Using Probabilistically Generated Virtual Patient Cases  
Jeroen Donkers, Bep Boode, Daniëlle Verstegen, Bas de Leng, Jean van Berlo
- 47 HSVO: a Functional XML Specification for Integrating Simulation Devices  
Rachel Ellaway, David Topps, Jordan MacDonald, Bryan Copeland, Adriana Olmos, Bruce Spencer

## IMPLEMENTING VIRTUAL PATIENTS IN CURRICULUM

- 52 Implementation of Virtual Patients: The First Years  
Kalle Romanov, Marja Silenti

- 53      The Use of Virtual Patients to Prepare for Skills Lab Training: Results of a Pilot Project in Paediatrics  
Ronny Lehmann, Stephan Oberle, Hans Martin Bosse, Christoph Nikendei, Burkhard Tönshoff, Sören Huwendiek
- 54      The Combination of Virtual Patients and Small Group Discussions to Promote Reflective Practice of Specialist Trainees  
Bas de Leng, Rene van Gent, Jeroen Donkers, Jean van Berlo, Daniëlle Verstegen, Frank Hess, Jörn Heid
- 55      Repurposing Linear 'Paper' Cases into Interactive Online Virtual Patients for Problem-based Learning: Comparing the Impact of VPs on Exam Performance  
Terry Poulton, Sheetal Kavia, Chara Balasubramaniam, Trupti Bakrania, Emily Conradi
- 56      Evaluation of Different Curricular Integration Scenarios of Virtual Patients: First Results Using the eViP Evaluation Instruments  
Benjamin Hanebeck, Stephan Oberle, Ronny Lehmann, Christian Roggenhofer, Ralph Nawrotzki, Georg F. Hoffmann, Burkhard Tönshoff, Sören Huwendiek

## VIRTUAL PATIENTS: REPURPOSING AND COLLABORATIVE DEVELOPMENT

- 57      To Start from Scratch or to Repurpose: That is the Question  
Andrzej A. Kononowicz, Aleksandra J. Stachoń, Monika Guratowska, Paweł Krawczyk
- 65      Collaborative Development of Virtual Patients in Clinical Education  
Norman Berman, Leslie Fall
- 68      Estimation of Time and Efforts for Repurposing Virtual Patients – Experiences from the Electronic Virtual Patient Project (eViP)  
Daniela Kempkens, Inga Hege, Bas de Leng, Uno Fors, Sören Huwendiek, Andrzej A. Kononowicz, Terry Poulton, Martin R. Fischer
- 69      Time and Effort of Repurposing Virtual Patients from Casus to Campus Using the eViP Standard: Automated vs. Manual Transfer  
Benjamin Hanebeck, Stephan Oberle, Jörn Heid, Frank Hess, Inga Hege, Martin R. Fischer, Martin Haag, Sören Huwendiek
- 70      Factors for Successful Collaborative Creation, Adaptation and Maintenance of Virtual Patients for Undergraduate Medical Education  
Martin R. Fischer, Inga Hege, Katja Radon, Sören Huwendiek

## WEB 2.0 AND SOCIAL NETWORKING FOR HEALTH EDUCATION

- 71      Educational Content Organization and Retrieval via a Social Network  
Eleni Kaldoudi, Nikolas Dovrolis, Stathis Konstantinidis, Panagiotis Bamidis
- 72      The Role of Social Networking in the eViP Programme  
Sian Claire Owen
- 73      Using Web 2.0 in Cultural Immersive Health Education  
Hung The Nguyen
- 79      Workflow Modeling Simulation in Second Life: A Case Study  
Juliana J. Brixey, Judith J. Warren
- 81      VERSE: Workflows for Simulation and Virtual World Telemetry and Control  
Rachel Ellaway, Roger Sanche, Craig Symington, David Topps

## E-LEARNING INNOVATIONS

- 85      Student E-learning Initiative: Students as Educators and Partners in the Delivery of Undergraduate Medical Education  
Jane Williams, Dominic Alder, Will Duffin
- 87      Tasteofmedicine.com – Innovative Uses of E-learning Technologies to Widen Access and Support Social Equity  
Kenton Lewis, Kirsty Wadsley

- 93 Mobile Moodle: A Mobile Extension to the Moodle Virtual Learning Environment  
Supriya Krishnan, Narain Ramluchumun, Chara Balasubramaniam, Terry Poulton, Steven Malikowski
- 98 Content Collaboration Across Multiple Systems: How the American College of Cardiology is Creating a Unified Approach Towards Lifelong Learning  
Lynne M. Galiatsatos, Andrew Rabin, Gary S. Rae, David S. Raimist
- 99 A Case Study of Repurposing Medical Educational Material to Three Different Content Types  
Eleni Dafli, Panagiotis Bamidis, Costas Pappas, Nikolaos Dombros

## THE BUSINESS OF E-LEARNING

- 100 Osteopathic Continuous Certification Process is Simplified by MedBiquitous Standards  
Annette Van Veen Gippe, Andrew Rabin
- 101 MedEdPORTAL: Peer Reviewing, Publishing, and Disseminating E-learning  
Robby Reynolds, Michael Saleh, Christopher Candler
- 105 Organising Open Educational Resources: The Higher Education Academy Subject Centre for Medicine, Dentistry and Veterinary Medicine  
Suzanne Hardy, Megan Quentin-Baxter
- 106 Challenges, Restrictions and Opportunities in Licensing Online Educational Material  
Maria Nikolaidou, Stathis Konstantinidis; Panagiotis D. Bamidis, Eleni Kaldoudi, Nikolaos Dombros, Marinos Papadopoulos, Dionysia Kallinikou
- 107 Sustainability of Digital Educational Resources: Virtual Patients  
Angela Miller, Gabrielle Campbell, Chara Balasubramaniam, Terry Poulton, Martin R. Fischer

## INNOVATION DEMONSTRATIONS

- 108 Pivote: Virtual Patients for Virtual Worlds  
David John Harvey Burden
- 109 A Mixed Reality Virtual Patient Breast Simulator with an Innovative Feedback System Improves Communication and Breast Examination Skills  
Aaron Kotranza, Benjamin Lok, Kyle Johnsen, Jennifer Irons Carrick, Candelario Laserna, Brenda Rosson, Mary Anne Park, D. Scott Lind
- 111 Programmable Patients: Simulation of Consultation Skills in a Virtual Environment  
Luke Bracegirdle, Stephen Chapman
- 117 Simodont, a Haptic Dental Training Simulator Combined with Courseware  
Pepijn Koopman, Jaap Buis, Paul Wesselink, Marjoke Vervoorn
- 123 Open Source Competency-Based Repositories in Action: an American Society for Clinical Pathology and University of Virginia Partnership  
John Voss, Chitra Subramaniam, Ye Chen, Bonnie Jerome-D'Emilia, Michael Feldman, Vladimir Goodkovsky, John Jackson
- 124 Virtual Patients in Virtual Worlds  
Emily Conradi, Luke Woodham, Sheetal Kavia, Terry Poulton
- 125 Virtual Physical Exam  
Ali Hussam, Shawn Thomas Foley
- 126 vpSim – A Virtual Patient Simulation Web Service  
James B. McGee, Peter M. Kant
- 127 Using Electronic Virtual Patients and Collaborative Groups for Problem Based Learning  
Ralph Aarons, Susan S. Albright
- 133 Virtual Patients: Situated Learning for Pre-clinical Year 1 Students  
Sunhea Choi, Alexandra Webb, Elizabeth Ault, Jean-Remy Doboc





## MEDBIQUITOUS EUROPE AND ITS ROLE IN IMPROVING TECHNOLOGY STANDARDS FOR MEDICAL AND HEALTHCARE EDUCATION

CHARA BALASUBRAMANIAM<sup>1</sup>, VALERIE SMOTHERS<sup>2</sup>

<sup>1</sup>St. George's University of London, United Kingdom, <sup>2</sup>MedBiquitous, USA

### What is MedBiquitous?

Healthcare educators face common challenges in their work to educate and assess healthcare students and practicing professionals. Yet it is often difficult for healthcare educators to share learning resources and information with one another in the current fragmented environment of healthcare education.

MedBiquitous was founded to address those problems. Founded by Johns Hopkins Medicine and leading professional medical societies, MedBiquitous is a not-for-profit, international group of professional medical and healthcare associations, universities, commercial and governmental organizations dedicated to advancing healthcare education through technology standards which promote professional competence, collaboration, and better patient care. MedBiquitous is accredited by the American National Standards Institute (ANSI) to develop information technology standards for healthcare education and competence assessment [1].

Technology standards are necessary for computers to share data with one another; the standards act as a lingua franca. With standards in place, organizations are better able to collaborate, coordinate, and share lessons learned [2].

The technology standards that MedBiquitous creates allow educators to:

- Share virtual patients and other e-learning content across institutions.
- Describe educational resources in a consistent manner, making it easier to find relevant resources.
- Track professional education, activities, and accomplishments.

MedBiquitous standards include:

- Activity Report: Digital certificates for continuing education and specialty certification activities.

- Healthcare LOM: Descriptions of learning activities and content.
- Healthcare Professional Profile: Profile data on healthcare professionals.
- Medical Education Metrics: Continuing education evaluation data.

The following specifications are currently in development or under ballot:

- Competency Framework: Defines a set of related learning outcomes or competencies and, when combined with other specifications, enables educational resources and activities to be tied to a competency framework.
- Educational Trajectory: Describes the path of an individual learner through one or more programs of study, including informal professional development and breaks in matriculation.
- SCORM for Healthcare: Enables interoperability for healthcare e-learning.
- Virtual Patient: Enables interoperability of computer-based patient scenarios.

The MedBiquitous Virtual Patient specification (MVP) is in ballot at the time of writing of this document.

### What is MedBiquitous Europe?

MedBiquitous Europe is a collaboration to promote the adoption and implementation of MedBiquitous technical standards and specifications for healthcare education within Europe.

The objectives for MedBiquitous Europe are to:

1. Provide a European point-of-contact for all activities relating to adoption and implementation of MedBiquitous technology standards for medical and healthcare education.
2. Provide support and guidance for European institutions looking to adopt standards as part of any European Commission initiatives.

3. Promote European input to and participate in the development of MedBiquitous technology standards for healthcare education and competence assessment [3].

What advances have been made with standards?

The Electronic Virtual Patient (eViP) and mEducator projects have been the key drivers for changing the landscape of healthcare education leveraging existing technology standards. Partnering institutions from both projects are also active MedBiquitous Europe members and contribute to the various working groups of MedBiquitous.

The eViP project ([www.virtualpatients.eu](http://www.virtualpatients.eu)) aims to create a bank of 320 repurposed and enriched virtual patients [4]. These virtual patients will be available under Creative Commons Licenses. All of these virtual patients are repurposed using MedBiquitous Virtual Patient Technical Standards [5].

The mEducator project ([www.meducator.net](http://www.meducator.net)) aims to implement and critically evaluate existing standards and reference models in the field of e-learning in order to enable specialized state-of-the-art medical educational content to be discovered, retrieved, shared and re-used across European higher academic institutions [6].

Both projects have succeeded in testing the application of existing standards for current-day practice in healthcare education. As part of this process, they have also proposed necessary changes and extensions to the existing standards based on rigorous testing and use cases. The work that they have done is already being adopted by other international groups and both projects are now considered to be exemplars within their respective fields.

Where next?

The eViP project has already contributed to the shaping of the MedBiquitous Virtual Patient standard (MVP), which is now going through the MedBiquitous ANSI-accredited development process. The work done by the eViP partners has led to further refinement of the development of three application profiles of the MVP:

1. Linear Application Profile, where learners progress from step to step in a predetermined order.
2. Branching Application Profile, where the learner's path through the content is determined by their decisions.
3. Global Navigation Application Profile, where the learner is able to navigate to any part of the virtual patient activity at any time.

By working in such families, it is envisaged that interoperability between systems of the same profile may be enhanced, allowing users to more eas-

ily import virtual patients from other systems with a similar navigation style.

The mEducator project has already tested the application of the Healthcare Learning Object Metadata (Healthcare LOM) standard for describing healthcare education resources and activities with a number of different types of educational resources. The mEducator partners have re-visited the application of existing metadata schemas for current day use. It has become clear that a number of Healthcare LOM extensions would benefit the wider sector in order to reflect what is actually needed to share and reuse content easily. It is envisaged that the work of the mEducator project will contribute to the next iteration of the Healthcare LOM standard via the MedBiquitous Learning Objects Working Group.

As we enter another economically challenging year, sharing becomes more important than ever before. Both eViP and mEducator projects have demonstrated that standards are essential to enable collaboration, diffusion of the best resources, and diffusion of models for their implementation. However, existing standards need to change and keep up with evolving best practices. As proven by these two projects, MedBiquitous Europe provides us with a forum to do this collegiately.

Please visit the MedBiquitous website for more information on how to join: [www.medbiq.org](http://www.medbiq.org)

## References

- [1] MedBiquitous: About Us [internet]. Baltimore: MedBiquitous; c 2001-2010 [cited 2010, Jan 28]. Available from: [http://www.medbiq.org/about\\_us/index.html](http://www.medbiq.org/about_us/index.html).
- [2] Smothers V., Greene P., Ellaway R., Detmer D.E. (2008), *Sharing innovation: the case for technology standards in health professions education*. Med. Teach. 30(2): 150-154.
- [3] MedBiquitous: MedBiquitous Europe. Baltimore: MedBiquitous; c 2001-2010 [cited 2010, Jan 28]. Available from: [http://www.medbiq.org/about\\_us/medbiq\\_europe/index.html](http://www.medbiq.org/about_us/medbiq_europe/index.html).
- [4] Balasubramaniam C., Poulton T. (2008), eViP: Electronic Virtual Patients. Issues and news on learning and teaching in medicine, dentistry and veterinary medicine. 01.16 (Newcastle upon Tyne, Newcastle University, The Higher Education Academy).
- [5] Zary N., Hege I., Heid J., Woodham L., Donkers J., Kononowicz A.A. (2009), *Enabling Interoperability, Accessibility and Reusability of Virtual Patients across Europe – Design and Implementation*. Stud. Health Technol. Inform. 150: 826-830.
- [6] Bamidis P.D., Kaldoudi E., Pattichis C. (2009), mEducator: a Best Practice Network for Repurposing and Sharing Medical Educational Multi-Type Content, In proceedings of PRO-VE 2009, Springer Verlag.



## REPURPOSING CARDIOLOGY TO PSYCHIATRY SESSIONS IN A 3D BASED VIRTUAL LEARNING ENVIRONMENT

ELENI L. DAFLI, KOSTANTINOS I. VEGOUDAKIS, COSTAS PAPPAS,  
PANAGIOTIS D. BAMIDIS\*

*Lab of Medical Informatics, Medical School, Aristotle University of Thessaloniki, Thessaloniki, Greece*

**Abstract:** Recent technological developments concerning Web 2.0 have enabled the use of three-dimensional virtual platforms for educational purposes. In this paper, focus is placed on the modification of an OpenSimulator based 3D environment for its reuse in a different field of medical education; developments are presented alongside the associated effort to reconstruct and repurpose this environment so as to fit medical specialties of different clinical skills. The aim of this study was to present repurposing aspects of a learning environment modification and adaption to the needs of various medical specialties, in an attempt to reuse – and therefore share – learning content between different medical areas. Initially, a 3-Dimensional environment was created using the OpenSim platform for use in cardiology. Then, the virtual environment was modified so as to be oriented to the needs of psychiatry. The reconstruction of the educational environment and context and the reformation of the educational clinical scenario offer the possibility of reusability of this content which can be tailored to the needs of each medical field.

### 1. Introduction

The appearance of virtual worlds has added additional dimensions beyond traditional Web services concerning communication, research, formal and informal education and training, career development and life-long learning. 3D virtual world applications have attracted attention from different industries. Among them, learning applications have proved themselves to be one of prospective type of virtual services. New technologies, such as Web 3D virtual worlds, have emerged to facilitate new educational on-line activities which could not previously achieved. At the moment, there is a variety of different options of 3D engines for virtual environment world platforms. The choice of the right 3D platform for an e-learning application has become a challenge. Herein are listed four of them that are used in e-learning applications. These are Second Life (<http://www.secondlife.com>), OpenSim ([www.opensimulator.org](http://www.opensimulator.org)), Active Worlds ([www.activeworlds.com](http://www.activeworlds.com)), and 3D Torque Game Engine (<http://www.garagegames.com>).

To comply with the contemporary idea of exchanging and sharing learning material in medical education, as well as, the reorientation of the characteristics and features of content [1],

one must consider how the application scenarios arising from a certain platform are turned into another platform so as to suit different audiences or purposes. To this extent, the aim of this paper is to present aspects of repurposing a 3D learning environment for its adaptation to the needs of two different medical specialties, in an attempt to reuse (and therefore share) learning content between different medical domains. More, specifically, the focus is placed on the modification of an OpenSimulator based 3D environment for its reuse in a different field of medical education

So, the structure of this paper is as follows. After a short presentation of the OpenSimulator platform, the developments are presented alongside the associated effort to reconstruct and repurpose this environment so as to fit medical specialties of different clinical skills. In section 4, emphasis is placed on the repurposing procedure itself, in order to account as a future “registry” or “reference” for similar attempts. The whole idea and its limitations are finally discussed in the last section of the paper.

### 2. The OpenSimulator platform in comparison to Second Life

Second Life is a 3D virtual environment created by Linden Labs. Users are able to log in through free (or premium paying) accounts, create 3D personas (avatars), and interact with oth-

\* Corresponding author; Address: Lab of Medical Informatics, P.O. Box 323, Medical School, Aristotle University of Thessaloniki, 54124 Thessaloniki Greece, tel:+302310999310, fax:+302310999263, email: [bamidis@med.auth.gr](mailto:bamidis@med.auth.gr)

OpenSim has been presented as a new alternative to Second Life in virtual worlds. It represents a trend in open source activities around 3D platforms, while leveraging the existing Second Life APIs [3]. The OpenSimulator Project is a BSD licensed Virtual Worlds Server which can be used for the creation and development of 3D Virtual environments. It is able to run on a standalone mode or linked to other instances through built-in grid technology [4]. This ability offers easy management of electronic content, easy backups of the 3D world and client-side upgrade at the preferred time.

An important advantage of the OpenSim platform is that it is open source. This means that institutions being interested in virtual applications do not need to spend money on virtual land reservation in Second Life, or construction tools and frameworks for distance education and the maintenance of all structures involved in the land. Consequently, the initial cost and variable costs of maintaining a land is avoided. The only necessary and inevitable actions is the creation of the 3D virtual world, using the proper Linden Scripting Language (LSL) scripts for the scenario and management of the server. The code is written in C#, and can run under Mono or Microsoft .NET runtimes. Because of its clean modular nature, it is possi-

### 3. Setting up the Opensim Platform

### 3.1 Technical prerequisites

Following the above discussion, the OpenSim platform was chosen for this piece of work. However, this meant that many run-tests were performed as OpenSim is in alpha stage, meaning that is not expected to run in production environments. The version chosen was 0.4.0, and was available via Subversion (SVN) [5], and seemed to be more stable than others. The OpenSim Standalone Server was built on a Windows XP machine. The use of .NET Framework version 2.0 or the latest Mono was necessary so as to be built and run. Also, the use of OpenDynamicsEngine was necessary as a physics engine, mainly for simulating rigid body dynamics. A major drawback is that OpenSim and LSL is in a very immature stage [4], and this means that there is no support for all available functions of LSL. There is a way of implementing new functions of LSL, however, this is complex and only intended for experienced developers. A list of all the functions available is presented in [6].

### 3.2 The initial 3D environment for use in cardiology

For both types of educational content, the original and the repurposed one, the OpenSim Standalone Server was built on a machine of Windows XP. In addition, Microsoft.Net Framework version 2.0 or later Mono, and OpenDynamicsEngine were used, as previously mentioned. There are several compatible viewers and some of them were tested for this application. These were RealXtend [7], Linden Client [8], OpenViewer



Fig. 1. Instance of the initial learning environment for the educational needs of cardiology.

[9] and OnRez Viewer [10], each one with particular characteristics and features. As Linden client (Second Life) was the most popular and stable, it was chosen as the most suitable for this application. Since the OpenSim server was already running in standalone mode and the simulator had been configured by using the OpenSim configuration file, no further changes were necessary to proceed. Furthermore, the simulator was running in region grid connections. These parameters were initially established and there was no need to be redefined for the reuse of the educational platform for the needs of the psychiatry session. Also, the use of OpenDynamics Engine as the physics engine, for simulating rigid body dynamics, was adopted in both applications. In addition, the builder tool contained within the Second life client was used in both the original and the repurposed works. (cf. Fig. 1)

#### 4. The repurposing procedure

##### 4.1 The reconstruction and adjustment of the OpenSim based environment to the needs of Psychiatry

The first step in the repurposing procedure was the modification of the original 3D virtual world. The assistance of the Second Life client, and specifically the builder tool was used to build all the necessary items needed for the new scenario. Besides, some of the items that were previously used in the cardiology training session had either to be removed or to be disabled (such as the electrocardiograph or types of monitors). The utilization of specific textures was essential and had to be applied to the objects, so as for the clinical space to be presented appropriately for the scope of a psychotherapy session.

The design of the virtual environment was finally attempted to be as similar to a psychotherapy consulting room as possibly achievable, in order to make participants feel comfortable enough (as in a real space) and simulate actual conditions of everyday life and social interaction [11]. Thus, respective actions and the general appearance of the group had to be presented in a very realistic way. Sites, volumes, colors, materials, forms were adapted to the requirements of the session. Moreover, the result should provide a virtual site promoting the treatment itself, on the one hand, and help the wider community to accept mental illness, on the other [12].

##### 4.2 The new educational needs and expected outcomes of the repurposed educational scenario

As far as the educational needs and expected learning outcomes are concerned, the educational scenario needed to be adapted to the needs of psychiatry as it was originally designed for the purposes of cardiology. Consequently, the theoretical and clinical skills, which students should be trained in, were readjusted as they were completely different between the two disciplines [13]. The dialog boxes and the process were also modified so as to be presented in a group therapy session mode in which the trainees could also be involved [14]. The “measurement” part was not necessary any more, and more attention was given to the dialogues and the theoretical part of the process, since the psychotherapy group session was based on the psychoanalytic theory. In addition, more participants had to be added for the session, because the session was based in group therapy procedures. To summarize, the importance of the new scenario – and the new environment – consisted of two conditions: i) the presence of more participants, psychiatric patients and students and interns – at the

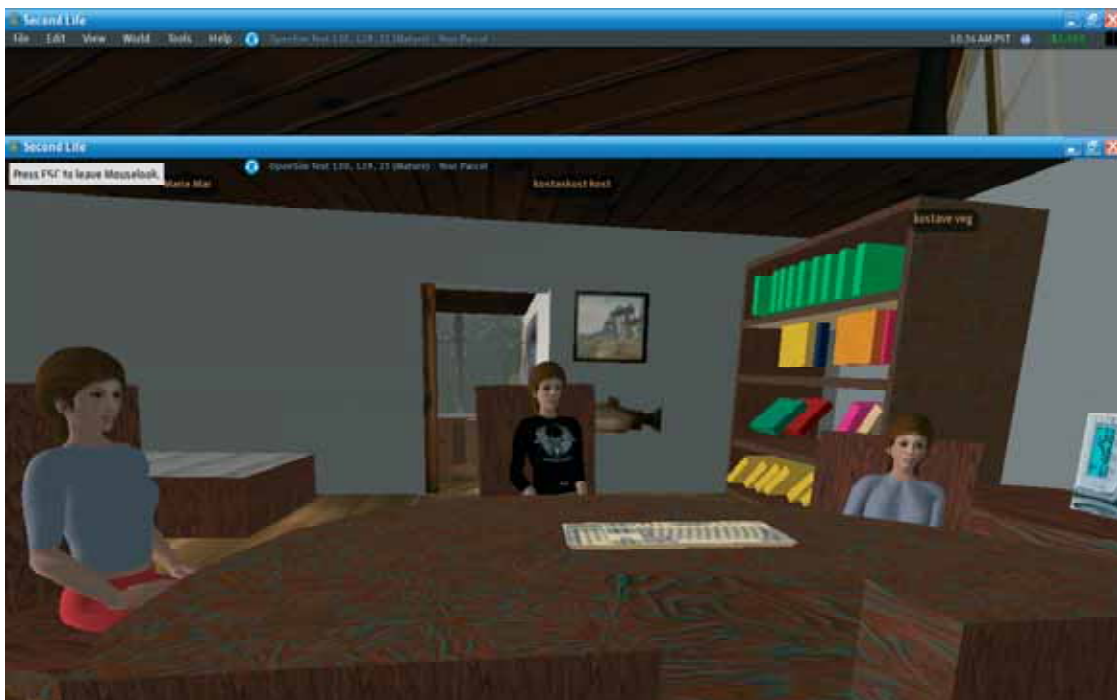


Fig. 2. An instance from the final environment adapted to the educational needs of psychiatry

same place and time, and ii) the interaction between these participants [13] [14].

### 4.3 Adjustment of avatars

In addition to the previous modifications, an adjustment of the characters, and consequently of the avatars, was necessary for the scope of the psychotherapy sessions. As mentioned before, the environment was referred to group therapy sessions, and so the increase of participant numbers was significant. Concerning the group psychotherapy session, there had to be a wider group of people (participants and trainees), with the coordinators, one (or more) psychotherapist(s) [12]. Moreover, the characters had to be presented properly. For example, avatars representing the doctors had to be dressed so as not to give the impression of strict medical advisers of the session, but rather the role of the coordinators of the virtual meeting. Consequently, white coats and some other "formal" medical characteristics had to be removed.

In addition, certain actions had to be altered in order to repurpose the initial learning environment. Extra-added specific actions provided better user interaction. Taking into account that there are scripts written in LSL in Second Life, OpenSim offers the same option, even though with some restrictions. In programming actions such as "sitting", the representation of names of objects and others was obtained through the Second Life client [15].

### 5. Conclusions

This paper examines the idea of repurposing and reuse of 3-D Virtual Learning Environments, among various medical specialties. Newly built virtual environments is cost, time and effort consuming. Exchange of applications between different areas of medical education helps to save time, money and effort, instead of creating, building and organizing everything from scratch.

In our case, the main advantages of this exchange are as follows. First, fixed factors and parameters related to the OpenSim platform were already built. Other requirements (Linden client as a spectator, OpenDynamicsEngine, Mono) were also set by the existing application. Thus, the administrative part of the work was easier, thereby offering an effort and time benefit.

In addition, the area outside and inside the virtual medical center was originally constructed for the cardiology session and there were only a few modifications required to adapt the environment to the needs of psychiatry sessions. Most of the items were already developed and especially the construction of the medical center, which takes much in time and effort. Moreover, user accounts / avatars were already set and there was only need to add a few more of them. Avatars were initially designed and only a few changes were necessary for group psychotherapy sessions, instead of virtual cardiology patients and doctors.

In conclusion, the emergence of virtual worlds has extra dimensions beyond traditional Web services on telecommunications, research, formal and informal education and training and professional development. New technologies that are be-

ing used for these purposes need much time, money and effort to be organized for every single use from the beginning. The exchange and sharing of content in medical specialties and different areas of medical interest could provide a solution to this. To conclude, the importance of such developments cannot be simply overlooked, and therefore, it composes the core research area of large European projects like "mEducator" [16], [17], [18]. It is expected that a significant amount of work should also be devoted into linking the work of the current paper to that of digital medical education standards [19].

### 6. Acknowledgements

This work was partially funded by the mEducator project, supported by the eContentplus 2008 program, Information Society and Media Directorate-General, European Commission (ECP 2008 EDU 418006).

### References

1. World Federation for Medical Education (WFME) (1998), Guidelines for using Computers in Medical Education. Med. Educ. 32 (issue 2), 205-8.
2. Ritzema T., Harris B. (2008), The use of Second Life for distance education, J. Comput. Small Coll., 23/6, 110-116.
3. Hong Cai, Bo Sun, Farh P., Meng Ye. (2008), Virtual Learning Services over 3D Internet: Patterns and Case Studies, SCC '08. Proceedings of IEEE International Conference on Services Computing, 2, 213-219.
4. OpenSimulator WebSite. Available: <http://opensimulator.org>; last access October 2009.
5. SVN Repository. Available: <http://dist.opensimulator.org>; last access November 2009.
6. A List of LSL functions. Available: [http://opensimulator.org/wiki/LSL\\_Status/Functions](http://opensimulator.org/wiki/LSL_Status/Functions); last access September 2009.
7. Main page of realXtend. Available: <http://www.realxtend.org>; last access September 2009.
8. Main page of Second Life. Available: [www.secondlife.com](http://www.secondlife.com); last access December 2009.
9. Main page of OpenViewer. Available: <http://openviewer.org>; last access December 2009.
10. Main page of viewer OnRez. Available: <http://viewer.onrez.com>; last access December 2009.
11. Delsignore A. (2008), Does prior psychotherapy experience affect the course of cognitive-behavioural group therapy for social anxiety disorder? Can. J. Psychiatry 53(8), 509-16.
12. Gorini A., Gaggioli A., Vigna C., Riva G. (2008), A second life for eHealth: prospects for the use of 3-D virtual worlds in clinical psychology. J. Med. Internet Res., 10/3, 21.
13. Yalom I.D., Theory and Practice of Group Psychotherapy, New York: Basic Books 1995.
14. Leszcz M., Kobos J.C. (2008), Evidence-based group psychotherapy: using AGPA's practice guidelines to enhance clinical effectiveness. J. Clin. Psychol. 64(11), 1238-60.
15. Scripting documentation of Opensimulator. Available: [http://opensimulator.org/wiki/Scripting\\_Documentation](http://opensimulator.org/wiki/Scripting_Documentation); last access December 2009.
16. Bamidis P.D., Kaldoudi E., Pattichis C. (2009), mEducator: A Best Practice Network for Repurposing and Sharing

- Medical Educational Multi-type Content. Proceedings of PRO-VE 2009, Springer Verlag 769-776.
17. mEducator, Multi-type Content Repurposing and Sharing in Medical Education. Available: <http://www.meducator.net>; last access January 2010.
  18. Kaldoudi E., Dovrolis N., Konstantinidis S.T., Bamidis P.D. (2009), Social Networking for Learning Object Repurposing in Medical Education. The Journal on Information Technology in Healthcare, 7(4): 233-243.
  19. Konstantinidis S.T., Kaldoudi E., Bamidis P.D. (2009), Enabling Content Sharing in Contemporary Medical Education: A Review of Technical Standards. The Journal on Information Technology in Healthcare, 7(6): 363-375.



## PRE-TECHNICAL ASSESSMENT OF VIRTUAL PATIENT DESIGNS

JANET TWOREK<sup>1</sup>, RACHEL ELLAWAY<sup>2</sup>

<sup>1</sup> Northern Ontario School of Medicine, Canada; <sup>2</sup> University of Calgary, Canada

**DESCRIPTION:** Designers of software preemptively direct and constrain their users to their interpretation of how the world works based on their understanding and goals in creating tools to meet particular objectives. This is particularly true of virtual patient applications. Many of the current crop of VP systems reflect a narrow range of educational applications even though their developers may see their tools as being the answer to everyone's needs. The affordances of different types of VP systems may be intentional, such as those specifically designed for problem-based learning, practicing diagnostic reasoning, exploring socio-cultural factors, or practicing commu-

nication skills. However, there may also be many unforeseen affordances such as cueing, direction, encouraging gaming or causing reversal effects through poor alignment of the difficulty with the abilities of the target learners. Undertaking a pre-technical phase of VP creation provides space to consider the educational goals of VP design and how software affordances may be leveraged to achieve specific learning objectives. This presentation will describe the high-level pre-technical assessment of virtual patient designs and how they guide the selection of the appropriate tools within which the design can be appropriately realised.



## EVALUATION OF DIFFERENT DESIGNS OF VIRTUAL PATIENTS: FIRST RESULTS USING THE EVIP EVALUATION INSTRUMENTS

STEPHAN OBERLE<sup>1</sup>, SIMONE HUBER<sup>1</sup>, RALPH NAWROTZKI<sup>3</sup>, CORDULA HARTER<sup>4</sup>,  
 EVA SCHÖNIT<sup>1</sup>, NAVINA SCHÄFER<sup>1</sup>, BURKHARD TÖNSHOFF<sup>2</sup>, SÖREN HUWENDIEK<sup>1</sup>

<sup>1</sup>Center for Virtual Patients, Heidelberg University Hospital, Heidelberg, Germany; <sup>2</sup>Center for Child and Adolescent Medicine, Heidelberg University Hospital, Heidelberg, Germany; <sup>3</sup>Anatomy and Cellbiology II, University of Heidelberg, Heidelberg, Germany; <sup>4</sup>Biochemistry Center, University of Heidelberg, Heidelberg, Germany

**Introduction:** Application of electronic virtual patients (VPs) is not only restricted to the clinical part of medical education. VPs can be used in preclinical years as well as in advanced trainings for physicians. The presented study overviews and compares different designs of VPs in different educational scenarios and summarizes their evaluations.

**Methods:** Due to the needs of each scenario the design of VPs got adjusted. The range of preclinical and clinical subjects comprised anatomy, biochemistry, child and youth psychiatry, paediatrics and others. In addition to the online evaluation through the students at the end of each VP, checklists completed by the VP designers got evaluated and compared due to each type of design using the eViP evaluation instruments.

**Results:** Evaluation results will be presented in detail including weaknesses and strengths of design with respect to the scenario the VPs were made for. Overall the feedback was encouraging and positive. A descriptive comparison of each type of design will be discussed including feedback of students and VP designers.

**Conclusions:** VPs can be adjusted in design to suit different educational scenarios. The eViP design evaluation instruments proved to be helpful to further optimize VP design according to the scenarios used in.

**Keywords:** virtual patient, campus, medicine, education, pre-clinical subjects, eViP, evaluation instruments, questionnaire

### Introduction

In medical education it is very challenging to teach medical students, how to apply their textbook knowledge into day to day practical thinking, which is required by a medical doctor dealing with real patients. Especially transferring basic science knowledge from pre-clinical subjects like anatomy, biochemistry or physiology into the clinical part of medical education is only marginally successful. According to Norman<sup>1</sup> at most 10 up to 15 % of this preclinical knowledge can be transferred by medical students into applied clinical thinking and clinical problem solving.

It could be shown that students can only develop medical skills needed for clinical reasoning and problem solving by experiencing real contact with patients in numerous cases, while trying to solve the current medical task actively on their own. Very important is that students receive proper feedback and in due time, too.<sup>2,3</sup> In the recent past it came into notice that real life patients are becoming increasingly less available for bedside teaching, due to the fact that patients stay shorter in hospital and units become more and more specialized. Therefore the use of virtual patients (VPs) has been more and more

intensified within the medical curriculum at many medical schools around the world as an adjunct to real patients.<sup>4,5</sup> Recently VPs were described as 'interactive computer simulation of real-life clinical scenarios for the purpose of medical training, education, or assesment'.<sup>6</sup>

The transfer of general basic concepts in early stages of medical education can be greatly increased according to Norman<sup>1</sup> by teaching textbook knowledge, especially from preclinical disciplines within clinical examples and not least by continuous repetition with many clinical examples in every subject throughout the whole period of medical education in terms of a learning spiral.

VPs are very time consuming and therefore costly in development.<sup>4</sup> Bearing all this in mind VPs have to be carefully designed and adjusted to different educational levels as well as different scenarios they are used in.

To date, only the electronic virtual patient (eViP) project<sup>7-9</sup> offers standardized evaluation instruments to evaluate the design of VPs and to be able to compare them. The presented study overviews and evaluates different VP designs in different educational scenarios.

## Methods

### Virtual patient software

For all VPs presented in this study the CAMPUS software was used, which is a vocabulary-based virtual patient shell.<sup>10</sup> It is designed for easy development of VPs with integration of background knowledge, for example in form of expert comments. Knowledge based questions can be asked as multiple choice or free-text questions, and it supports the use of multimedia, such as pictures, audio and video as well as interactive graphics first introduced by Huber et al.<sup>11</sup>

The CAMPUS player can be used most of all in two modes: the classic and the card-player. The first one is more interactive and more realistic whereas the latter one is HTML-based (can be played with every web browser) and best used for repetition or in scenarios, in which the main focus is e.g. on basic sciences.

### Setup

In the following subjects VPs were included into the regular medical curriculum at University of Heidelberg and evaluated in this study:

- Paediatrics, 17 exemplary cases, evaluated by 5<sup>th</sup>-year medical students. Classic-Player based, integrative part of a blended learning scenario with a tutor facilitating a small group discussion on priority worked through VPs, as preparation and wrap-up of seminars.
- Surgery, 2 cases, evaluated by 3<sup>rd</sup>-year medical students. Classic-Player based, integrative part of a seminar in which VPs are worked through supervised and facilitated by a tutor.

- Child and youth psychiatry, 2 cases, evaluated by 3<sup>rd</sup>-year medical students. Card-Player based, at home as preparation and wrap-up before and after corresponding seminars.
- Anatomy, 1 case, evaluated by 1<sup>st</sup>-year medical students. Card-Player based, integrative part of a seminar in which a VP is worked through. One student being a tutor for the VP gave an introduction to the other students before all went through the VP. After the work up of the VP a teacher facilitated a discussion on this VP.
- Biochemistry, 1 case, evaluated by 1<sup>st</sup>-year medical students. Card-Player based, integrative part of a seminar in which a VP is worked through after a lecture and before a discussion on the respective VP. A difference to the anatomical case above is, that students got a short introduction by the lecturer instead of a student.

In paediatrics students had to pass an end exam, which is computer-based and contains next to classical multiple-choice questions and long-menu questions covering aspects of the VPs used within the seminars and at home.

### Design

All cases have been especially designed for their specific use in different subjects and therefore different scenarios.

- Paediatrics  
At University of Heidelberg this subject started to implement VPs years ago, thus the pool of existing VPs in paediatrics is quite large. The cases included in this study have been repurposed especially for fostering clinical reasoning.<sup>12</sup>
- Surgery  
Cases have been developed from scratch specifically for the seminars they were meant for.

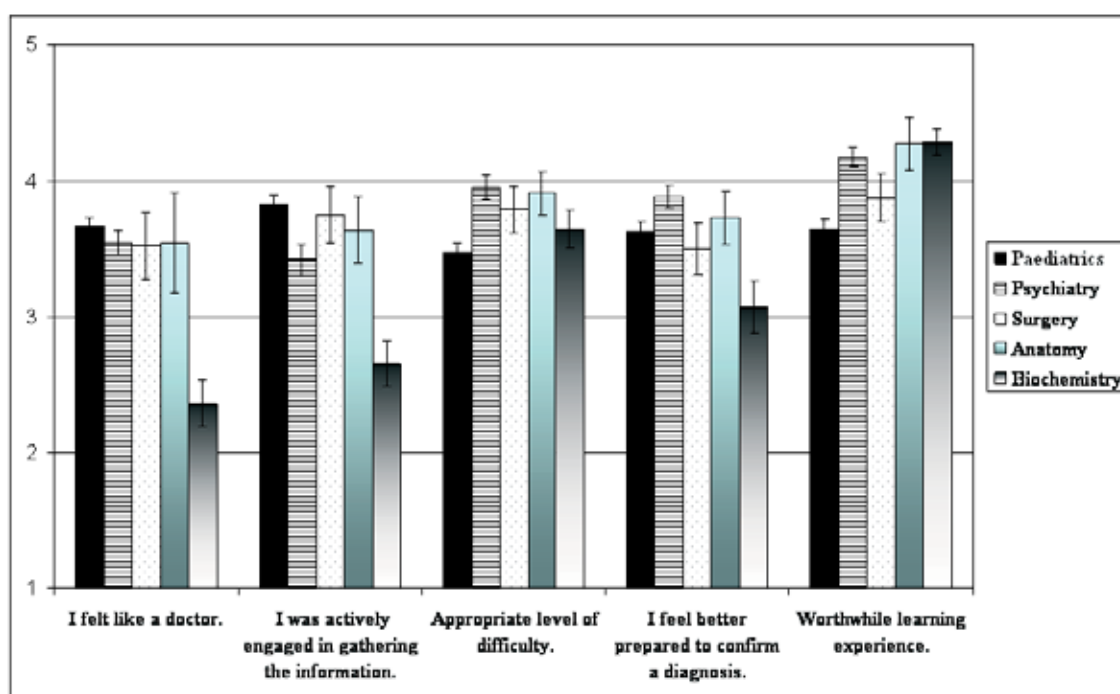


Fig. 1. Student's questionnaire concerning the design of VPs. 5 questions out of 12 of the corresponding eViP evaluation questionnaire are shown given as mean and standard error on a Likert-scale from 1=strongly disagree to 5=strongly agree.

- Child and youth psychiatry  
Cases have been developed from scratch. Due to the fact that the main focus of these cases is taking the medical history and exploration the structure of these cases is completely different. Compared to classical VPs the basis of text divided into questions (free-text and multiple-choice) and comments is much more extended.
- Anatomy  
The cases have been repurposed from existing VPs originally designed for education and assessment within the regular paediatric curriculum. First of all the clinical content has been drastically reduced and simplified to meet the needs and knowledge of pre-clinical students, e.g. instead of taking the medical history or physical examination a summary has been displayed. Secondly the corresponding case has been enriched extensively with preclinical learning content including interactive graphics.<sup>13</sup>
- Biochemistry  
The same holds true for the biochemical case (see Anatomy).

## Evaluation

The questionnaires used have been developed within the electronic Virtual Patient (eViP) project<sup>14</sup> and are designed for students as well as for VP-designers. These multilingual instruments are available via the eViP website.<sup>15</sup>

At the very end of each VP students were asked to complete an online questionnaire concerning the design of the VP. It consists of 12 questions covering 'Authenticity of patient encounter and the consultation', 'Professional approach in the consultation', 'Learning effect of consultation' and 'Overall judgment of case workup'. Answers could be given on a Likert-scale from 1='strongly disagree' to 5='strongly agree'. Furthermore, three 'Open-ended questions' (freetext) could be given concerning 'Special strengths of the case', 'Special weaknesses of the case' as well as 'Additional comments'.

In the pre-clinical subjects the questions have been slightly adjusted to consider the fact that the clinical content has been dramatically reduced.

In addition to the students also the VP authors have had to answer a similar questionnaire going much more into specific detail. It consists of 51 questions covering general questions about the case as well as 'Authenticity of patient encounter and the consultation', 'Professional approach in the consultation', 'Coaching during consultation' and 'Overall judgment of the case'. Answers could be given on a Likert-scale from 1='strongly disagree' to 5='strongly agree'. Furthermore, two 'Open-ended questions' (freetext) could be given concerning 'Special strengths of the case' and 'Special weaknesses of the case'.

Due to the complexity showing all single items a descriptive summary comparing the different subjects and scenarios is given.

## Results

The online questionnaires got completed by students after finishing the corresponding VP included into the present study:

Paediatrics 119, surgery 24, child and youth psychiatry 104, anatomy 11, biochemistry 28. 5 exemplary questions are shown (Fig. 1). 4 and 5 on the Likert-scale gets evaluated as positive feedback shown in percentage in relation to all given answers. Following the results to 5 exemplary questions are summarized:

"While working on this case, I felt I had to make the same decisions a doctor would make in real life."

were attested by 67% in paediatrics, 61% in surgery, 57% in child and youth psychiatry, 64% in anatomy and 14% in biochemistry.

"While working through this case, I was actively engaged in gathering the information (e.g. history questions, physical exams, lab tests) I needed, to characterize the patient's problem."

constituted 78% in paediatrics, 75% in surgery, 55% in child and youth psychiatry, 64% in anatomy and 19% in biochemistry.

"I felt that the case was at the appropriate level of difficulty for my level of training."

was assured by 54% in paediatrics, 71% in surgery, 82% in child and youth psychiatry, 82% in anatomy and 64% in biochemistry.

"After completing this case, I feel better prepared to confirm a diagnosis and exclude differential diagnosis in a real life patient with this complaint."

thought 64% in paediatrics, 50% in surgery, 74% in child and youth psychiatry, 64% in anatomy and 43% in biochemistry.

"Overall, working through this case was a worthwhile learning experience."

was attested by 66% in paediatrics, 79% in surgery, 87% in child and youth psychiatry, 91% in anatomy and 96% in biochemistry.

Table 1 gives an extract of the open-ended comments.

Each VP got also evaluated in a more detailed way by the corresponding VP designers (Fig. 2).

The designers of VPs appreciated to have an insight into both the student's questionnaire as well as the checklist for the authors. Having both at hand, it becomes easier to decide how to improve a VP. In the VP designers opinion the freetext comments to each question were also helpful in this respect. With the eViP design questionnaires they felt empowered to compare different VPs in the same subject area but also across disciplines.

## Discussion and Conclusions

With this study we present first results using the eViP evaluation instruments. Due to space constraint in this article it is only possible to picture five representative questions out of each type of questionnaire. Our data indicate that these instruments are suitable for comparing and improving the design of VPs. This works within a specific subject as well as between different disciplines. The instruments used here in combination with the eViP instruments for the curricular integration of VPs (first results presented by Hanebeck B. et al. in this issue) will help to see each VP in its specific context making it possible to compare and evaluate VPs across national borders. We look

Table 1: Extract of freetext comments.

Paediatrics – – – Strengths
Very good structuring ones clinical reasoning.
Very realistic design of the virtual patient.
Very good and detailed presentation of the case.
I liked very much the summary of disease aspects at the very end.
It's very good, that a treatment is not always needed.
Tables with standard values.
It's very good, that I have to decide actively before having any laboratory or technical results.
Independent decision on my own of diagnostic and therapeutic steps.
Good repetition from another case played through in another context.
Paediatrics – – – Weaknesses
Too many ICD10-diagnoses needed.
Finding the correct ICD10 is very difficult.
Too little tolerance with respect to typing mistakes in long menu questions.
Too long – too detailed.
Not always consistent in the workflow of the case.
I cannot choose alternative other than the ones given by the author.
Choosing laboratory values and different therapies wasn't easy.
Still too difficult, because I have too little background.
I should know literally all possible diagnoses, what is impossible after one week of paediatrics.
The case was not adjusted to our level of knowledge and therefore shouldn't be used at the end exam.
Surgery – – – Strengths
Simple everyday case.
Good setup – better than just MC-questions only.
I've already experienced a very similar case in reality.
Scenario is very close to reality.
Surgery – – – Weaknesses
No checking of ECG and BP even if patient has heart problems.
Hard to catch up the diagnosis (due to handling of the program).
Child and youth psychiatry – – – Strengths
Very good, very interesting, informative.
Typical patient.
Clear structure.
Good questions about how to talk with patients.
Child and youth psychiatry – – – Weaknesses
Too much text.
Bad presentation.
No 'direct' communication with patient.
Maybe there should be more MC-questions in preparation to the exam.
Too simple to find the diagnosis from the very beginning.
Taking the medical history is very difficult.
Anatomy – – – Strengths
Well done. Very helpful for myself.
Not too complex.
Close to reality.
I could answer many questions thanks to another seminar I visited before (genetics).
Anatomy – – – Weaknesses
Summary about own performance would be nice.
A lot of examinations or test I've never heard of; I'm only a preclinical student.
Biochemistry – – – Strengths
Very good case.
Very nice idea. Please tell all other subjects, too ...
It was a lot of fun.
Repetition of metabolic pathways.
Interactivity – connects basic and clinic science.
Not too boring.
Biochemistry – – – Weaknesses
Not suited for preclinical students.
Very abstract – far off daily medical routines.
I cannot feel like a real doctor – it's just a PC and all empathy is missing.

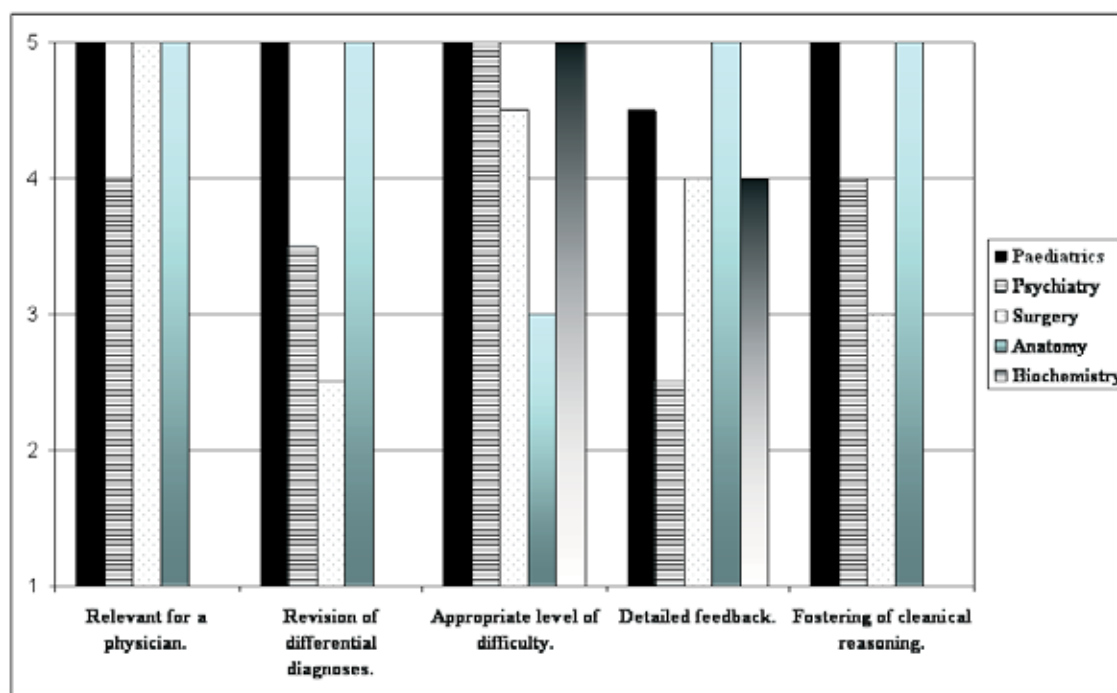


Fig. 2. VP designer's questionnaire concerning the design of VPs. 5 questions out of 51 of the corresponding eViP evaluation questionnaire are shown on a Likert-scale from 1=strongly disagree to 5= strongly agree.

forward to getting feedback from others using these evaluation instruments.

## Acknowledgement

We would like to express our gratitude to all eViP partners for collaboration in the developing of the evaluation instruments:

Prof. Resch, Dean of Study, the committee on student fees, and most of all, the students who volunteered their time to help us create a better education for those who will follow.

## References

1. Norman G.: Keynote lecture given at the Congress of the Association for Medical Education in Europe (AMEE) 2008: Making basic science relevant: teaching for transfer problem, 2008.
2. Eva K.W. (2005), What every teacher needs to know about clinical reasoning. *Med. Educ.*, 39: 98-106.
3. Norman G. (2005), Research in clinical reasoning: past history and current trends. *Med. Educ.*, 39: 418-27.
4. Huang G., Reynolds R., Candler C. (2007), Virtual patient simulation at US and Canadian medical schools. *Acad. Med.*, 82: 446-51.
5. Leong S.L., Baldwin C.D., Adelman A.M. (2003), Integrating web-based computer cases into a required clerkship: development and evaluation. *Acad. Med.*, 78: 295-301.
6. Ellaway R., Poulton T., Fors U., McGee J.B., Albright S. (2008), Building a virtual patient commons. *Med. Teacher*, 30: 170-4.
7. Poulton T., Fors U., Fischer M., Davies D., de Leng B., Huwendiek S., Muntean V., Roterman I., Balasubramaniam C. (2008), The European electronic Virtual Patient programme – the story so far, AMEE Conference.
8. Poulton T., Conradi E., Fors U., Fischer M., Huwendiek S., Ellaway R., de Leng B., Davies D., Muntean V., Laidler P. (2007), eViP: an EC-funded project to create a bank of multilingual, multicultural, virtual Patients. AMEE Conference, 25-29.08.2007, Trondheim, Norway. Abstract 20/P14. p. 20.
9. [www.virtualpatients.eu](http://www.virtualpatients.eu)
10. Garde S., Bauch M., Haag M., Heid J., Huwendiek S., Rudenrich F., Singer R., Leven F.J. (2005), CAMPUS – computer-based training in medicine as part of a problem-oriented educational strategy. *Studies in LEID*, 2: 10-19.
11. Huber S., Hess F., Donkers J., Heid J., de Leng B., Huwendiek S., Haag M. (2009), Enriching virtual patients with interactive images. *BAMS* 5(9): 73-7.
12. Hanebeck B., Toenshoff B., Huwendiek S. (2009), Repurposing virtual patients for clinical reasoning: Development of a guideline and assessment of time and effort. *BAMS* 5(9): 69-72.
13. Oberle S., Huber S., Toenshoff B., Nawrotzki R., Huwendiek S. (2009), Repurposing virtual patients for preclinical years – a pilot study. *BAMS* 5(9): 79-82.
14. Huwendiek S., Haider H.R., Toenshoff B., de Leng B. (2009), Evaluation of curricular integration of virtual patients: Development of a student questionnaire and a reviewer checklist within electronic virtual patient (eViP) project. *BAMS* 5(9): 35-44.
15. <http://www.virtualpatients.eu/resources/evaluation-tool-kit/>.

## ASSESSING DESIGNS FOR ASSESSMENT VIRTUAL PATIENTS – AN EVALUATION OF PROTOTYPE DESIGNS

JONATHAN ROUND<sup>1</sup>, EMILY CONRADI<sup>1</sup>, SOPHIE VAUGHAN<sup>2</sup>, TRISTAN BATE<sup>1</sup>,

MICHAEL FITZPATRICK<sup>3</sup>, TIM GREEN<sup>1</sup>, TERRY POULTON<sup>1</sup>

<sup>1</sup>St George's University of London, United Kingdom; <sup>2</sup>St Helier Hospital, United Kingdom;

<sup>3</sup>Homerton University Hospital, United Kingdom

### DESCRIPTION:

**Background:** The first clinical year of medicine at SGUL runs VPs for Problem-based Learning. These are augmented with formative virtual patients (AVPs) relating to the weekly subject matter. Various models of AVP have been evaluated in order to understand what features make good AVPs.

**Methods:** The range of AVP styles include: linear / branching; scoring decision-points/ scoring end-points; hidden scoring/ exposed scoring; continuous feedback/ end feedback only.

The year runs in two cohorts; each cohort is exposed to AVPs covering the same subject area, but differing in style of delivery.

**Results:** Student perceptions of authenticity, engagement, feedback and value were evaluated. Statistics on access numbers, time taken, and scoring were also gathered and analysed. These findings, together with performance, were then compared in relation to the different styles of AVP.

Early results show students found decision-making challenging, but relevant. They value feedback on decisions, and want to be able to see their score as they progress. Further analysis comparing different AVP designs will be presented.

**Conclusion:** AVPs are a useful tool in medical assessment, and this study has shown that they are well received by students, offering more realistic assessment that enable students to apply knowledge to clinical scenarios.



## TRANSFER OF MANUAL DEXTERITY SKILLS ACQUIRED ON THE SIMODONT, A DENTAL HAPTIC TRAINER WITH A VIRTUAL ENVIRONMENT, TO REALITY. A PILOT STUDY

DIRK BAKKER\*, MAXIM LAGERWEIJ, PAUL WESSELINK, MARJOKE VERVOORN

*Academic Center of Dentistry Amsterdam (ACTA), Institute of Education, 1066 EA Amsterdam, The Netherlands.*

**Abstract:** **Introduction:** Dental students invest many hours in manual dexterity training to prepare themselves for the clinics. Exercising on plastic has the advantage of learning within a standardized environment; continuing exercises on prefabricated teeth are unrealistic as plastic does not generate a training facility for clinical problem solving. Introducing a virtual learning environment with haptics and 3D models with realistic pathology (the Simodont) enables students to become competent before they enter clinics, assuming that the competences are easily transferred from virtual reality to reality. Therefore a study has been carried out to investigate if skills developed in virtual reality are transferred to reality. **Methodology:** Twenty-eight students participated in the study; 10 trained in the traditional phantom lab, 10 trained in the Simodont lab and 8 acted as a control group. Performance was tested before, during and after training. **Result:** It turned out that all students performed better after little or more training, independent of the training environment. **Conclusion:** Skills developed in virtual reality on the Simodont were transferred to reality.

**Key words:** dental education, preclinical training, haptics, virtual reality

### Introduction

The goal of dental education is to guide students' development through different stages from novice to competent, eventually resulting in an expert clinician. Students traditionally devote several years to the acquisition of sufficiently fine manual skills to prepare them for entry-level dental practice. In the current simulation laboratory, training is restricted to non realistic procedures using phantom heads, often on plastic teeth. Dental education, of all the health professional schools, is the discipline that could benefit the most from virtual reality since a significant proportion of preclinical dental education is dedicated to teaching psychomotor skills (1, 2, 3).

A simulator, Simodont, (Moog, Nieuw Vennep, the Netherlands and ACTA, Academic Centre of Dentistry Amsterdam, Amsterdam, The Netherlands) consisting of a force feedback robot arm connected to software in such a way that every movement of the arm is visualized on a screen, has been developed to replace the traditional lab conditions by a realistic virtual learning environment (Figs. 1 and 2).

The haptics are based on the Moog patented admittance control paradigm for the HapticMaster (4, 5). The simulator



Fig. 1. Student working on the Simodont

\* Contact author: Dirk Bakker, d.bakker@acta.nl



Fig. 2. Simodont unit with courseware

contains two separate loops (threads), namely a haptic loop and a graphics loop, running at different frequencies. A surface model is used to represent teeth and a tool for a better visual quality while maintaining a good performance of rendering in the graphics loop. The dental tool has six degrees of freedom positional sensing, generating 3 degrees of freedom force feedback and it moves relative to the position and orientation of a haptic probe. Collision detection and tooth cutting simulation are running along with the haptic loop in such a way that it allows computing realistic force feedback and simulating tooth cutting within only 1 millisecond. A high resolution stereo, real size co-located visual display approaches the acuity limits of the human eye. 3-D projection and mirror technology allow the full resolution, full stereo image to be seen "in" the physical workspace of the hand piece. A realistic model of the behavior of the drill speed, under the control of a foot pedal and the force exerted by the operator on the drill drives a built-in sound module which accurately renders the sound of a dental drill. Volumetric teeth data are acquired from extracted teeth using an I-CAT CBCT (120 KvP, 5 mA, Imaging Sciences, Pennsylvania, USA). A surface mesh is reconstructed from the segmented volumetric output of the segmentation tool using the marching cube algorithm (6).

Such a simulator offers the students the opportunity to develop from the beginning the required competencies in an almost realistic virtual learning environment.

Acceptance of such a simulator as a training tool is only possible if the skills developed on the simulator appear to be transferrable to the present reality in the preclinical laboratory. Therefore, prior to the introduction of the Simodont in dental education a pilot study has been carried out to investigate whether skills developed on the Simodont are transferred to reality.

## Material and methods

Twenty eight 1st year students, who had no experience in using a dental bur, participated in the study. The group consisted of 18 female and 10 male students; 25 students were right-handed, 3-left handed. The average age was 19.5 yrs, with a range from 17 to 32 years.

All students started with a manual dexterity test at the phantom head lab. Thereafter, the students were randomly di-

Table 1. Study design

Session	Control (gr 1)	Phantom head (gr 2)	Simodont (gr 3)
1	Test 1	Test 1	Test 1
		Exercise	Exercise
		Rest	Rest
		Exercise	Exercise
2		Exercise	Exercise
		Rest	Rest
		Exercise	Exercise
		Rest	Rest
		Exercise	Exercise
3	Test 2	Test 2	Test 2
		Exercise	Exercise
		Rest	Rest
		Exercise	Exercise
4		Exercise	Exercise
		Rest	Rest
		Exercise	Exercise
		Rest	Rest
	Test 3	Test 3	Test 3

vided in 3 groups: 8 students acted as a control group (group 1), 10 students trained on the traditional phantom head, cutting plastic (group 2) and 10 on the Simodont simulator (group 3). Group 2 and 3 exercised for three hours and 35 minutes during 2 sessions (2 x 35 minutes exercise and 30 minutes break in between). At the beginning of the third session all three groups performed a second manual dexterity test. Thereafter, group 2 and 3 practiced again 2 x 35 minutes with 30 minutes break in between. In the fourth session, they first practiced for 2 x 35 minutes with a 30 minutes break in between. Thereafter, a third manual dexterity test was performed by all three groups after a break of 15 minutes after the last exercise (Table 1).

The manual dexterity test was performed on a frasaco® A-PTSM mounted in a phantom head (Fig. 3, 4).



Fig. 3. The phantom head lab

The assignment was to cut away the inner circle without touching the outer circle and make the walls of the cut circle smooth and perpendicular to the bottom (Fig. 5)

The students used an airtor at 200.000 rpm with a diamond bur (FG109/010).

Two faculty members with more than five years of clinical and teaching experience performed the evaluation of the procedures. The preparations were graded anonymously and independently. The preparations were scored on two criteria: the size of the circle and the inclination of the wall, using a 4 point scale ( <25%, 25-50%, 50-75%, > 75% correct) (Fig. 5). The scores of the criteria were summated. The inter-observer correlation was 0.78.

The data were analyzed using SPSS 17 by the Kruskal-Wallis test followed by Tukey tests for *post hoc* pairwise multiple comparisons at a significance level set at  $\alpha = 0.05$ .



Fig. 4. Frasaco A-PTSM

## Results

The results of the test at the specified time points after practicing on plastic or the Simodont at all three sessions are shown in figure 6.

It appeared that the control students did not improve during the three tests where the students that practiced on the Simodont performed significantly better after the second session than the control students, as those who practiced on the phantom heads did not show a significant improvement. After the fourth session during the third test the students who practiced on the Simodont produced similar results as after the second session, where as the students that practiced on the phantom heads now performed significantly better than the controls. At the third test no significant difference in performance was found between the students who practiced on the phantom head or the Simodont.



Fig. 5. Preparation performed by a student

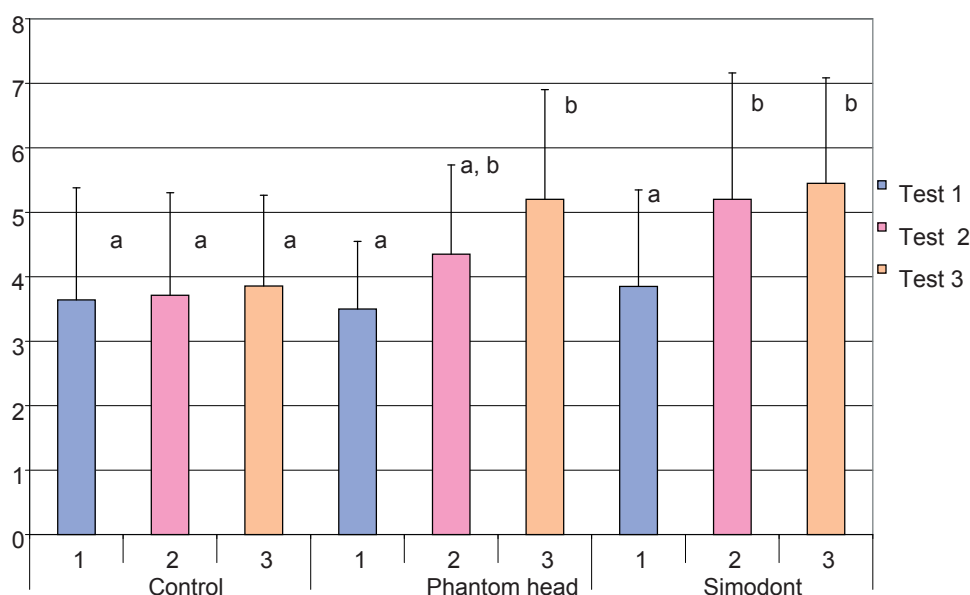


Fig. 6. The means of the summated scores of the criteria (maximum score = 8) of the tests of the students that served as controls, or practiced on phantom heads or the Simodont during the three sessions (1,2 and 3). Different letters between test results represent statistically significant differences. Identical letters indicate no statistically significant difference between the test results.

## Discussion

The main observation seen in this study is that students who practiced either on plastic or the Simodont performed better during the final test than those who did not, indicating that the practicing was useful to reach the desired performance. Furthermore, at the end of the experiment the students who practiced on plastic and those who practiced on the Simodont performed equally well showing that apparently skills developed on the Simodont can be applied in reality, thus implying transfer of skills from virtual reality to reality. This result suggests that in this respect the Simodont may be a useful instrument for dental students to develop their manual dexterity during dental education.

In comparison to the traditional preclinical laboratory the Simodont offers several advantages. As all instruments and materials are virtually represented no costs are made for dental hand pieces, burs and plastic teeth to practice on. Also realistic pathology can be treated without risks for patient and student. Furthermore no water and suction are involved which eliminates Legionella threats. It was very convenient for students that in case they had to redo an exercise, they just had to click to get a new exercise model where in reality a plastic tooth has to be replaced in the phantom head which is a rather tedious procedure and continuously distracts the focus and concentration of the students.

An interesting observation during the study was that the majority of the students working on the Simodont had a more desired upright working position than students working in the phantom head lab. Further research should be carried out to find out if this also leads to improvement of clinical working positions.

## Conclusion

Skills developed in virtual reality on the Simodont were transferred to reality thus the Simodont appeared to be a useful instrument for the development of manual dexterity of dental students.

## References

1. Rose J.T., Buchanan J.A., Sarrett D.C.: The DentSim system. *J. Dent. Educ.* 63: 421-3.
2. Sukotje C.: The impact of targeted shortened preclinical exercises on student perceptions and outcomes. *J. Dent. Educ.* 71: 1070-9.
3. Ferguson M.B.: Preclinical restorative training. *J. Dent. Educ.* 66: 1159-62.
4. Van der Linde R.Q. (2002), Lammertse P., Frederiksen E., Ruiter B.: The HapticMaster, a New High-Performance Haptic Interface, *Proc. Eurohaptics, Edinburgh Univ.*, 1-5.4.
5. Van der Linde R.Q., Lammertse, P. (2003), HapticMaster – a generic force controlled robot for human interaction. *Industrial Robot* 30: 515-524.
6. Rajon D.A. Marching cube algorithm: review and trilinear interpolation adaptation for image-based dosimetric models. *Computered Medical Imaging and Graphics.* 27: 411-35.

## SIMULATION OF A VIRTUAL PATIENT WITH CRANIAL NERVE INJURY AUGMENTS PHYSICIAN-LEARNER CONCERN FOR PATIENT SAFETY

AARON KOTRANZA<sup>1</sup>, JUAN CARLOS CENDAN<sup>2</sup>, KYLE JOHNSEN<sup>3</sup>, BENJAMIN LOK<sup>1</sup>

*University of Florida, <sup>1</sup>Department of Computer and Information Science and Engineering,  
<sup>2</sup>Department of Surgery, <sup>3</sup>University of Georgia, Faculty of Engineering*

**Abstract:** We have created the Neurological Exam Rehearsal Virtual Environment (NERVE), a virtual patient based simulation targeted to train medical students in the diagnosis of abnormal findings in the neurological examination. In NERVE, a learner communicates with and performs a physical examination of a life-sized virtual character experiencing double vision as a result of a cranial nerve palsy. NERVE affords verbal communication through natural speech and gestures, and affords physical interaction through manipulation of virtual tools such as an ophthalmoscope. Creation of NERVE is motivated by the limited quantity and depth of current medical education and simulation approaches to providing learners with exposure to abnormal physical findings in the context of a doctor-patient interaction.

NERVE not only provides an immersive and on-demand learning opportunity, but provides students with the opportunity to experience the patient's double vision in the first person in a "Patient Vision Feedback" (PVF) session. PVF allows the learner to experience how the world looks to the virtual patient, providing an opportunity for enhanced perspective taking and empathy. Thirty-two medical students have examined a virtual patient in NERVE. Twenty-nine of these students were able to correctly diagnose the virtual patient's cranial nerve palsy, demonstrating content validity of NERVE. A subset of eight medical students experienced Patient Vision and, as a result, demonstrated improved concern for the patient's wellbeing. NERVE is able to augment a neurology curriculum by providing increased exposure to abnormal findings and providing students with a unique insight into how the disease affects the patient's wellbeing.

**KEYWORDS:** virtual patient, medical simulation.

### 1. Introduction

Exposure to abnormal physical findings, such as diplopia (double vision) resulting from a cranial nerve palsy, is difficult to provide in an educational setting. These abnormal findings are relatively uncommon and require immediate medical attention – making hands-on learning opportunities rare for novice healthcare professionals (medical students, residents). Patient simulation using virtual characters to portray abnormal findings provides an immersive and always-available learning opportunity to augment existing educational methods.

We have developed one such patient simulation, the Neurological Exam Rehearsal Virtual Environment (NERVE). Using NERVE, students are able to communicate with and physically examine a life-size virtual human patient (VP) presenting with a cranial nerve palsy. The learner performs a neurological exam of the virtual human patient using natural speech and virtual tools (ophthalmoscope, eye chart, hand and fingers) manipulated using a Nintendo Wii Remote. The virtual human provides a realistic presentation of a cranial nerve disorder, with abnormal physical findings such as restricted eye movements and double vision, and relevant patient history and expression

of emotions. NERVE also affords learners the ability to assume the role of the patient and view the world through the eyes of a patient with double vision. Incorporating this "Patient Vision Feedback" (PVF) experience, NERVE targets physical examination and diagnosis skills, alongside the interpersonal skills of perspective taking and proper use of empathy.

In evaluations of NERVE with medical students, we have established the content validity of NERVE for practicing diagnosis and examination skills. NERVE is able to simulate a neurological examination to a high enough fidelity to allow learners to correctly diagnose which of the VP's cranial nerves are affected. Twenty-nine of 32 medical students arrived at a correct diagnosis in exams of patients with CN3 and CN6 palsies in NERVE. This represents a significant proportion by one-way Chi-square ( $\chi^2(1) = 19.5, p < 0.0001$ ). A subset of these medical students also conducted a PVF experience. In this paper we describe the development of NERVE and the results of a formal study comparing learners' level of concern for the patient's safety with and without experiencing the patient's double vision first-hand in PVF. Study results demonstrated that PVF effectively increased learners' consideration of how the cranial nerve disorder impacts the patient's life, as only those partici-



pants who experienced PVF before examining the patient expressed concern for the patient's safety.



Fig. 1. A clinician uses NERVE to perform a neurological exam of Vic, a virtual human patient with double vision due to a CN6 palsy.

### 1.1. Motivation

Cranial nerve palsies are nerve disorders that can result in abnormal physical findings such as: a pupil that does not contract in light, an eye that does not move through a full range of motion, and double vision [1]. The diagnosis of the cranial nerve palsy is based primarily on interpreting these abnormal findings in the context of the patient's medical history [2]. Cranial nerve palsies are relatively uncommon, resulting in delays in diagnosis with suboptimal patient outcomes. These delays are concerning as the most frequent causes of cranial nerve palsies require immediate medical attention. Further, providing developing healthcare professionals (e.g. medical students) with exposure to cranial nerve palsies is difficult in an educational setting (e.g. medical school or continuing education) as the diseases are not demographically predictable. Thus, exposure to abnormal findings in human patients is not standardized and occurs only if a student happens to be in the neurological clinic at the time that a patient arrives with abnormal findings, i.e. exposure is "catch as catch can".

Cranial nerve experiences with virtual human patients (VPs) would fill an important educational role in providing standardized, hands-on exposure to abnormal findings in a neurological exam – providing a platform for teaching, practice, and evaluation.

Currently, medical students learn diagnosis through lecture, textbook video-based didactics, and supervised patient encounters [3]. With this approach, medical students may graduate without experiencing abnormal findings in a neurological exam of a patient. Students' diagnostic skills are typically tested by an expert observer at most once in a neurology clerkship, and some students go untested. When these skills are tested, students arrive at (what an expert would consider) a correct diagnosis 50% of the time [4].

The lack of exposure to abnormal findings may also hamper affective skills with patients presenting with these abnormal

conditions. Patients are often fearful because of social or cosmetic problems (e.g. drooping eyelid, lazy eye) and because they worry that they will lose sight completely [5] and their symptoms may indicate a serious condition such as aneurysm or brain tumor [6]. Without the experience of talking to patients with these fears and taking these patients' perspective, novice learners may not address the patient's concerns or consider the patient's safety (e.g. did a patient with severe double vision drive to the clinic?). It is imperative for the physician to address issues of patient safety [7]. Additionally, with current educational approaches, the limited opportunities for practice and evaluation cause students to report a low level of knowledge of the neurological exam and low confidence in their abilities [8][9].

NERVE aims to provide additional opportunities for learners to practice diagnosis of cranial nerve disorders in the context of a doctor-patient interaction, and targets affective learning through a "Patient Vision Feedback" (PVF) experience which allows the learner to experience the cranial nerve patient's double vision first-hand.

### 1.2. The Role of Virtual Patients in Medical Education

Educational technologies are used extensively at all points on the medical education continuum and vary widely in complexity, degree of realism, and cost. Such resources include relatively straightforward online multimedia tutorials; high-fidelity virtual patient applications that ask learners to diagnose and manage simulated patients; and immersive, team-based simulations designed around lifelike mannequins. While medical simulations span a significant number of applications from surgical planning to procedural training (e.g. laparoscopic simulators), we have focused on developing simulators for patient conditions. Patient condition simulators are aimed to augment (not replace) standardized patient (SP)-based curricula, employ VPs with a variety of interfaces, and enable students to practice and experience a range of patient symptoms.

SP encounters can be realistic, can discriminate between trainees with different amounts of experience, and have some predictive validity to success in residency training. Demonstration of abnormal physical findings has, however, been a challenge. In fact, SPs can actually serve as a source of confusion for the examiner with one report stating that many SPs have unrelated, actual physical findings that can confound the clinical scenario [20]. The Liaison Committee on Medical Education (LCME) – the nationally recognized accrediting authority for medical education programs leading to the M.D. degree in U.S. and Canadian medical schools – presents its member institutions with the following educational mandate (ED-2): "Each course or clerkship that requires interaction with real or simulated patients should specify the numbers and kinds of patients that students must see in order to achieve the objectives of the learning experience." [21] In essence, the LCME is giving equal weight to real and simulated patients. The possibility of demonstrating abnormal findings in a VP, or using a VP to augment the SP scenario, intertwines perfectly with this stated educational goal. By constructing appropriate VPs, students will be able to gather core knowledge and experiences that they otherwise may not receive.



## 2. Prior Simulation-Based Approaches to Neurological Examination

Prior simulation approaches to providing additional practice of the neurological examination have encompassed both purely physical interactions and purely virtual interactions.

Purely physical simulation has yet to completely recreate abnormal findings in a neurological examination. Recreation of abnormal findings such as restricted eye movements and partial loss of sensation in the face would require robotics beyond that used in sophisticated physical simulators such as the Human Patient Simulator [10]. Instead of attempting to simulate a full exam, physical simulation has focused on training narrower components such as diagnosing abnormal findings in the fundoscopic exam (looking at the patient's retina through the ophthalmoscope). In one such system, slides of photos of abnormal retinas are inserted in the eyes of a mannequin head [11], allowing the learner to experience abnormal findings in the narrower scope of a fundoscopic exam.

Purely virtual simulation approaches have more completely simulated the neurological exam and abnormal findings. A purely virtual web-based approach (2D graphics) has been developed by the University of California Davis [12] to train diagnosis of cranial nerve palsies. A pair of disembodied eyes follows the user's mouse cursor, providing the user with information to make a diagnosis based on eye movements.

There are currently no simulation approaches, of which we are aware, which address a complete set of abnormal findings (i.e. eye internal and external appearance, movement, and reaction to light; drooping eyelid, sensation or lack of sensation in the face and eyes; expression of seeing double based on where the eyes are looking) or which simulates the interpersonal aspects of the scenario. NERVE simulates this range of abnormal findings as well as the physical exam components required to diagnose disorders of seven cranial nerves: CN 2, 3, 4, 5, 6, 7, and 12 (out of a total of 12 cranial nerves). With the incorporation of the patient vision experience, we have so far focused on developing scenarios (patient history, patient appearance) for cranial nerves which affect patient eye movement: CN 3, 4, and 6.

## 3. NERVE

The virtual human patient is modeled in Autodesk Maya and rendered using the open-source rendering engine, Ogre 3D. The VP is presented at life-size on a large screen display, such as a 52" LCD monitor.

The user wears a hat affixed with three infrared-reflective fiducials. These fiducials are tracked by an outside-looking-in infrared tracker (Naturalpoint OptiTrack), to report the user's head pose (position and orientation) relative to the VP. This allows the VP to be rendered from the user's perspective, e.g. allowing the user to get up close to the VP's face to examine the pupils and also farther away to test eye movements or visual acuity. Tracking the user's head pose also allows the VP to make eye contact with the user.

To perform an exam of the VP, the user manipulates virtual tools: an ophthalmoscope, an eye chart, and a virtual articulated hand and fingers representing the user's right hand.

These virtual tools are controlled by one physical object which estimates the feel of manipulating a tool such as the ophthalmoscope, while providing more robust interaction (in terms of tracking errors) than tracking the pose of the user's hand and fingers. This physical object is the Nintendo Wii Remote ("Wiimote"), augmented by infrared tracking. This provides 6 degree-of-freedom position and orientation of the controlled virtual tool, as well as additional articulation (e.g. raising or lowering fingers on the hand to hold up a specific number of fingers, turning on and off the ophthalmoscope's light) by manipulation of the Wiimote's buttons and trigger.

A typical NERVE interaction proceeds as:

1. The learner greets the VP and queries the VP's reason for coming to the clinic. The learner also observes immediately visible abnormal findings, such as an eye that always looks down and to the left or ptosis, a drooping eyelid.
2. The learner and VP proceed to converse about the VP's symptoms and relevant medical history.
3. The learner picks up the Wiimote and uses it to conduct the physical exam.
  - a. The ophthalmoscope light can be used to test pupillary response, by aiming the light into either of the VP's pupils.
  - b. The ophthalmoscope lens can be used to perform a simplified fundoscopic exam – an image of the relevant retina is displayed when the ophthalmoscope is held close to an eye.
  - c. The ophthalmoscope or hand-fingers tool is used to test the patient's eye movements through the full range of vision. This is accomplished by asking the VP to "follow my finger" or "follow the light" and then proceeding to trace out an uppercase "H" with the ophthalmoscope or tool. This "H" tests the patient's eye movements through the traditional cardinal eye movements (left, up-left, down-left, right, up-right, down-right).
  - d. Convergence of binocular vision is tested by holding up a specific number of fingers on the hand-fingers tool and asking the patient how many fingers he sees. This can be repeated with the patient covering either eye. If the patient sees the correct number of fingers with one eye covered, this indicates that the double vision is a function of a unilateral cranial nerve injury.
  - e. The patient's peripheral vision is tested by holding the hand-finger tool in the VP's peripheral vision, asking "tell me when you see my finger shaking" and shaking the wiimote rapidly. The VP reports, appropriately for the disorder, "I can (not) see your finger shaking."
  - f. The eye chart tool is used to test the patient's visual acuity, choosing a line on the chart and asking the patient to read that line, or asking the patient to read the lowest line he is able to read.
4. After completing the physical exam, the learner and VP converse about the learner's findings, any of the VP or learner's concerns, and treatment plans or "next steps" recommended by the learner.

In the remainder of this section, we provide details of the implementation of the components of NERVE. Section 4 describes the patient vision feedback and Section 5 discusses the formal study of the impact of patient vision feedback on the learner's affective performance.

### 3.1. Virtual Character

NERVE's VP, Vic, is a virtual character with the appearance of a male patient. Vic is capable of speech (pre-recorded human speech), gestures (keyframe-based animation), and facial expressions (vertex animation). Vic is also able to meet the user's gaze, e.g. when the user is speaking to Vic, and avert from the user's gaze, e.g. during certain of Vic's responses and when Vic is waiting for the user to speak.

To support having a neurological examination performed on Vic, Vic was given gestures and facial expressions related to neurological tests, and Vic's eyes were controlled using a model of abnormal eye movement that we developed.

#### 3.1.1. Supporting Neurological Tests

In addition to the functionality described in the "typical NERVE interaction", Vic is able to support other neurological tests. Vic has keyframe and vertex animations that allow him to: tilt his head, touch his chin to his chest, smile, frown, stick out his tongue, raise his eyebrows, blink, wink, puff out his cheeks, and turn his head from side to side. These abilities are enabled or disabled as per the cranial nerve injury being simulated. Vic also supports a test of facial sensation. The hand-finger tool is used to touch Vic in various locations on his cheeks and forehead. The location of the touch is determined using collision detection of the virtual fingers and Vic's face. Depending on the affected cranial nerve, Vic reports whether he is able to feel the touch (e.g. CN5 can reduce facial sensitivity).

#### 3.1.2. Simulating Abnormal Eye Movements

The most important aspect of simulating cranial nerve disorders 3, 4, and 6 is displaying pathology-correct abnormal eye movements. These eye movements are the primary basis for diagnosis, in addition to other aspects of the patient's appearance such as tilting of the head (CN4 palsy), and secondary aspects such as reporting of headache [13] or trauma to the head.

Moving the human eye to look at an object or perform a task such as following the doctor's fingers requires a complex interaction of six muscles. Because of the computational expense to compute this interaction at interactive rates to a desired degree of fidelity, we have developed a computational model of eye movements that is not physically based, but has been validated by multiple neurologists and educators to produce movement consistent with real physiology.

This model uses linear interpolation of the eight cardinal eye movements (left, up-left, down-left, right, up-right, down-right, up, and down) to restrict eye movement in a way that appears physiologically correct for the specific cranial nerve disorder exhibited by the VP. This model can be visualized as a region in a 2-dimensional Pitch-Yaw plane to which the VP's eye movement is restricted (Figure 2). The (pitch, yaw) values corresponding to the maximal cardinal eye movements for the CN3, 4, and 6 palsies were determined through review of case data and textbook diagrams [14], the UC Davis eye simulator [12], and discussion with expert neurologists.

For each eye, the movement model defines a set of eight vectors corresponding to the cardinal movements, each 45 degrees apart. Each vector is associated with a (yaw, pitch) pair representing the maximum yaw and pitch of the eye for that cardinal position. Considering a 2-dimensional plane with dimensions of yaw and pitch, these vectors divide the plane into eight sectors. Given a desired gaze position (e.g. "look to the left", "follow my finger", or gazing at the learner's head position), this model outputs a new gaze position altered by the constraints imposed on eye movement by the cranial nerve disorder. For an affected eye, the process proceeds as (illustrated in Figure 2):

1. Given the desired gaze position, calculate the (yaw, pitch) required to rotate the eye from its default (straight ahead) position.
2. This (yaw, pitch) pair defines a vector  $d$ , the desired gaze vector.
3. Assuming  $d$  originates from the origin of the normal eye model, determine which two normal eye movement vectors  $v1$ ,  $v2$  define the sector in which  $d$  lies.
4. Calculate the angles between  $d$  and  $v1$ ,  $v2$  as  $a1$  and  $a2$ .
5. Normalize and invert  $a1$  and  $a2$ :  
 a.  $a1' = a1 / (a1 + a2)$ ;  $a2' = a2 / (a1 + a2)$   
 b.  $a1 = 1.0 - a1'$ ;  $a2 = 1.0 - a2'$
6.  $a1$  and  $a2$  are now weights for linear interpolation. The smaller the angle between  $d$  and the neighboring vector ( $v1$  or  $v2$ ), the larger the weight.
7. Using the abnormal vectors  $v1'$  and  $v2'$  corresponding to the  $v1$  and  $v2$ , find the vector  $d'$  defining the maximum allowed (yaw, pitch) along the desired gaze vector  $d$ :  $d' = (v1' * a1 + v2' * a2) / (a1 + a2)$
8. Desired gaze length  $l_d = \|d\|$ ; Maximum gaze length  $l_m = \|d'\|$
9. If  $l_d > l_m$ , set  $l_d = l_m$ .
10. Let  $s$  indicate the (yaw, pitch) vector corresponding to the abnormal eye looking straight ahead.
11. The final gaze vector  $g$  is then calculated as:  $g = s + d' * (l_d / l_m)$ . Example vectors  $d$  and  $g$  are illustrated for the case of CN6 in Figure 2.

The same process is performed for an unaffected eye, with the substitution of normal eye vectors for the abnormal eye vectors used in Step 7 (i.e.  $v1' = v1$ ;  $v2' = v2$ ).

Once the final gaze yaw and pitch angles are calculated, the eye does not rotate to these angles instantly, but moves over time. To accomplish this we define the maximal angle the eye can rotate per second and linearly interpolate between the current eye yaw and pitch angles and the desired gaze yaw and pitch angles based on the maximal angle per second and the duration of the current frame.

### 3.2. Communication

Verbal communication between learner and virtual human is accomplished using a natural language approach. The learner wears a wireless microphone which transmits the learner's speech to a speech-recognition module. The speech-recognition module uses a commodity speech-recognition engine (both Dragon NaturallySpeaking 9 and Microsoft Speech have been used). The speech-recognition module outputs text which approximates the learner's speech. This text is matched to

a database of VP responses – VP speech, gestures, or facial expressions. In the CN3 and CN6 scenarios, the VP can understand 1050 different learner queries, and responds with one (or more) of 215 different responses.

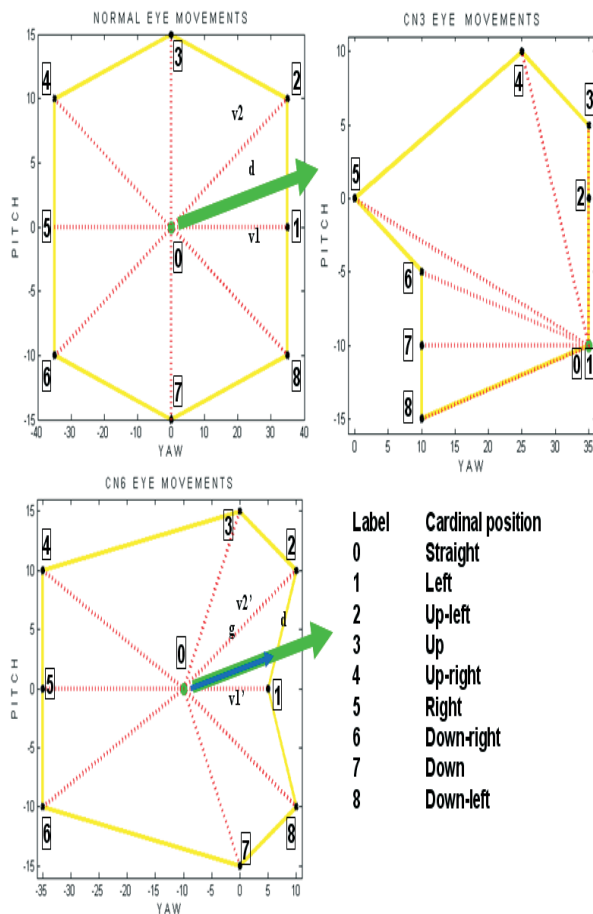


Fig. 2. Virtual human eye movements are defined by a region which represents the maximum yaw and pitch in a given direction. This region is defined by eight cardinal movement directions (dotted lines “1” – “8”) from the central point (“0”), with linear interpolation between adjacent cardinal directions (solid lines). The regions for normal eye movement (*top*) and CN6 affected eye movement (*bottom*) are shown. When the virtual human with CN6 affected eye attempts to look along a direction *d*, the neighboring cardinal vectors *v1* and *v2* are linearly interpolated to find the maximum (yaw, pitch) capable by the CN6 affected eye along vector *d*. This resulting eye movement is indicated by *g*.

### 3.3. Physical Examination

Physical examination of Vic is accomplished using three virtual tools: the ophthalmoscope, hand-and-fingers, and eye chart. These tools are manipulated using a Wiimote, augmented with external 6 degree-of-freedom infrared tracking.

The wiimote was chosen because it is shaped as a hand-held tool and has high degree of freedom control. The wiimote features an array of integrated sensors that are reported at 100Hz update rate over a Bluetooth connection: 11 buttons, 3 orthogonal accelerometers ( $\pm 3g$ ), and a 45-degree field-of-view infrared camera (128x96) that tracks up to 4 points at

1/8 to 1 pixel resolution depending on the size of the infrared point. In addition, the wiimote can display information through integrated LEDs, speaker, and vibration motor. Open source software was used to acquire data from the wiimote across the Bluetooth interface [15]. A summary of the wiimote's potential as an interaction device and descriptions of many applications can be found in the work of Lee [16]. External infrared optical tracking of the wiimote provides the position and orientation of the wiimote at 100Hz update rate and sub-centimeter accuracy.

#### 3.3.1. Ophthalmoscope

An ophthalmoscope is a hand-held tool equipped with a lens for viewing the back of the inside of the patient's eye (the fundus) to determine the health of the patient's retina and look for symptoms of cranial nerve disorders such as retinal hemorrhages. The ophthalmoscope moves with six degrees-of-freedom and its position is mapped one-to-one to the position of the wiimote.

The ophthalmoscope size, shape, and weight are closely approximated by the wiimote, providing passive haptic feedback. As the ophthalmoscope is often held close to the patient's head and sensitive eyes, it is useful to inform the user if they contact the patient with the (virtually) metal and non-sterile ophthalmoscope. Active-haptic feedback is provided in the form of force feedback when the virtual ophthalmoscope makes contact with the virtual human's head. If the ophthalmoscope makes contact with the virtual human's eye, vibratory force feedback is received and the virtual human blinks and jerks his head back.

The ophthalmoscope is typically used to perform two tests: the pupillary reflex test and fundoscopic test. The pupillary reflex test is performed by turning on the light of the virtual ophthalmoscope by pressing the “trigger” button on the rear of the wiimote, and manipulating the wiimote to aim this light into each of the virtual human's eyes (Figure 3 *top*). The fundoscopic test is performed by turning on the light and moving the ophthalmoscope close to the virtual human's eye ( $<8$  cm). When this is detected, an image of the fundus of that eye is displayed above the virtual human's head (Figure 3 *bottom*). This provides a simplistic simulation of the fundoscopic exam, as use of the ophthalmoscope to view the fundus is simplified, e.g., we use a static image of the fundus instead of an ophthalmoscope-orientation-dependent image. However, our goal is not to train the fundoscopic exam, but to allow a learner to obtain the information provided by a fundoscopic exam for use in diagnosing the cranial nerve disorder.

#### 3.3.2. Eye chart

The virtual eye chart is used to test the patient's visual acuity. The eye chart is fixed in 3D space, much as a physical eye chart is affixed to a wall. Rather than the eye chart position and orientation being controlled by the wiimote, a virtual finger pointing to a line on the eye chart is manipulated. The eye chart contains eight lines. To point to a line, the user translates the wiimote vertically. The vertical (Y-axis) position of the wiimote is binned into eight intervals corresponding to the eight



lines on the eye chart. This illustrates the adaptation of user input to specific tool characteristics. The eye chart is used in the visual acuity test. While the virtual finger is pointing to a line on the eye chart, the user is able to ask the patient to read the pointed-to line, e.g. “can you read this line?” The virtual human reads the currently pointed to line if he is able to depending on the CN affected (Figure 6 *top*). With CN3, 4, and 6, the patient can not read any of the lines with both eyes open. The user is able to ask the patient to cover one eye and try again – with one eye closed, the virtual human has 20/20 visual acuity. Alternatively the user can ask the virtual human to report “what is the lowest line you can read?”

### 3.3.3. Hand-and-fingers Gesture Tool

To provide gesture inputs used in neurological exam tests, a virtual hand and fingers tool is provided. The hand moves with six degrees-of-freedom and its position is mapped one-to-one to the position of the wiimote.

Gestures that can be performed using this tool include making a fist, holding between 1 and 5 fingers up, pointing with one finger, and shaking a finger. The hand tool is used in many of the neurological exam tests. Unlike other non-encumbering approaches to tracking a human hand, e.g. computer-vision based techniques, using buttons to indicate the indented hand gesture provides noise-free gesture recognition. I.e., the state of the virtual hand represents both the state of the user’s hand and the hand that the virtual human sees and responds to – there is no ambiguity resulting from gesture recognition error.

**Finger counting test:** The hand can transform from an open hand to a clenched fist. The number of fingers the doctor is holding up can range from 0-5. The up and down arrows on the directional pad of the wiimote are used to raise and lower fingers. To test the patient’s ability to maintain binocular vision in all fields of gaze, the user will hold one or more fingers up and ask the patient to look straight ahead and report “how many fingers do you see?” (Figure 4). If the fingers are held outside of the virtual human’s field of view, he will answer “I can’t see your hand.” For the double vision disorders (CN3, 4, and 6) if the fingers are in view of only one eye the virtual human will report the number of fingers held up (Figure 4 *bottom*); if the fingers are in view of both eyes, the virtual human will report twice the number of fingers held up (Figure 4 *top*). Because of the noise-free gesture recognition, if the virtual human reports twice the number of fingers held up by the virtual hand, the user can be certain that the virtual human is experiencing double vision; there is no ambiguity that the gesture recognition may be malfunctioning.

**Oculomotor (eye movement) test:** By asking the patient to “follow my finger” (alternatively the ophthalmoscope can be used for this test: “follow the light”), the user can test the functionality of the patient’s oculomotor muscles and, correspondingly, cranial nerves that innervate these muscles (Figure 5). The virtual human holds his head still facing forwards, and attempts to follow the position of the finger with both of his eyes. Because the wiimote and finger move in a one-to-one correspondence, the user receives the same kinesthetic feedback as he would in the real-world exam. This correct kinesthetic information is necessary for learning the task of moving the fin-

ger in the shape of an uppercase “H” to test the extremes of the patient’s eye movements.

**Peripheral vision test:** To test the patient’s peripheral vision, the user holds the virtual hand outside of the virtual human’s peripheral vision, instructs the patient “tell me when you see my hand” and then proceeds to move the hand into the patient’s peripheral vision. The virtual human answers “I can see it now” when the finger enters the field of view of either eye. Alternatively, the user can raise one finger on the hand, hold the hand in the patient’s peripheral vision, shake the wiimote, and ask the patient to “tell me when you see my finger shake”. Shaking is detected as changing values in the wiimote’s internal accelerometers.

**Facial sensitivity test:** To test if the patient has feeling in the face, the user can poke the virtual human’s face with one or more fingers and ask “can you feel this”. The user knows when he is making contact with the virtual human’s face because vibratory force-feedback is provided by the wiimote when the fingers or hand collide with the face. Collision detection is performed using the meshes of the virtual human’s head and the hand and finger tool, using the OPCODE Optimized Collision Detection library incorporated in the Ogre 3D rendering engine.

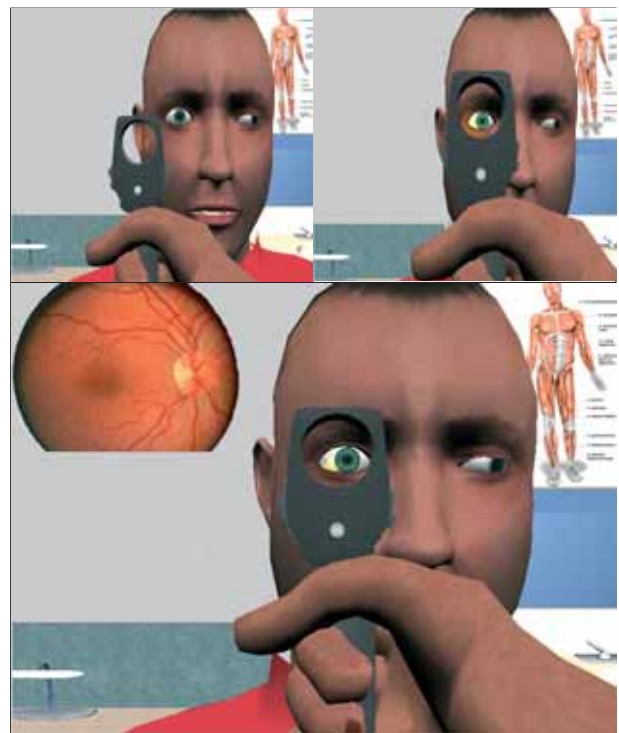


Fig. 3. (*Top*) Testing the pupillary reflex by shining a virtual light in the eye with the ophthalmoscope. (*Bottom*) Performing a fundoscopic test with the ophthalmoscope to check for pathology in the retina that could cause the CN palsy, e.g. diabetic retinopathy.

It is important to note that if a test requires both user speech and tool manipulation, as is the case for all the tests using the hand gesture tool, the simulation module is designed to perform the test asynchronously or synchronously, whichever is appropriate for the test. For example, “how many fingers do you see?” wants synchronous information, so the virtual hu-



Fig. 4. The finger counting test. (Top) with both eyes open, the virtual human with a CN3 affected left eye sees double. (Bottom) by closing an eye, he sees the correct number of fingers.



Fig. 5. Checking the eye movement of a virtual human patient with a left eye affected by CN6 palsy. The left eye can not look to the patient's left.

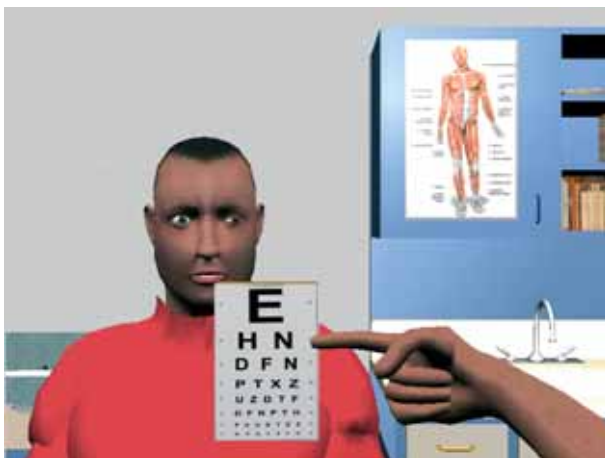


Fig. 6. Testing visual acuity with the virtual eye chart.

man responds (instantly) based on the number of fingers held up on the virtual hand at the time when the simulation module receives the user speech input. However, “tell me when you see my finger shake” and “can you feel this” ambiguously refer to events that could be happening at that point in time or in

the near future, and are handled as asynchronous commands. When one of these utterances is received by the simulation module, it puts the simulation into a state in which it is actively looking for a finger shake or a collision between hand and head. If the finger is shaking, was recently shaking (e.g. within 4 seconds into the past), or begins to shake within the next 10 seconds (and before another command is given by the user or the hand tool is deselected), the virtual human will report that he sees the finger shaking. Allowing for asynchronous events provides more robust communication – e.g. the user does not have to continuously shake the wiimote while asking the question multiple times until the two actions coincide.

#### 4. Patient Vision Feedback

In addition to simulating the doctor-patient interaction of the neurological exam, NERVE incorporates an additional experience to aid learners in understanding how the cranial nerve disorder and associated diplopia affects the patient's life. The patient vision feedback is a real-time experience that allows the learner to view a virtual exam room through the eyes of the patient, providing the learner with firsthand experience of life with double vision and abnormal eye movements.

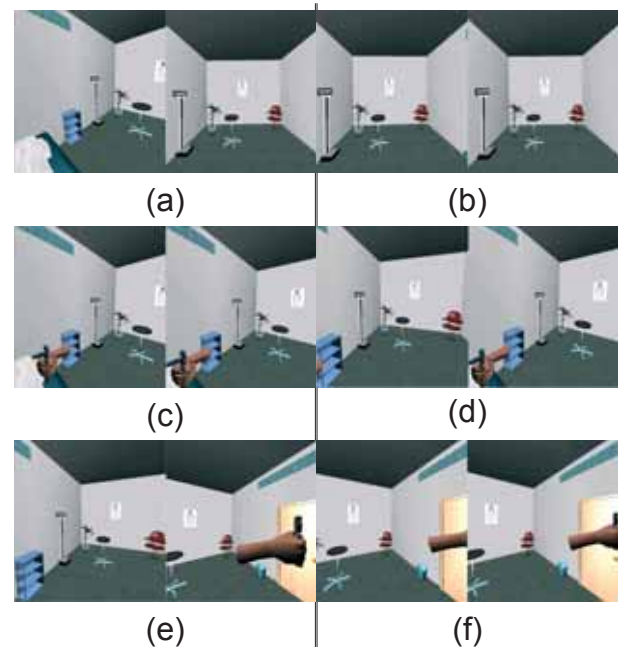


Fig. 7. Patient Vision Feedback (PVF) with a left eye affected by CN3 (a, c, e) and CN6 (b, d, f). Images are taken when looking straight ahead (a, b), down and left (c, d) and to the right (e, f).

The goals of PVF are two-fold: (1) provide the learner with more information for understanding how a specific cranial nerve impacts eye movements and, in turn, vision, and (2) provide the learner with an understanding of how the disorder impacts the patient's vision, how this makes the patient feel, and how this might affect the patient's life. The expected outcomes are (1) that learners will more often identify which cranial nerve is affected and (2) learners will exhibit increased consideration of the patient's wellbeing – specifically the patient's safety. For example: whether it is safe for a patient to drive home from the

clinic. In the user study described in Section 5, the discovered outcomes were that (1) learners were able to identify the cranial nerve affected from experiencing PVF – without examining the patient, and (2) learners who experienced PVF before examining the patient expressed concern that the patient would be unsafe driving a vehicle, while learners who examined the patient without experiencing PVF did not express concern for the patient's safety.

#### 4.3.1. *Prior Work in Motivating Perspective Taking*

The educational construct which is targeted by the 2<sup>nd</sup> aim of VPF (increased concern for patient wellbeing and safety) is that of perspective taking. In taking the perspective of another, one first considers what she knows of the other person's knowledge, senses and experiences. This leads her to an affective understanding of the other – understanding the other's emotions and state-of-mind [17]. The outcome of this process is expression of this affective understanding, through empathy and concern for the other.

Raj developed an after-action-review experience, virtual social perspective taking (VSP), which sought to improve medical students' use of perspective taking in a clinical breast exam scenario [18]. Learners performed breast exam of a virtual human patient using a mannequin and virtual patient hybrid (Mixed Reality Human [19], and then relived their interview and exam from within the body of the virtual human. The learner looked through the virtual human's eyes, seeing what the virtual human saw during the exam – the virtual world and the learner. As the virtual human, the learner heard what the learner had said during the exam and was asked to speak what the virtual human spoke during the exam. The learner embodied the avatar of the virtual human and controlled the pose of the avatar's head. To emphasize that the learner was reliving the experience in the body of the virtual human, the learner could see the movements of his avatar in a virtual mirror. In a study of 16 medical students, residents, and clinicians at the Medical College of Georgia, participants reported that their self-ratings of perspective taking and empathy decreased after experiencing VSP (learners were able to more accurately and critically evaluate their performance) and that self-reported perspective taking and empathy performance improved in a subsequent VP breast exam. Participants also reported that they expected to improve their approach to perspective taking and empathy in future patient interactions.

#### 4.3.2. *Implementation*

To experience the patient's vision, the learner wears a stereoscopic head mounted display (HMD). The virtual exam room is rendered twice, once from the perspective of each of the virtual human's eyes. Each image is fed to a corresponding screen of the stereoscopic HMD, and the job of fusing the images into a stereo view (or experiencing double vision when images can not be fused) is left to the learner's eyes.

During this experience, a second user performs an exam of the virtual human in NERVE (Figure 8). The learner experiences the exam through the eyes of the virtual human. This allows the learner to understand how the patient's eye move-

ment, e.g. when following the second user's finger or ophthalmoscope, affects the patient's vision. The learner experiences correct stereo vision, e.g. when looking down and to the left with CN3 palsy (Figure 7c) as well as double vision, e.g. when looking straight ahead with CN3 palsy (Figure 7a). Alternatively, the learner experiences a pre-recorded exam.

### 5. User Study of PVF Effectiveness

We conducted a user study to evaluate the impact of the patient vision feedback on the learners' ability to diagnose the affected cranial nerve and on the learners' affective performance.

Eighteen medical students with prior experience performing neurological exams of human patients, but no experience with abnormal pathology in an exam of a human patient, were recruited from the 2<sup>nd</sup>-year medical student population at the University of Florida.

To directly evaluate the impact of PVF on participant performance, participants were divided into two groups. Group-PV experienced the patient vision feedback before examining the patient and Group-NPV did not experience patient vision before examining the patient. To provide a similar educational experience to all participants, Group-NPV experienced PVF *after* examining the patient; this interaction was not included in the analysis of the impact of PVF.

#### 5.1. Procedure

Two participants arrived at a time. Each participant completed a background survey assessing their experience with the neurological exam.

The experimenter then explained to both participants how to talk to the virtual human and how to use the Wiimote to manipulate the virtual ophthalmoscope, hand, and eye chart tools. The experimenter explained which tests could be performed on the virtual human (these were also listed on the LCD screen, to the left of the patient). Participants were told that PVF would let them experience the patient's double vision during the exam and that they should attempt to determine, during PVF, which eye and cranial nerve was abnormal.

After receiving instruction, Participant-PV donned a stereoscopic HMD displaying the virtual exam room and Participant-NPV wore a hat augmented with infrared markers used to track her head pose. Participant-NPV viewed the virtual human and exam room rendered on the non-stereoscopic large screen display. By tracking her head pose, the virtual scene is rendered from her perspective, as if the display was a window into the virtual world (Figure 8).

Participant-NPV performed a medical history and exam of a virtual human with a CN6 affected left eye. During this exam, Participant-PV viewed the virtual world, including the tools manipulated by Participant-NPV, through the eyes of the virtual human. This allowed Participant-PV to experience the patient's double vision during an exam, allowing Participant-PV to evaluate the severity of the patient's double vision and the patient's eye movements. Participant-PV was a passive observer; the movement of virtual tools was controlled by Participant-NPV and the speech, actions, and eye movements that Participant-PV experienced were controlled by the virtual human simulation.





Fig. 8. Physical setup of study. The standing participant (Participant-NPV) is performing an exam of the virtual human while the sitting participant (Participant-PV) wears an HMD to view the exam through the virtual human's eyes.

After Participant-NPV completed the history and exam of the virtual human patient with CN6 disorder, Participant-PV removed the HMD and completed the post-patient-vision survey.

Participant-NPV then performed an exam (without taking a medical history) of a virtual human with a CN3 affected left eye. Participant-NPV then completed a post-exam survey.

The participants then switched roles and repeated the procedure, with Participant-NPV experiencing the patient's vision in PVF and Participant-PV performing a history and exam of the CN6 virtual human patient followed by an exam of the CN3 virtual human patient.

The counterbalanced design of Group-PV and Group-NPV's procedures allows us to evaluate the impact, on diagnosis and affective performance, of experiencing a patient's abnormal vision before examining the same patient. Both CN3 and CN6 patients were included to alleviate guessing of the VP's disorder based on the portion of the study that a participant had completed.

## 5.2. Results and Discussion

Two participants, one in each group, expressed that they did not experience double vision at any time during the patient vision feedback. We were unable to determine whether this was due to malfunctioning of the HMD or a peculiarity of the participants' vision. It is possible for the HMD to automatically toggle between non-stereoscopic (left eye duplicated for both left and right eyes) and stereoscopic display; however, the experimenter tested the HMD before each participant and did not note any problems in this regard. However, because these participants did not actually experience the virtual patient's double vision, and were evenly split between the two groups, they were removed from analysis.

### 5.2.1. PVF Provided Sufficient Information to Diagnose the CN Disorder

Nearly all participants in both groups were able to correctly diagnose both the CN3 and CN6 virtual patients through physi-

cal examination (9 of 9 in Group-PV and 8 of 9 in Group-NPV). This was not a significant difference, and thus PVF did not improve the correctness of diagnosis. However, there is evidence that PVF was sufficient for diagnosing the cranial nerve disorder.

Eighty-one percent of participants correctly diagnosed the cranial nerve disorder while viewing PVF. Seven of the eight participants in Group-PV were able to correctly diagnose the virtual patient with CN6 palsy from experiencing patient vision alone (i.e. before conducting an exam of the patient). Additionally, 6 of 8 participants in Group-NPV were able to diagnose CN6 from the patient vision feedback. Although Group-NPV had previously examined a virtual human patient with CN6, they had most recently examined a virtual human with CN3 and were not told what disorder they would experience with patient vision (it could have been CN3, CN6, or other). Overall, 13/16 participants were able to correctly diagnose CN6 from experiencing the patient's vision. This is a significant percentage of the participants (one-way chi-square test:  $\chi^2 = 5.1$ ,  $p < 0.05$ ). This result shows that viewing a (virtual) neurological exam through the eyes of a virtual human patient with cranial nerve palsy provides the information needed to diagnose the cranial nerve disorder affecting the virtual human's eye movements.

From this result, we expect that similar virtual experiences may be able to improve learner performance in diagnosing other cranial nerve disorders – however, CN3 and 6 diagnoses were not difficult enough for learners to need PVF to reach a correct diagnosis.

### 5.2.2. PVF Resulted in Increased Concern for Patient Safety

Affective performance (perspective taking leading to concern for patient wellbeing) was evaluated as expressed (verbal or written) concern for patient safety, i.e. informing the patient that he should not drive a vehicle. Significantly more participants who experienced patient vision before examining the VP (Group-PV) expressed concern that the patient should not drive than did participants who did not experience patient vision before the exam (Group-NPV). Seven of eight participants in Group-PV expressed this concern vs. zero of eight participants in Group-NPV. This is significant at  $p < 0.005$  by Fisher's exact probability test.

Almost all participants who experienced patient vision before the exam expressed concern that the patient should not drive, with five participants expressing this on the post-patient-vision survey, one participant (of the five) directly telling the patient during the exam, and three participants expressing this on the post-exam survey (one participant in this group expressed concern on both the post-patient-vision and post-exam surveys). None of the participants in Group-NPV, who performed the exam before experiencing patient vision, expressed concern that the patient should not be driving either verbally or in the survey.

All participants were equally primed to think about driving, as the patient first began to experience double vision while he was driving home from work: "I was driving home from work and all of the sudden the lines on the road started to cross." However, only those participants who had seen through the

eyes of the patient before assuming the role of the doctor expressed concern for the patient's safety. This indicates that (literally) providing participants with the patient's visual perspective caused the participants to engage in perspective taking. The participants experiencing PVF considered the patient's feelings and the impact of the double vision on the patient's life, and developed a concern for the patient's safety that later (in the role of the doctor) allowed them to identify driving as a danger to the patient. Thus participants' affective performance was improved by providing them with PVF prior to their examination of the VP.

## 6. Conclusions

We have presented a virtual patient-based simulation for increasing developing health professionals' exposure to abnormal physical findings in neurological examination. The Neurological Examination Rehearsal Virtual Environment (NERVE) affords history taking and physical examination of a life-sized virtual human character presenting with double vision as a result of a cranial nerve palsy. Using NERVE, learners develop the skills of collecting information through neurological tests and integrating this information to arrive at a correct diagnosis. The content validity of NERVE has been determined through testing with 32 medical students and neurology residents. Additionally, NERVE incorporates an experience which allows a learner to experience a patient's double vision first-hand. This patient vision feedback (PVF) assists learners in perspective taking, considering the impact of the cranial nerve disorder on the patient's life, and results in increased concern for the patient's safety. These results indicate that NERVE is a promising technology for augmenting a neurology curriculum.

## References

- [1] Shingleton B.J., O'Donoghue M.W. (2000), Blurred vision, *New England Journal of Medicine*, 343/8, 556-562.
- [2] Kutschke P.J. (1996), Taking a history of the patient with diplopia, *Insight* 21/3, 92-95.
- [3] Gelb D.J., Gunderson C.H., Henry K.A., Kirshner H.S., Jozefowicz R.F. (2002), The neurology clerkship core curriculum, *Neurology* 58/6, 849-852.
- [4] Davis L.E., King M.K. (2007), Assessment of medical student clinical competencies in the neurology clinic, *Neurology* 68, 597-599.
- [5] van de Graaf E.S., Felius J., van Kempen-du Sar H., Looman C.W.N., Passchier J., Kelderman H., Simonsz H.J. (2009), Construct validation of the Amblyopia and Strabismus Questionnaire (A&SQ) by factor analysis, *Graefe's Archive for Clinical and Experimental Ophthalmology* 247/9, 1263-1268.
- [6] Comer R.M., Dawson E., Plant G., Acheson J.F., Lee J.P. (2007), Causes and outcomes for patients presenting with diplopia to an eye casualty department, *Eye* 21, 413-418.
- [7] Diplopia: Follow-up [Internet]. eMedicine Ophthalmology; [updated 2008 Sept. 8; cited 2009 Sept. 15]. Available from: <http://emedicine.medscape.com/article/1214490-followup>
- [8] Schon F., Hart P., Fernandez C. (2002), Is clinical neurology really so difficult?, *Journal of Neurology, Neurosurgery, and Psychiatry* 72, 557-559.
- [9] Moore F.G.A., Chalk C. (2009), The essential neurologic examination: What should medical students be taught?, *Neurology* 72/23, 2020-2023.
- [10] van Meurs W.L., Good M.L., Lampotang S. (1997), Functional Anatomy of Full-scale Patient Simulators, *Journal of Clinical Monitoring and Computing* 13/5, 317-3247.
- [11] Limbs and Things – Eye Examination Simulator [Internet]. Limbs and Things Co.; [cited 2009 Oct. 4]. Available from: <http://www.limbsandthings.com/uk/products.php?id=96>
- [12] Lasso R., Keltner J., Henderson G. (2002), Virtual patient/eye simulator – Evolution of a futuristic teaching tool, *Proceedings of the AMIA 2002 Annual Symposium*, 1074.
- [13] Ramirez-Lassepas M., Espinosa C.E., Cicero J.J., Johnston K.L., Cipolle R.J., Barber D.L. (1997), Predictors of Intracranial Pathologic Findings in Patients Who Seek Emergency Care Because of Headache, *Archives of Neurology* 54/12, 1506-1509.
- [14] Bickerstaff's Neurological Examination in Clinical Practice, 6th Edition, ed. J.A. Spillane, Wiley-Blackwell 1996.
- [15] Managed Library for Nintendo's Wiimote [Internet]. Brian Peek; [updated 2007 Mar. 14; cited 2008 Oct. 31]. Available from: <http://blogs.msdn.com/coding4fun/archive/2007/03/14/1879033.aspx>
- [16] Lee J.C. (2008), Hacking the Nintendo Wii Remote, *IEEE Pervasive Computing* 7/3, 39-45.
- [17] Gehlbach H. (2004), A New Perspective on Perspective Taking: A Multidimensional Approach to Conceptualizing an Aptitude, *Educational Psychology Review* 16/3, 207-234.
- [18] Raij A., Kotranza A., Lind D.S., Pugh C.M., Lok B. (2009), Virtual Experiences for Social Perspective Taking, *Proceedings of IEEE Virtual Reality 2009*, Lafayette, LA, Mar. 14-18, 2009, 99-102.
- [19] Kotranza A., Lok B., Deladisma A., Pugh C.M., Lind D.S. (2009), Mixed Reality Humans: Evaluating Behavior, Usability, and Acceptability, *IEEE Transactions on Visualization and Computer Graphics* 15/3, 369-382.
- [20] Williams, R. (2004), Have Standardized Patient Examinations Stood the Test of Time?, *Teaching and Learning in Medicine* 16(2), 215-222.
- [21] Liaison Committee on Medical Education. Website visited on September 19th, 2006. (<http://www.lcme.org/function-slist.htm>).

## TOWARDS THE DEVELOPMENT OF A GOLD STANDARD FOR AUTHORING, INTRODUCING AND SUSTAINING VIRTUAL PATIENTS IN MULTI-CAMPUS CLINICAL EDUCATION ENVIRONMENTS

DAPHNE VASSILIOU<sup>1,5\*</sup>, KATARINA ARNRUP<sup>1,5</sup>, OLLE BROSTRÖM<sup>1,5</sup>, M. EVANS<sup>2,5</sup>,  
M. RUIZ<sup>2,5</sup>, K. HAGWALL<sup>3,5</sup>, P. HENRIKSSON<sup>3,5</sup>, M. SKÖLD<sup>4,5</sup>, RONNY SEJERSEN<sup>5</sup>,  
NABIL ZARY<sup>5</sup>

<sup>1</sup> Stockholm South Hospital, Sweden, <sup>2</sup> Karolinska University Hospital Huddinge, Sweden, <sup>3</sup> Danderyd Hospital, Sweden, <sup>4</sup> Karolinska University Hospital Solna, Sweden, <sup>5</sup> Karolinska Institutet, Sweden

**Abstract.** The use of Virtual Patients (VPs) in medical education is increasing but they tend to become author-dependent. Research about the usual context of clinical courses distributed over several hospitals and with several teachers has not been addressed. The purpose of the study was therefore to develop a model for authoring, implementing and sustaining the use of VPs in a multi-campus clinical educational environment.

Using a cyclical action research methodology, we studied the introduction of VPs in teaching medical students studying at four different university hospitals. Four teachers created five VPs during a period of eighteen months. Sixteen teachers used the VPs in their courses. Two teachers, beside the original authors, worked with further improvement of the cases.

The model developed is composed of four phases (readiness, initiation, introduction and maintenance). This model produced an incentive for teachers to create and improve VPs. This could be likened to authoring clinical guidelines, which are also passed on and improved by generations of clinicians.

It is crucial for the continued use of VPs that issues of authoring and sustainability are addressed at an early stage. The aim of the proposed model is to systematically ensure that all issues are addressed in a timely fashion such as making the teaching team feel shared ownership and responsibility for the VPs.

**Key words:** Virtual Patient, Authoring, Implementation, Sustainability

### 1. Introduction

Virtual patients have been used for educational purposes since the 1970s however their perceptible introduction in medical education is recent [1]. The virtual patient research field has started to increase the empirical base for what the VPs are best suited for [2], best practices for designing VPs [3, 4], models for user-friendly author tools [5], taxonomies for how to describe VPs in a systematic manner [6] and also technical standards in order to share VPs between institutions [7, 8].

Research about the usual context of clinical courses distributed over several hospitals and with several teachers has not been addressed. Issues regarding what is the best process to introduce VPs in such context and who should be involved in the authoring of the VPs need to be investigated. Furthermore a normal situation in many clinical courses is the high turn-over

of faculty. Strategies to ensure that the VPs are improved and its use sustained in such setting are lacking.

The purpose of the study was therefore to develop a model for authoring, implementing and sustaining the use of VPs in a multi-campus clinical educational environment.

### 2. Material and Method

#### 2.1 Context of the study

The Clinical Diagnostics (currently: Disease and Illness II) course at the medical programme at Karolinska Institutet was chosen for the study. The aim of the course is to give the students the basic skills required in order to reach a diagnosis when they, as professionals, are consulted by a fellow human who is concerned about his/her health. The course is the first one to focus on clinical everyday practice and – in both its former and current form – comes at the time when students

\* Contact author: Daphne Vassiliou, daphne.vassiliou@sodersjukhuset.se

are preparing to start their clinical rotations. For that reason, the course is located in the different teaching hospitals which collaborate with the Karolinska Institutet. All four hospitals teaching the course were involved in the project.

## 2.2 Participants

### Faculty

All four course directors from the different hospitals, all with a long experience of managing the course in Clinical Diagnostics, were involved in this study. The course directors appoint clinical assistants, the number of which varies in the different hospitals, who are involved in teaching and the logistics of the course. The course directors as a rule keep their position for many years, whereas the clinical assistants are replaced every one to two years. All clinical assistants teaching the course were involved in this study. Every course director works in close collaboration with a course administrator, who contributes to the implementation of innovations in the course curriculum.

### Technologists

The course directors and clinical assistants worked in close collaboration with the Virtual Patient Lab at the Department of LIME at Karolinska Institutet. Experts on virtual patient systems were consulted throughout the study.

### Students

Students starting their clinical rotations at the medical programme at Karolinska Institutet choose between four different locations to do their clinical practice: Karolinska University Hospital at Solna or Huddinge, Danderyd Hospital and Stockholm South Hospital (Södersjukhuset). All are located in Stockholm, Sweden.

## 2.3 Method

We applied a cyclical action research methodology. Five phases were conducted within each research cycle. Initially, a problem is identified and data is collected for a more detailed diagnosis. This is followed by a collective postulation of several possible solutions, from which a single plan of action emerges and is implemented. Data on the results of the intervention are collected and analyzed, and the findings are interpreted in light

of how successful the action has been. At this point, the problem is re-assessed and the process begins another cycle. This process continued until the complete model was created.

## 3. Results

The model (Figure 1) is composed of four phases (readiness, initiation, introduction and maintenance). The first three phases are linear and occurs the first time virtual patients are introduced in a course. The last phase iterates each time the course is delivered.

### 3.1 Readiness phase

The authors were faced with the challenge of integrating a large amount of diverse theoretical knowledge in a way that is easy for the students to grasp. The challenge is not a new one. Nevertheless, two factors make the challenge greater for today's medical teachers: as the sheer amount of knowledge increases, the teachers basically have to teach more in less time. Also, an increasing ethical sensitivity about the role of patients in clinical training has created the need for alternative training techniques.

At the beginning of the study, the duration of the course (Clinical Diagnostics) was 11 weeks. During the past few years, the Karolinska Institutet has done a major revision of the curriculum of the medical programme [9]. Since the autumn semester of 2009, the course is the third and last part of a curriculum entity called Disease and Illness II, and is assigned 7 weeks. The course now is immediately preceded by courses in microbiology, immunology and clinical pathology. The challenge was to help the students focus on integrating all the pre-clinical knowledge about the different organ systems they have acquired during the first three years of their studies and implement it in their clinical skills.

A system with large possibilities of integrating data from clinical chemistry, physiology, radiology, microbiology and combine them with taking patient history and doing a clinical assessment was identified in the Web-SP system [5].

### 3.2 Initiation phase

Even though the initiative for the implementation of the Web-SP system was taken by one of the teaching hospitals, it was soon evident that the system would be used and assessed in all hospitals teaching the course. This presented with a challenge as the hospitals, even though located in the same greater city area, are not geographically close to each other and only one

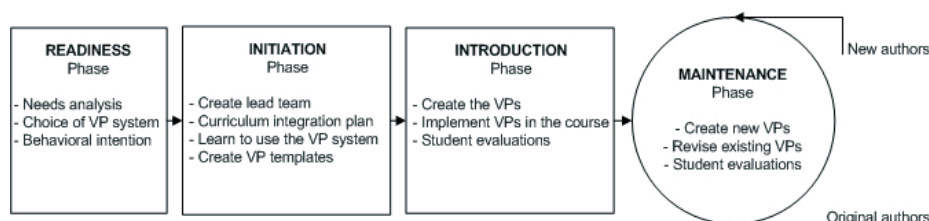


Fig. 1. Model for authoring, implementing and sustaining the use of VPs in a course



of them is in the vicinity of the core facility. It was decided that all immediately involved – i.e. the course directors, at least one of the clinical assistants, a learning technologist and representatives from the core facility when possible – were to meet on regular basis to discuss progress, current problems and set up a work agenda.

The first such meeting took place in November of 2007. The medical teachers were introduced to the Web-SP system and an agreement was reached to try and create cases as soon as possible. Problem areas were identified: the main concern was that the existing Web-SP template was not sufficient for the needs of the course. A major revision was needed, and even though some teachers tried to proceed in creating cases with the existing template it was soon agreed that a new template had to be created, in a male and female version.

In the meanwhile, the project was presented to the departments of the subjects which we aimed to integrate. Course directors for microbiology, bacteriology, radiology, pharmacology among others were informed during teachers meetings at the Karolinska Institutet and their views and ideas were taken into consideration.

The work with creating the patient template was completed, in its first version, in April 2008. Great care was taken so the template resembled the possibilities the student has in real life when searching for a diagnosis. In taking patient history, the case creator has a large variety of questions to choose from. The Web-SP template system categorises questions under different organ systems and the authors aimed at making the interrogation resemble reality as much as possible. The different categories cover all information the student has to learn to assess, such as co morbidity and social situation but also the patient's own speculation and fears about his/her condition. In clinical examination, the Web-SP template was provided with a "perfectly healthy" exam. All of the template's 25 hot spots were examined and the findings listed, none of which were pathological.

An extensive selection of laboratory and imaging diagnostics had to be provided in order to maintain semblance to real life. The authors used the Karolinska University Hospital/Karolinska University Laboratory as a guide in categorising the diagnostic procedures. In particular, the case creator has, in the template, the possibility to choose from laboratory testing for clinical chemistry, immunology, transfusion medicine, inherited metabolic diseases, bacteriology, virology, biopsies for clinical pathology and cytology, a variety of the most common endoscopic procedures and radiological imaging techniques, clinical physiology and neurophysiology. The template resembles clinical reality, so the possibility of bedside-testing (simple procedures and tests that can be performed at the ward/outpatient unit of a hospital) is also provided.

The template was created by clinical assistants in close collaboration with and supervision by a learning technologist. Thus, the system allowed for "laymen" to create cases, which is something we consider of significant importance.

### 3.3 Introduction phase

Once the template versions (male/female) were created, each of the four hospitals was assigned the creation of one patient case. Since the different course directors/clinical assistants

are practicing in various specialties, they proceeded in creating cases in their respective fields, which was natural. The first two cases, illustrating patients suffering from Crohn's disease and multiple myeloma respectively, were tested on the four hospitals during the autumn term of 2008. In the spring of 2009, all four hospitals had contributed with each their case and students in all hospitals were given access to the four patient cases. During the spring term of 2009 an additional case was completed.

### 3.4 Maintenance phase

The VPs were authored by the clinical assistants of each teaching hospital, under the supervision of the course director. Since the clinical assistants usually return to full-time clinical practice after a period of one to four terms, the need to sustain the cases, improve them and pass them on, as well as continually introducing new colleagues in four different hospitals to the Web-SP system presented a challenge. As the platform itself was revised and improved, and new suggestions came from teachers and students, cases created by colleagues that had left the team had to be altered. Every case is considered the property of its author and that had to be taken into consideration when changes were made. The group continued to meet regularly, twice each semester, in order to discuss problems and find solutions.

A first agreement was reached in September 2009. A consensus based process involving the teachers and representatives from the core facility including a learning technologist resulted in that teachers accepted editing of their VP by peers. The case format was altered so that both the original authors and those having contributed to and revised the case would be evident to the student working with the case. The original authors "relented" access to the case format on condition that only other clinical assistants, competent in their area of expertise, would be the ones altering and adjusting the cases. The "heirs" were in the same way encouraged to improve the cases they "inherited" since their contribution could be tracked. Also, this provided an incentive for all teachers to create cases as their legacy would be still alive and cared for long after they had left the course.

The role of the learning technologist was re-assessed during the meetings leading to the consensus. Even though the Web-SP system does not require extensive computer skills, an introduction is needed before the new teachers start using it and the learning technician is involved right from the start to avoid unnecessary problems.

## 4. Discussion

Implementing VPs in medical teaching often involves a large number of teachers in several hospitals. We found that regular meetings are crucial in keeping the process alive. The first, vital, step in creating VPs suitable for the needs of the students is to create a healthy platform. Obviously, the platform has to have a male and female version, and be as detailed as possible. The platform has to be reviewed and accepted by the group and all potential adjustments and improvements have to be made before the group proceeds in creating the patient



cases. One or a couple of teachers from the group can be responsible for creating the healthy platforms as long as they are constantly and thoroughly assessed by the rest of the group. With a solid introduction and constant support by the learning technician, a clinical teacher can create a platform without any special computer skills.

After the platform is complete, the creation of patient cases is appointed to the different members of the teaching group, taking into consideration their personal areas of expertise. Cases can be created by one or several teachers in collaboration. It is of crucial importance that the cases are presented for the whole group and suggestions from all teachers are taken into consideration before making the cases available to students. If the case involves areas of expertise that the author is not totally familiar with, other specialists have to be consulted. A university hospital environment makes it easier for case creators to access all areas of expertise.

It is our experience that the most suitable VPs for medical education are created by medical teachers themselves. The VP platform should be easily accessible by the computer layman and easy to navigate if clinicians are to design any cases on their own. The Web-SP platform fulfilled the criteria. A certain complexity is to be expected when creating life-resembling cases. The role of the learning technician is crucial in introducing the platform to new users, keeping users updated, helping with technical problems and troubleshooting. Most importantly, the learning technician acts as a link between users and software developers, informing each group of the other's ideas and needs. Optimally, the learning technician is part of a core facility specialising in educational tools. Their expertise is needed for keeping the system alive, introducing updates and new versions and contributing with new ideas from the educational field.

Teachers should be encouraged to create new cases and edit the existing ones when needed. We have seen that teachers are more active in using VPs when they have been involved in the creative process. With the learning technician helping introduce the system and support from course directors, it is feasible to engage a large proportion of the teachers in the VP-process, not just an "elite". Teaching with the help of VPs is, in our opinion, a group project, hard to implement by the solitary teacher. It is also of great importance that the course directors are involved in the process.

The group involved in and responsible for the VPs in the course curriculum should interact on regular basis. Regular meetings and contact via email in order to assess progress made, define problems and work out solutions.

The question of sustaining the cases was addressed during the creation process. The author of a case in the Web-SP platform has sole access to the details of the case and no alterations can be made by anyone who does not identify themselves to the system as the original author. In order for

prospective authors to feel that their ownership of a case is not challenged by future adjustments, we agreed that author contribution would be evident in the presentation of a case, as well as improvement and updates. That model produced an incentive for teachers to create and improve VPs. This could be likened to authoring clinical guidelines, which are also passed on and improved by generations of clinicians.

## 5. Conclusion

It is crucial for the continued use of VPs that issues of authoring and sustainability are addressed at an early stage. The aim of the proposed model is to systematically ensure that all issues are addressed in a timely fashion such as making the teaching team feel shared ownership and responsibility for the VPs.

## 6. References

1. Ellaway R.H., Poulton T., Smothers V., Greene P. (2009), Virtual patients come of age. *Medical teacher* 31(8): 683-684.
2. Cook D.A., Triola M.M. (2009), Virtual patients: a critical literature review and proposed next steps. *Medical education* 43(4): 303-311.
3. Bearman M., Cesnik B., Liddell M. (2001), Random comparison of 'virtual patient' models in the context of teaching clinical communication skills. *Medical education* 35(9): 824-832.
4. Huwendiek S., Reichert F., Bosse H.M., de Leng B.A., van der Vleuten C.P., Haag M., Hoffmann G.F., Tonshoff B. (2009), Design principles for virtual patients: a focus group study among students. *Medical education* 43(6): 580-588.
5. Zary N., Johnson G., Boberg J., Fors U.G. (2006), Development, implementation and pilot evaluation of a Web-based Virtual Patient Case Simulation environment – Web-SP. *BMC medical education* 6: 10.
6. Huwendiek S., de Leng B.A., Zary N., Fischer M.R., Ruiz J.G., Ellaway R. (2009), Towards a typology of virtual patients. *Medical teacher* 31(8): 743-748.
7. Zary N., Hege I., Heid J., Woodham L., Donkers J., Kononowicz A.A. (2009), Enabling interoperability, accessibility and reusability of virtual patients across Europe – design and implementation. *Studies in health technology and informatics* 150: 826-830.
8. Kononowicz A.A., Heid J., Donkers J., Hege I., Woodham L., Zary N. (2009), Development and validation of strategies to test for interoperability of virtual patients. *Studies in health technology and informatics* 150: 185-189.
9. Välkommen till läkarprogrammet vid Karolinska Institutet [<http://courses.ki.se/utbildningsprogram/Lakare/start sida>].

## STANDARDIZED AND EXTENSIBLE JAVASCRIPT-API FOR LOGGING FUNCTIONALITY FOR THE MVP PLAYER

JÖRN HEID, FRANK HESS, SIMONE HUBER, MARTIN HAAG

*University Hospital Heidelberg, Germany*

**DESCRIPTION:** The MedBiquitous Virtual Patient (MVP) specification option uses the SCORM 2004 package to communicate with the learning management system (LMS). SCORM offers a universal API for tracking learner progress like completion status or received credit points. However, the logging possibilities are insufficient for advanced analysis e.g. for formative assessment.

Tasks like visualizing learner tracks or generating statistics of logging data for extensions to the MedBiquitous standard, like QTI knowledge questions, were not supported or could only be individually implemented by each player implementation.

The standardization of the MVP allows the definition of a standardized log API in JavaScript for logging on the LMS or external server, covering all MVP actions. The API offers the possibility to plug in different providers where SCORM is just one of many. A provider can implement features to visualize the learner's progress in different detail levels for formative assessment purposes or aggregate the log data to help to improve the VP.

A MVP player will only have to implement calling a single logging API, enabling advanced analysis functionality when a suitable implementation is plugged in. With this a plugin can use the data from any MVP conformant player.



## HOW DUNGEONS & DRAGONS MADE US BETTER VPS: RANDOMIZING PHYSIOLOGICAL DATA TO RAPIDLY PRODUCE 97 CLINICALLY REALISTIC VPS

JANET TWOREK, MIKE PAGET, KEVIN McLAUGHLIN, BRUCE WRIGHT

*Undergraduate Medical Education, Faculty of Medicine, University of Calgary – Calgary, Canada*

**Abstract:** Creating multiple clinically realistic virtual patients (VPs) is a daunting, time-consuming process whereby time saved with a basic template still requires the end-user to populate physical exam, laboratory investigations and physiological data specifically to the nuances of each case. Within the gaming domain, it is common to populate multiple characters within a game by randomizing a range of values or characteristics (e.g. eye colour, height, weapons). Transferred to the clinical context, the ability to randomize all laboratory and other investigation results to default within the range of accepted physiological parameters for each finding allowed the University of Calgary to rapidly create ninety-seven VPs with clinically appropriate alphanumeric normal values. Using spreadsheet and database software, randomization was achieved by establishing the range of normal laboratory results. In addition, patient background, such as marital status, occupation, and so forth were also generated for each VP. These data-populated VPs were then imported into Open Labyrinth, where Subject Matter Expert time was condensed to providing abnormal findings to fit the context of the clinical presentation and desired diagnosis. The combination of common office productivity software and an open source VP platform allows others to leverage the same process for local curricular VP-based programs. This technique also optimizes programmer, instructional designer and subject matter expert time commitments to the project.

### Introduction

Creating a virtual patient (VP) takes time – upwards of 33 hours (Hanebeck, Tonshoff, & Huwendiek, 2009), or even as high as 100 hours each (Huang, Reynolds, & Chandler, 2007). For curricular programs looking to build a number of virtual patients for frequent use in curriculum events or evaluation, the effort to create an adequate volume of virtual patients may be a significant investment – for developers, as well as subject matter experts.

Methods to save time in creating virtual patients include the use of templates, repurposing existing virtual patients (Frey, Hege, Hinske, & Fischer, 2009), and sharing existing VPs with other institutions or groups (Balasubramaniam, Poulton, & Huwendiek, 2009). The sequential build approach these methods engage is time consuming. Regardless of the congruence of data categories, each VP content must be (re-)created and/or proofread independently, contributing to development time. For example, in early iterations of VP creation at the University of Calgary, subject matter experts provided single cases (with patient identifiers removed) from their clinics, which programmers and instructional designers transferred into the VP template. This was inefficient for VP creation for several reasons. First, dialogue segments with the patient are not represented in the extracted version of the patient chart; the instructional designer

and programmers had to create patient stories or responses to questions “asked” of the VP. Second, the majority of lab or investigation findings typically available in the extracted chart provided by the SME were abnormal. Normal values for other parts of the interview had to be re-created based on programmer or instructional designer knowledge, or through consultation with a subject matter expert.

Concurrently, the fidelity of VP content to real patients was of concern. In some VPs, users simply encounter the term “normal” when the physical exam or laboratory finding is not abnormal. This approach does not provide actual results or lab values that the student would review and interpret with real patients in clinical settings. One goal at the University of Calgary is to provide a collection of ninety-seven VPs that include as much real patient data as possible in order to challenge the medical student in an online case experience as equally comparable to clinical encounters. A notable constraint is development time to create realistic laboratory, investigation or physical exam values for each diagnosis or case, in addition to accurate patient verbal responses on presenting complaint and social history. Subject matter expertise is needed, but the pool of physicians to draw from is not readily available throughout the time investment required to achieve VP content goals.

Within the online and video gaming domain, it is common to populate multiple characters within a game by randomizing

a range of values or characteristics (e.g. eye colour, height, weapons) (Pound, 2010; Wizards RPG Team, 2008). In Dungeons & Dragons, for instance, as a player moves to a new venue, characters need to be rapidly created to populate this new space. Creating a game environment that is at once rapidly generated but free of dull homogeneity is difficult. The Dungeon Masters guide (Wizards RPG Team, 2008) provides an example of descriptors for patrons at a pub, randomized with the role of the dice. This model is reminiscent of the goal of adding realistic depth to otherwise generic profiles of VPs.

Transferred to the clinical context, the ability to randomize all social history, laboratory, and other investigation results to default within the range of accepted physiological parameters for each finding allows VP templates to be quickly populated with actual alphanumeric values instead of a generic term (e.g. "normal") or general normal value (e.g. blood pressure of 120/80). This article will discuss the method employed to randomize data to VP templates for subject matter expert proofreading and final VP publication to the server.

## Methods

This section will discuss the specific steps to creating the data sets and randomization of values to the VP template. In addition, the overall process for creating VPs through data insertion to proofreading to publication will be elucidated.

The VP template employed by the University of Calgary follows a clinical case format that is grounded in the doctor's perspective of the patient interview (Higgs & Jones, 2008; Schwartz & Elstein, 2008). Section headers reflect standard patient chart headings (e.g. history of present illness, social history, physical exam, etc). Sections are constructed around the standard questioning approach University of Calgary (Grant, 2009) as well as the laboratory investigations available through the local health region laboratory service. Each VP section must be populated with data in order to create a complete VP.

## Obtaining Data for Randomization to VPs

To create VPs which portray patients with realistic life stories and clinical incidence of disease, personal characteristics and population descriptors must be assembled. Many data sets are readily available online through population statistics or lists of common property. For example, name registers and lists of popular baby names by birth year (e.g. <http://www.behindthename.com/top/>) provide long lists of names, including some statistical insights regarding the incidence and prevalence of specific names. Such data may then be inserted into a table within a database; in our case, Microsoft Access. Data may then be stored in the tables for later insertion into the VP, or require further sorting. In the case of creating names for VPs, first and last names from online sources were randomly re-assigned within the database tables to create new first and last name combinations for each VP.

Creating realistic family histories and patient "life stories" for the social history sections of each VP requires multiple categories of personal information (e.g. present employment, name of pet, etc). Rich sources of population descriptors exist

online and were drawn from to create personal information for each VP. To construct family histories of illness and disease, the top five statistically most prevalent causes of death were obtained from provincial and national data available from Canadian and American-based sites (e.g. <http://www.phac-aspc.gc.ca/publicat/lcd-pcd97/index-eng.php>). Gender-specific morbidities (e.g. ovarian cancer) were removed and replaced with illnesses and diseases affecting both males and females. Occupations and length of time employed were created from provincial wage information (e.g. <http://www.alis.gov.ab.ca/WAGEinfo>). It is even possible for VPs to own pets, as kennel club registries provided ample data from which to construct species of pets to be later assigned to some VPs (e.g. <http://www.westminsterkennelclub.org/>). The same procedure – identifying an aspect of a patient's social history, finding a verified source of data lists on this same aspect, and inserting into a table within a database – was repeated for every element of the social history section of the patient interview.

Laboratory investigation and physical exam results were also constructed in a similar manner. Normal physiological ranges of most laboratory results are published online through the health region's laboratory service (e.g. <http://www.calgary-labservices.com/LabTests/>). Each laboratory investigation corresponds to one table within the database; the normal physiological range values form the possibilities for laboratory results that may be assigned to each VP. Physical exam results were obtained from the University of Calgary physical examination guide. A subject matter expert (i.e. faculty leader in physical examination, patient communication and diagnostic reasoning) reviewed and approved the possible laboratory and physical examination outcomes listed in the database tables to ensure their accuracy and fidelity to clinical encounters.

## Creating a Virtual Patient – normal values

The process of creating a virtual patient from a collection of data tables assigns data from a collection of tables in a database to one common table (the VP "template" table). The VP template described earlier contains questions in each section that must be populated (see Figure 1). The VP template has been converted to "database format", where each question in the template is a line item in the VP "template" table in the database. Data is drawn from each of the patient characteristic tables (e.g. employment, length of employment, pet) and assigned to fill the question on the VP template master table. See figure 2 for table relationships in the database. The result is the database table for one VP is filled with values for every question in every section of the patient interview. The randomization of values from normal ranges (e.g. lab investigations) or from the random selection of individual values from lists (e.g. names, pet names, causes of death) results in each VP being different from the next. As the assignment of normal values to the VP template table occurs rapidly and in concert with the assignment of values to other VP template tables, multiple VPs can be quickly created.

Once data is assigned to the template, it is exported to Microsoft Excel (see Figure 3). Individual VPs may be assigned to individual spreadsheets, or several VPs may be assigned each to their own tab within the spreadsheet.



## Creating a Virtual Patient – abnormal values

For specific diagnoses to be made, individual laboratory, physical exam and even social history values collectively paint a picture of cues and patterns related to the underlying illness or disease in a patient (Klein, 1999; G. R. Norman, 2005; G. R. Norman, 2006). Once a VP template is populated from the database and exported into Excel, a subject matter expert (often, a generalist physician or a specialist dedicated to teaching in the undergraduate curriculum) reviews the output data. He or she then, conscious of the final diagnosis for the VP, alters specific normal values to be abnormal, in fitting with the case. He or she also alters any normal values that need to be slightly higher or lower within a normal range to reflect the disease (e.g. elevated cholesterol value for a patient with thyroid issues). Social history or patient dialogue is also adjusted to be consistent with the disease (e.g. if the diagnosis is cirrhosis of the liver due to excessive drinking, social history reflects excessive drinking and/or slurred speech – as the case merits).

## Publishing the Final Virtual Patient

Once the subject matter expert is satisfied with the VP, the programmer imports the data from the Excel spreadsheet into the database in Open Labyrinth, an open source software for creating VPs. Each question and section header in the Excel spreadsheet maps 1:1 with nodes in the Open Labyrinth VP interface. The result after import is a series of nodes, all connected in order, within Open Labyrinth, to form a final user-navigable VP. The URL to the published VP is sent to the subject matter expert for proofreading; any adjustments are noted via email and made by the programmer. The final published version of the VP is then available for curricular implementation and student use.

Notably, having access to open source VP software is a key component facilitating the rapid creation of VPs. The open source structure of the OpenLabyrinth framework allows direct access to its SQL Server database. Thus, direct data transfer between productivity software, commonly accessible database software, and the VP software is possible.

## Results and Discussion

The process employed at the University of Calgary permitted multiple VPs created in rapid succession. Each VP has a realistic life story, lab and physical exam values, and a clinically relevant profile that should permit students to arrive at the intended diagnosis. Further research into the diagnostic accuracy achievable through use of VPs is needed (Cook, 2005; Cook & Triola, 2009).

A key anecdotal result was the time taken for subject matter experts to create, edit, and proofread each VP. Initially, faculty would edit one VP at a time to provide abnormal results. These faculty were amazed at the short editing time – self-reported at approximately 30 minutes per VP. Those faculty involved with creating multiple VPs requested two to three VPs be exported from the Access database into separate tabs on the same spreadsheet. Side-by-side editing reduced VP creation

time to approximately 45 minutes for two VPs (self-reported by faculty). Side-by-side editing was also noted to be particularly valuable for diagnoses within the same clinical presentation (e.g. cranial arteritis and tension headache under the clinical presentation of headache), as it permitted faculty to focus on the convergences and dissimilarities between cases with similar profiles. Collectively, the process for editing VP content on spreadsheets for import into the final user interface has more strategically engaged and occupied busy clinicians in the creation of VPs.

Lastly, the rapid creation of VPs through templates and database transfers may have broader appeal. Schools without the programming or subject matter expert resources to support the sequential creation of VPs, or who lack access to large shared VP sources, or have local program-specific needs (e.g. integrated rural clerkship, three-year medical school), may find the aforementioned approach appealing and accessible. Schools with existing VP programs may continue to expand their repertoire of VPs using the approach described. There may also be lessons here that may be leveraged for larger collaborative projects that cross languages and cultural contexts (e.g. eViP).

## Conclusion

Prior gaming experience has inspired the invaluable conceptualization of rapid detailed character creation for VPs. Leveraging commonly available productivity and database software, with the open source structure of Open Labyrinth, has facilitated the data transformation of randomized and edited data sets into multiple clinically realistic VPs. The time commitment of subject matter experts, instructional designers, and programmers has been reduced to make the requirement of producing large numbers of viable VPs possible for use in medical school curricula. Medical schools interested in adopting VPs, as well as schools with existing VP programs, may choose to leverage the lessons here to optimize their VP creation process.

## References

1. Balasubramaniam, C., Poulton, T., Huwendiek, S. (2009), Repurposing existing virtual patients: An anglo-german study. *Bio-Algorithms and Med. Sys.*, 5(9), 91-98.
2. Cook, D. A. (2005), The research we still are not doing: An agenda for the study of computer-based learning. *Acad. Med.*, 80(6), 541-548.
3. Cook, D. A., Triola, M. (2009), Virtual patients: A critical literature review and proposed next steps. *Med. Educ.*, 43(4), 303-311.
4. Frey, C., Hege, I., Hinske, P., Fischer, M. R. (2009), Repurposing virtual patients within the electronic virtual patient (eViP) project. *Bio-Algorithms and Med. Sys.*, 9. Retrieved from: [http://www.bams.cmuj.krakow.pl/index.php?option=com\\_content&task=view&id=180&Itemid=63](http://www.bams.cmuj.krakow.pl/index.php?option=com_content&task=view&id=180&Itemid=63).
5. Grant, V. (2009), Physical exam guide. Unpublished manuscript.
6. Hanebeck, B., Tonshoff, B., Huwendiek, S. (2009), Repurposing virtual patients for clinical reasoning: Development of a guideline and assessment of time and effort. *Bio-Algo-*

- rhythms and Med. Sys., 9. Retrieved from: [http://www.bams.cmuj.krakow.pl/index.php?option=com\\_content&task=view&id=176&Itemid=63](http://www.bams.cmuj.krakow.pl/index.php?option=com_content&task=view&id=176&Itemid=63).
7. Higgs, J., Jones, M.A. (2008), Clinical decision making and multiple problem spaces. In: J. Higgs, M. A. Jones, S. Loftus, N. Christensen (Eds.), Clinical reasoning in the health professions (3rd ed., pp. 3-17). New York: Elsevier.
  8. Huang, G., Reynolds, R., Chandler, C.L. (2007), Virtual patient simulation at U.S. and Canadian medical schools. Academic Medicine, 82(5), 446-451.
  9. Klein, G. (1999), Sources of power: How people make decisions. Boston, MA: MIT Press.
  10. Norman, G. R. (2005), Research in clinical reasoning: Past history and current trends. Med. Educ., 39, 418-427.
  11. Norman, G.R. (2006), Building on experience – the development of clinical reasoning. N. Engl. J. Med., 355(21), 2251-2252.
  12. Pound, C. (2010), Chris pound's language machines. Retrieved January 23, 2010, from: <http://www.ruf.rice.edu/~pound/>.
  13. Schwartz, A., Elstein, A. S. (2008), Clinical reasoning in medicine. In: J. Higgs, M. A. Jones, S. Loftus, N. Christensen (Eds.), Clinical reasoning in the health professions (3rd ed., pp. 223-234). New York: Elsevier.
  14. Wizards RPG Team. (2008), Dungeon master's guide (4th ed.). Wizards of the Coast.

	A	B	C
1	Patient Name:	(first last)	Erika Moen
2	Age:		62
3	Setting:	(Emergency, Clinic, Inpatient)	Clinic
4	Clinical Presentation:	From Blackbook	Headache
5	Final Diagnosis:	Short form	Cranial arteritis
6	Main distractors		Tension headache, analgesic headaches, TMJ arthritis.
7	SubSection	Node	Answer (Subquestion: Subanswer)
8	History of Present Illness	What brings you in today?	I've been getting bad headaches recently
9	History of Present Illness	When did this start?	The headache came on gradually approximately four months ago.
10	History of Present Illness	Where is the pain?	I feel it all over my scalp and above both of my jaws.
11	History of Present Illness	How often do you get the headaches?	Now the headache is present every day, and has steadily increased in severity.
12	History of Present Illness	How would you rate this headache on a scale of 10, where 1 is no pain and 10 represents the worst pain ever.	4 or 5.
13	History of Present Illness	What makes it worse?	Nothing that I can think of.
14	History of Present Illness	Is the headache worse if you cough or sneeze, or is it affected by lying or standing?	No.
15	History of Present Illness	How does the headache vary throughout the day?	It doesn't really vary throughout the day unless I take medication for it.
16	History of Present Illness	Have you been troubled by headaches in the past?	I have never really had headaches before, in fact I've always been healthy up until now.
17	History of Present Illness	Any problems with your vision, or dizziness, weakness, or numbness?	No
18	History of Present Illness	Have you noticed anything else?	During this time I have also felt more tired and had aches and pains in my body, especially my upper arms, legs, and sometimes in my jaws.
19	History of Present Illness	How is your appetite and weight?	I've lost my appetite a bit over the past few months and my wife thinks I've lost weight, although I haven't weighed myself.
20	History of Present Illness	Do you have difficulty eating?	No, except that my jaws sometimes get sore.
21	History of Present Illness	Any problems swallowing, or problems with your bowels?	I've had no problems swallowing, or with my bowels.
22	History of Present Illness	What about other symptoms: problems breathing, pains in the chest, skin rash?	None of these.
23	History of Present Illness	Do you feel depressed.	No. I don't think so.
24	History of Present Illness		
25	History of Present Illness		
26	History of Present Illness		

Fig. 1. Screen shot of the VP template in Microsoft Excel format. The "Subsection" column reflects the patient case communication header (e.g. History of Presenting Illness, Investigations, etc) in Open Labyrinth. The "Node" column reflects the sub-node content questions related to each subsection. The "Answer" column is where the subject matter expert enters in the patient response appropriate to the case.

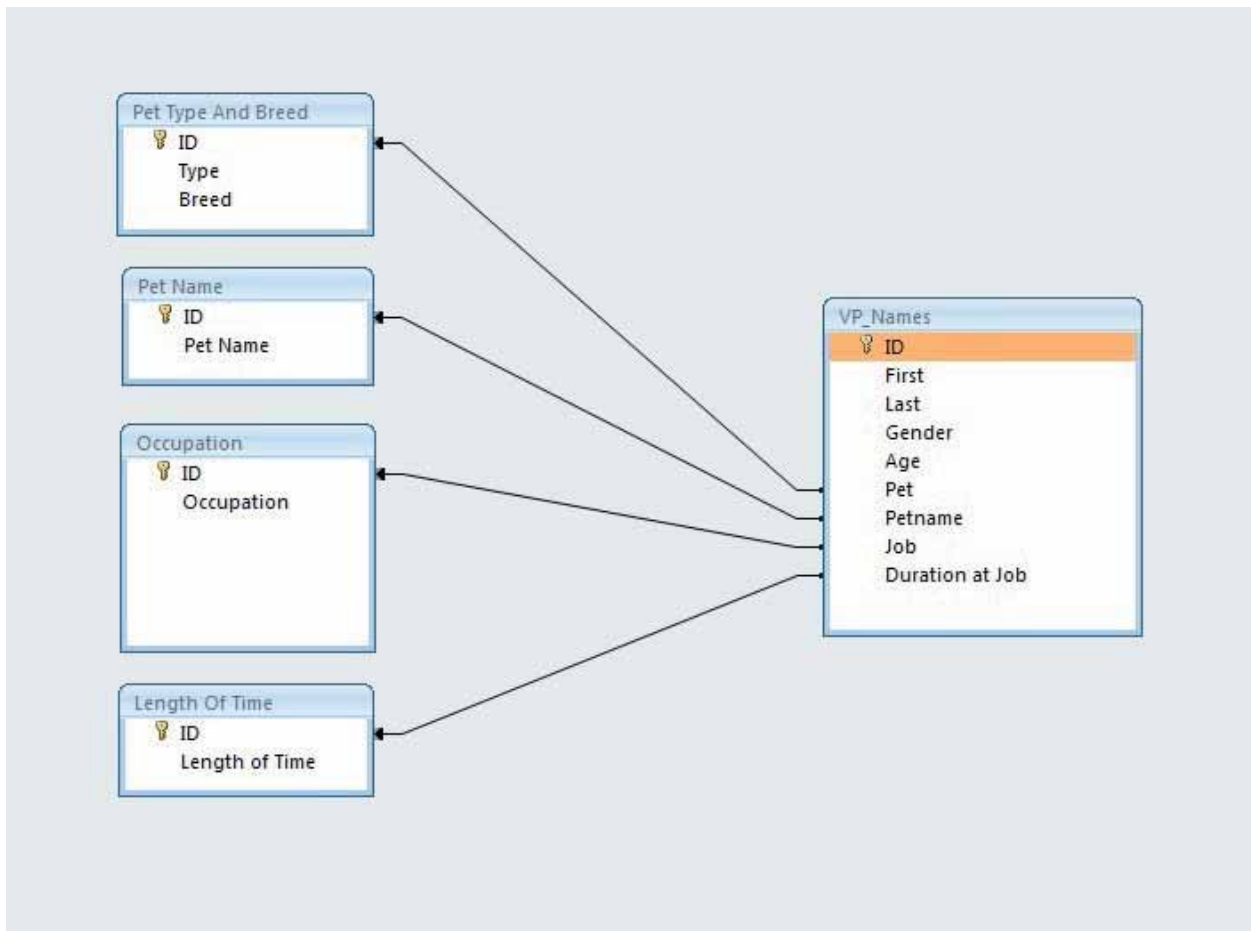


Fig. 2. Table relationships within the database. Each patient characteristic table is linked to the overall virtual patient template (“VP\_Names” in figure).

	A	B	C	D	E
1	Patient Name:	(first last)	Erika Moen		Juana Broadbus
2	Age:		62		37
3	Setting:	(Emergency, Clinic, inpatient)	Clinic		Clinic
4	Clinical Presentation:	From Blackboard	Headache		Headache
5	Final Diagnosis:	Short form	Cerebral artery		Tension headache
6	Main disorders:		Tension headache, analgesic headaches, TMD arthritis		Analgesic headaches
7	<b>Subquestion</b>	<b>Note</b>	<b>Answer (Subquestion Subanswer)</b>	<b>Note</b>	<b>Answer (Subquestion Subanswer)</b>
8	History of Present Illness	What brings you in today?	I've been getting bad headaches recently.	What brings you in today?	I've been getting more headaches recently.
9	History of Present Illness	When did this start?	The headache came on gradually approximately four months ago.		Headaches have been more frequent over the past four months.
10	History of Present Illness	Where is the pain?	I feel it all over my scalp and above both of my jaws.		I feel this is like a tight band around my head.
11	History of Present Illness	How often do you get the headaches?	Now the headache is present every day, and has steadily increased in severity.		Now the headache is present at least two or three days per week. The headaches come on gradually and can last for a few hours.
12	History of Present Illness	How would you rate this headache on a scale of 10, where 1 is no pain and 10 represents the worst pain ever?	4 or 5.		4 or 5. They haven't really increased in severity, but they are just more common now. I feel like I'm always propping pills these days. I don't need to stop what I'm doing, but I do find it difficult to concentrate.
13	History of Present Illness	What makes it worse?	Nothing that I can think of.		Nothing that I can think of.
14	History of Present Illness	Is the headache worse if you cough or sneeze, or is it affected by lying or standing?	No.		No.
15	History of Present Illness	How does the headache vary throughout the day?	It doesn't really vary throughout the day unless I take medication for it.		It doesn't really vary throughout the day unless I take medication for it. The headache can come on at any time, but are a bit more often in the afternoon and evening.
16	History of Present Illness	Have you been troubled by headaches in the past?	I have never really had headaches before, in fact I've always been healthy up until now.		I get headaches quite often, maybe about once or twice a month, and this has been the pattern for as long as I can remember.
17	History of Present Illness	Any problems with your vision, or dizziness, weakness, or numbness?	No.		No.
18	History of Present Illness	Have you noticed anything else?	During this time I have also felt more tired and had aches and pains in my body, especially my upper arms, legs, and sometimes in my jaws.		During this time I have also felt more irritable because of these headaches. I have difficulty sleeping and relaxing.
19	History of Present Illness	How is your appetite and weight?	I've lost my appetite a bit over the past few months and my wife thinks I've lost weight, although I haven't weighed myself.		My appetite is fine and I've not lost weight. If anything, I might have gained a couple of pounds.
20	History of Present Illness	Do you have difficulty eating?	No, except that my jaws sometimes get sore.		No.
21	History of Present Illness	Any problems swallowing, or problems with your bowels?	I've had no problems swallowing, or with my bowels.		No.
22	History of Present Illness	What about other symptoms: problems breathing, pains in the chest, skin rash?	None of these.		No.
23	History of Present Illness	Do you feel depressed?	No, I don't think so.		I don't think so.
24	History of Present Illness				
25	History of Present Illness				
26	History of Present Illness				

Fig. 3. Sample Microsoft Excel view of virtual patient “template” populated by the randomization of data to the database. Note side-by-side editing of two virtual patient cases (columns B and C for VP called “Erika Moen” and columns D and E for VP called “Juana Broadbus”).

## ENHANCING CLINICAL REASONING USING PROBABILISTICALLY GENERATED VIRTUAL PATIENT CASES

JEROEN DONKERS, BEP BOODE, DANIËLLE VERSTEGEN, BAS DE LENG,  
JEAN VAN BERLO

*Maastricht University, Netherlands*

**DESCRIPTION:** Clinical reasoning involves the application of both objective and subjective probabilities. The ranking within the differential diagnosis, for instance, depends completely on the proper use of probabilistic reasoning. Objective probabilities can be found in literature, but in practice people tend to use subjective probabilities often based on a non-representative set that they have been confronted with. This effect is worse when, as often happens, the majority of the cases that are used in education are either very typical or very exceptional. We propose a method using virtual patients to overcome this problem. In our approach, domain knowledge

(Diabetes mellitus in our case) as well as demographical and epidemiological data are encoded in a probabilistic network (i.e. a bayesian belief network). This network is used to generate a set of about hundred patient cases that is representative for a true population. All these patient cases are presented as brief virtual patients to each student. Using a scenario with prompts to estimate key probabilities and moderated group discussions, we believe students will be able to achieve a better set of subjective probabilities. We test the approach against a control group in the domain of Diabetes mellitus for general practice clerkships.



## HSVO: A FUNCTIONAL XML SPECIFICATION FOR INTEGRATING SIMULATION DEVICES

RACHEL ELLAWAY<sup>1</sup>, DAVID TOPPS<sup>1</sup>, JORDAN MACDONALD<sup>1</sup>, BRYAN COPELAND<sup>2</sup>,  
ADRIANA OLMOS<sup>3</sup>, BRUCE SPENCER<sup>2</sup>

<sup>1</sup>Northern Ontario School of Medicine, <sup>2</sup>National Research Centre Canada (IIT), <sup>3</sup>McGill University, Canada

**Abstract:** Although we live in a time where systems and services are combined and integrated in more and more useful ways, there are still many data silos. Simulation for healthcare education is a notable example where although there has been a proliferation of devices and services there is little connectivity or integration between them. The MedBiquitous Virtual Patient specification affords a degree of sharing of content but not runtime data and there is nothing that ties other forms to this model. The Healthcare Services Virtual Organization (HSVO) project has developed an XML-based messaging specification as part of a network-enabled platform that can connect, run, control and exchange data between any services connected to its messaging bus. Middleware interfaces essentially 'wrap' each service translating its native functions into a set of common actions and parameters to be exchanged with other services on the bus.

The HSVO NEP also involves the use of lightpaths and services that include the OpenLabyrinth virtual patient platform, the Laerdal SimMan 3G, stereoscopic and tomographic datasets, physiological algorithms and camera arrays. This presentation will present the rationale for the specification, the XML model itself and examples of how it works in practice.

### Introduction

Simulation has become an essential part of healthcare education in the last decade or so [1]. Despite its growing ubiquity educational simulation is still relatively new and the many modalities (mannequin, box trainer, on-screen, actor, prosthetic etc) are used in relative isolation from each other. Certainly at a time when many information systems and services are being combined and integrated, simulation for healthcare education remains siloed.

Even where simulation modalities are co-located they are unaware of each other and unable to respond as an integrated whole. For instance, the MedBiquitous Virtual Patient specification affords a degree of sharing of content between compliant virtual patient systems but not at runtime. The HL7/RIM model developed for healthcare systems interoperability might be used to integrate clinical data but it has no activity or heuristic basis. The unmet challenge therefore is how to integrate simulation devices and modalities for healthcare education to create integrated 'simulation continua' [2].

The Healthcare Services Virtual Organization (HSVO) project was set up to address these issues. HSVO is a collaboration between Lakehead University, Northern Ontario School of Medicine, McGill Medical Simulation Centre, McGill Centre for Intelligent Machines, National Research Council Canada, Communications Research Centre Canada, Stanford Univer-

sity School of Medicine, Innovation in Learning, Inc, iDeal Consulting and the University of Wisconsin.

HSVO has developed an XML-based messaging specification to standardize the connection and control of devices and the exchange of data between them. Middleware interfaces essentially 'wrap' each service translating its native functions into a set of common actions and parameters to be exchanged with other services on the bus. The HSVO platform also makes use of user-definable lightpaths to connect nodes on its network by remote control of the network hardware involved. HSVO integrates a number of services including the OpenLabyrinth virtual patient engine, the Laerdal SimMan 3G mannequin, stereoscopic and tomographic datasets, physiological algorithms and camera arrays. This paper describes the data specification and architecture developed by HSVO to achieve activity-level simulation device integration.

### The Architecture

There were three major challenges to be addressed in the HSVO Project:

1. Simulation devices are highly heterogeneous with no standard way of controlling, communicating or otherwise expressing their data and functionality. There was therefore a requirement to standardize the way that different simu-



lation devices could communicate and be controlled. This was addressed by the creation of:

- a. A messaging specification that standardized the expression and transport of commands, reports and other data across the platform.
  - b. A 'bus interface' middleware layer for translating between what any given device can do (and how it does it) and the HSVO standard messaging schema. The bus interface would also accommodate any HSVO functionality not supported by its device.
2. Simulation activities are also heterogeneous. While some devices (such as the Laerdal SimMan) allow scenarios to be pre-defined, these scripts are highly device specific. There was therefore a need to create a common activity definition format to allow for multi device activities to be authored and executed using the HSVO platform. This was addressed by the creation of an integrating and control tool called SAVOIR (Service-oriented Architecture for a Virtual Organization's Infrastructure and Resources) that could not only simultaneously control multiple devices, sessions and activities, but also allow for the authoring of activities and the presentation of data and communication services between participants.
  3. There is no standardization of the technologies or techniques used to express the tools or services they would need to use. The platform therefore needed to be technology and context independent allowing for any programming language and network technology to connect and integrate with the platform. The open source MULE Enterprise Service Bus was used to provide a technologically agnostic framework for the input and output of HSVO messages.

Figure 1 shows how all of these components are linked to form a single system architecture.

The devices connected to the HSVO Platform currently include:

- Laerdal SimMan 3G high fidelity mannequin – this is controlled by a combination of a ghost application that directly controls the tutor laptop (that in turn controls the manne-

quin) and the use of the SimMan 3G API – <http://www.laerdal.com/simman3g>

- OpenLabyrinth virtual patient engine – this is controlled via a remote state observer tracking interactions with an OpenLabyrinth activity and responding to them – <http://groups.google.com/group/openlabyrinth>
- Camera array allowing for multiple camera views and interpolated virtual camera views between actual physical cameras.
- Hypovolemic shock physiological model from Innovation in Learning and Stanford.
- Stereoscopic imaging using the Remote Stereo Viewer ([http://havnet.stanford.edu/research/rsv\\_app.html](http://havnet.stanford.edu/research/rsv_app.html)) and Bassett collection data (<http://lane.stanford.edu/bassett/index.html>) from Stanford.
- Volumetric data imaging using VOLSEG ([http://havnet.stanford.edu/research/immersive\\_app.html](http://havnet.stanford.edu/research/immersive_app.html)) and the visible human data set.
- Multi-way video conferencing and collaboration using the Isabel toolset (<http://isabel.dit.upm.es/>)

The other key component of the HSVO platform is the network. HSVO uses a combination of commodity Internet, layer 3 Internet and, when required, an Articulated Private Network (APN) connected by dedicated 2 Gigabit Ethernet (GbE) fibre optics. Network and lightpath control is managed using ARGIA and CHRONOS which are able to reach across a network and take control of switches to ensure end to end uninterrupted bandwidth for the duration of an education session. The variety in network configurability means that the HSVO platform can rapidly scale up and down in response to fluctuations in demand (see figure 2).

## Messaging

There are a number of standard messages for communicating between the SAVOIR integration layer and individual bus interfaces

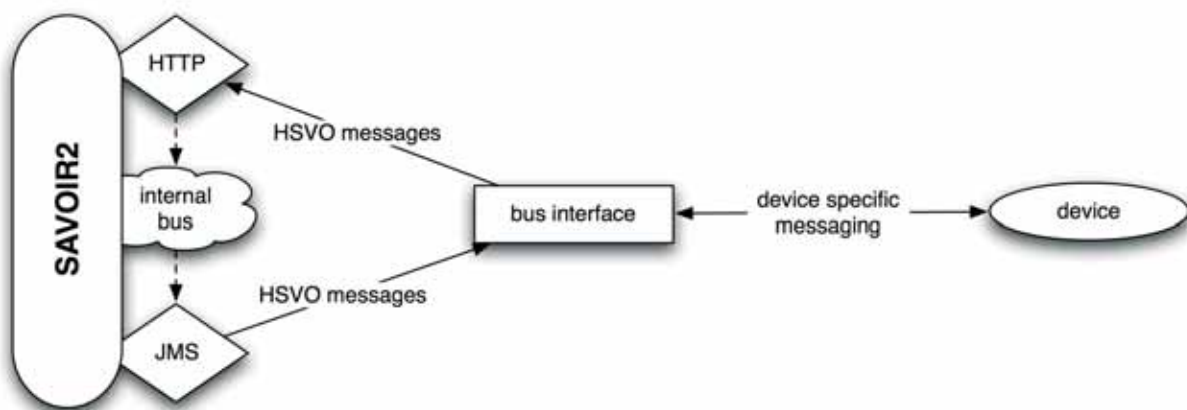


Fig. 1. Basic HSVO system architecture. A bus interface is configured to work with its paired device in a reciprocal fashion with as much mutual comprehension as the device supports and the bus interface needs. The bus interface also translates between the device-specific messages and the HSVO standard messages for communicating with SAVOIR. Incoming messages join the bus via an HTTP connection and exit it via a Java Message Service. Although this diagram shows a single device, the normal deployment involves connecting multiple devices to SAVOIR.

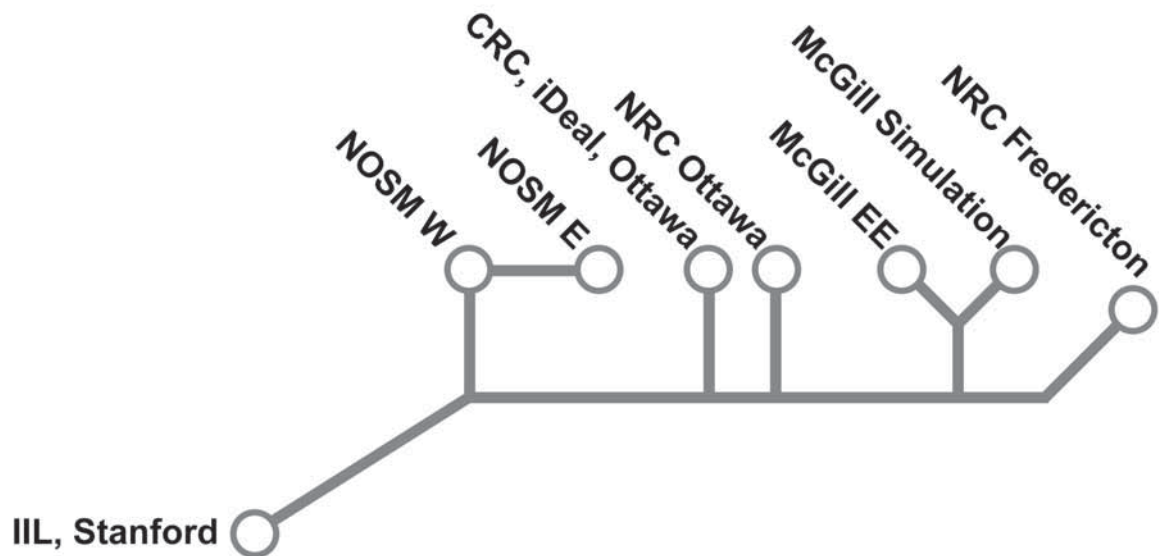


Fig. 2. Topology of the HSVO articulated private network (APN). Each site is connected to a high-speed fibre optic backbone that can provide guaranteed lightpaths of 2GbE between any other site.

- *Authenticate*: a message from SAVOIR to a specified bus interface telling it to authenticate this session using a set of parameters. How these parameters are interpreted and used to authenticate the session is up to the bus interface and its device.
  - *Acknowledge*: reply to SAVOIR from a specified bus interface confirming that a specific action was successful. This is only required for 'authenticate' and 'load' actions.
  - *Load*: a message from SAVOIR to a specified bus interface telling it to load certain "configuration" data in order to start running a session. As with all messages a service is pre-registered and only the service ID and savoir User need to be expressed in the message itself.
  - *Start*: a message from SAVOIR to a specified bus interface initiating a device process, along with the data or configuration that the device needs to run.
  - *Launch*: a message from a specified bus interface asking SAVOIR to launch a program on the specified user's workstation.
  - *Stop*: a message from SAVOIR to a specified bus interface telling it to stop and drop any loaded configuration.
  - *Pause*: a message from SAVOIR to a specified bus interface to stop advancing the activity in a device or its state model pending a resume action.
  - *Resume*: a message from SAVOIR to a specified bus interface to recommence an activity in a specified device with whatever configuration parameters were previously loaded. If it is running in an active window this also gives it focus.
  - *GetStatus*: a message from SAVOIR to a bus interface requesting a 'reportStatus' message in return outlining the service's current state.
  - *ReportStatus*: a message from a specified bus interface broadcasting its available parameters and their current values (or status) within a specified session context.
  - *GetProfile*: a session-agnostic message from SAVOIR requesting the profile of a specified bus interface.
  - *ReportProfile*: a session-agnostic message from a specified bus interface broadcasting its available activities and any parameters within activities.
  - *SetParameter*: a message from SAVOIR to a specified bus interface instructing to change a variable in its configuration. This instruction could have been triggered from the scenario activity description to update a parameter given certain rule, or to match a variable extracted from another device. SAVOIR will check if the parameter needs to be translated (i.e. from Centigrade to Fahrenheit) before sending the parameter value to the device.
  - *Notify*: a message from SAVOIR sending alerts or notes to a device's users. This could be feedback messages saying that is time to switch attention to another edge service, that an edge service is in 'pause' mode, etc.
  - *ReportFailed*: a message from a bus interface to SAVOIR indicating that the device it interacts with is unavailable.
  - *EndSession*: a message from SAVOIR instructing all bus interfaces within a particular session to stop.
  - *SessionEnded*: a message from SAVOIR instructing all listening services to close current session.
- These messages are sent using a common syntax such as:
- ```
<message action="reportStatus"
  sessionID="1234567">
  <service id="OL_NOSM" user="rellaway">
    <parameter id="ROOT" unit="null"
      value="37" />
    <parameter id="CURRENT_HEALTH" unit="null"
      value="3" /> <parameter id="CURRENT_NODE"
      unit="null" value="79" /> <parameter
      id="HEART_RATE" unit="per_minute"
```

```

value="92" /> <parameter id="TIME_
ELAPSED" unit="seconds" value="1000"
/> <parameter id="TIME_REMAINING"
unit="seconds" value="300" />
</service>
</message>

```

The common messaging framework allows for many other devices to be connected paired with a bus interface. This open connectivity model affords significant scalability and adaptability. A software development kit (SDK) has been developed to support this process and is expressed in the Python, Java and C# languages.

## Implementation

The HSVO network enabled platform is a distributed set of software and hardware components located across the articulated private network or occasionally on the open Internet. Deploying the platform involves a certain amount of configuration and tuning of components and settings as set out in the following table:

## Using the HSVO Network Enabled Platform

The HSVO platform works in two modes:

- *Ad-hoc mode* allows users to configure and launch any device in any way they wish
- *Scenario mode* supports the creation and execution of scenarios made up of a predefined series of device interactions. Once defined a scenario can be instantiated multiple times – each instance constitutes a session.

The following example sets out the way a scenario might be constructed:

1. Learners start off by logging in and assembling in a holding area – when the tutor is ready they start the scenario with the learners using an OpenLabyrinth virtual patient
2. At key points, marked by particular OpenLabyrinth nodes being selected, visualization support is provided by RSV windows opening on one or more specified machines showing anatomy datasets. When the learner moves on to the next node the ‘helper’ windows are closed again
3. If the variable for patient health in OpenLabyrinth drops below a certain value, OpenLabyrinth is paused and the SimMan mannequin is started with the key vital signs passed across to the mannequin activity

| Service                                                | Location        | Implementation factors                                                                                                                                                                                                                 | Network needs |
|--------------------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| SAVOIR2 – the HSVO platform hub                        | NRC             | One instance of SAVOIR is used to control an instance of the platform                                                                                                                                                                  | Low           |
| SimMan 3G – high fidelity human mannequin              | McGill and NOSM | The SimMan rig consists of a robot/ mannequin plus tutor and learner laptops. The HSVO bus interface controls the tutor laptop. SimMan is therefore a physical device with options to virtualise it through screen sharing and video   | Low           |
| OpenLabyrinth – online serious game engine             | NOSM            | OpenLabyrinth is a web application that can make services available at any end point over http or its own API/webservice connections                                                                                                   | Low           |
| Camera array – multiple virtual camera views           | McGill          | The camera array consists of a number of physical cameras plus a co-located rendering server – more cameras mean more servers                                                                                                          | High          |
| Hypovolemic shock – physiologic model                  | IIL             | This takes the form of a webservice hosted on the IIL server at Sunnyvale in California                                                                                                                                                | Low           |
| Remote Stereo Viewer – renders stereoscopic image sets | NRC, IIL        | There are three components to RSV – the desktop client (that needs to be installed at each site), the rendering server (located at NRC in Ottawa) and the dataset located at Sunnyvale in California                                   | High          |
| VOLSEG – renders volumetric image data                 | All sites, NRC  | There are three components to VOLSEG – the desktop client (that needs to be installed at each site), the rendering server (located at NRC in Ottawa) and the dataset (also located at NRC in Ottawa)                                   | High          |
| Isabel – mult-site video conferencing                  | All sites, CRC  | There are three components to Isabel – the desktop client (requiring an Ubuntu desktop and running at all sites), the local server allowing for SAVOIR control over Isabel at an end point and the master Isabel server running at CRC | Medium        |

4. If the learners manage to resuscitate the mannequin then they are returned to the OpenLabyrinth virtual patient to complete the scenario. If they do not save the mannequin they are taken to a new virtual patient to work through a remedial activity.

Expressed as a set of rules the pseudocode for this would look like:

```
<scenario>
<start device="OL(22)" />
<rules>
<rule device="OL" param="node" value="14"
action="launch(RSV("thorax1"))" />
<rule device="OL" param="node" value="17"
action="launch(RSV("thorax2"))" />
<rule device="OL" param="DBP" value="60"
action="pause(OL)" />
<rule device="OL" param="DBP" value="60" a
ction="launch(simman(hypovolemic.sce))" />
<rule device="simman" param="state"
value="alive" action="pause(simman)" />
<rule device="simman" param="state"
value="alive" action="resume(OL(22))" />
<rule device="simman" param="state"
value="dead" action="pause(simman)" />
<rule device="simman" param="state"
value="dead" action="launch(OL(24))" />
</rules>
</scenario>
```

Note that SAVOIR uses Drools ([www.jboss.org/drools/](http://www.jboss.org/drools/)) as its rule engine and the actual expression is different from the illustration given. In running the scenario the following messages (simplified) would be sent:

1. Start scenario – sent to each device specified in the pre-defined scenario
2. Load OpenLabyrinth case 22 sent to OL
3. ReportStatus sent by OL reporting the value of its variables and the current node ID each time an action is taken
4. Launch sent to RSV along with the data to use when certain OL nodes selected
5. Close sent to RSV when the next node is selected
6. Pause sent to OL when the vital signs drop below a certain point
7. Load and launch sent to SimMan
8. ReportStatus sent by SimMan reporting a key vital sign each time an action is taken or a set period of time has elapsed
9. Pause sent to SimMan
10. Resume or load and launch sent to OL depending on state of SimMan
11. EndSession sent to all devices

As can be seen the recorded rules for a scenario are used to define what messages are sent when the parameters of different devices reaches different states. There is therefore both an internal representation of a scenario in terms of rules and an external representation in terms of the messages between SAVOIR and the different devices connected to it.

## Discussion

The model for integrating and controlling multiple simulation devices set out in this paper has been developed as part of a network-enabled platform project for healthcare education and training. We developed an open XML messaging model to allow us to simplify and standardize the interface between devices and the SAVOIR core and to allow for any future device to be connected using simple and reusable software components.

The resulting model is akin to educational modeling languages [3] in that it specifies the sequencing and other logic that determines what resources a learner receives and what aspects of their actions control the flow of that sequencing. However, this model differs from specifications such as IMS Learning Design and IMS Simple Sequencing in taking a hub-based approach and concentrating on the state of the connected devices to determine the flow of an activity.

In taking the HSVO model forward we anticipate that there will be minor updates as there are to any specification but we are confident that the model for integrating simulation devices is a robust and extensible one that allows for many different kinds of devices, activity designs and settings than the ones developed and tested within the HSVO Project.

## Acknowledgements

Funding for this work was provided by CANARIE Inc. as part of its network enabled platforms program. We would like to thank the HSVO Project team for their contributions: Jeff Blum, Martin Brooks, Scott Campbell, Jeremy Cooperstock, Bryan Copeland, Cristina Dalroti, Parvati Dev, Rachel Ellaway, Bruno Emond, LeRoy Heinrichs, Justin Hickey, Bobby Ho, Kevin Lachapelle, Sandy Liu, Jordan MacDonald, Kapildev Misra, Aaron Moss, Adriana Olmos, Swaroop Patnaik, Alison Peek, Rene Richard, Michel Savoie, Steve Senger, Kevin Smith, John Spence, Bruce Spencer, Haijian Sun, David Topps, Younghua You and Hanxi Zhang. For more information see the project website at [www.hsvo.ca](http://www.hsvo.ca)

## References

1. Issenberg S. B. (2006), The Scope of Simulation-based Healthcare Education. *Simulation in Healthcare* 1(4): 203-208.
2. Ellaway R., Kneebone R., Lachapelle K., Topps D. (2009), Connecting and combining simulation modalities for integrated teaching, learning and assessment. *Medical Teacher* 31(8): 725-731.
3. Rawlings A., van Rosmalen P., Koper R., Rodríguez-Artacho M., Lefrere P. (2002), Survey of Educational Modelling Languages (EMLs), CEN/ISSS WS/LT Learning Technologies Workshop. Online at <http://sensei.lsi.uned.es/palo/eml-version1.pdf>, last accessed 31 January 2010.

## IMPLEMENTATION OF VIRTUAL PATIENTS: THE FIRST YEARS

KALLE ROMANOV, MARJA SILENTI

*Research & Development Unit for Medical Education, University of Helsinki, Finland*

**DESCRIPTION:** Background: The Virtual patient pool (VPP) was introduced in Feb 2007 to the 3rd – 6th year medical students at the Helsinki University. The VPP allows students to perform extensive examinations (medical history, clinical examinations, laboratory tests, imaging) and to suggest diagnosis and/or treatment. An immediate feedback of the VP is available after the submission. Right from the start we began to publish monthly patient cases during the academic year for voluntary use. Each “Patient of the month” is available for ten days and its availability is informed with an email and one reminder to the students (approximately 550 students). In this abstract we report how the voluntary VPs have been utilized.

**Summary of work:** Until Nov 2009 we have published 22 VPs covering family medicine, infectious diseases, endocrinology, hematology and cardiology. We have gained roughly 2500 events of the use of the VPs. In this study we investigate the trends of the use of VPs, how students of various levels of their studies have utilized VPs during the academic year, the quality of the clinical and diagnostic examinations of the cases and the proportion and the background variables of aborted use of the VPs.



## THE USE OF VIRTUAL PATIENTS TO PREPARE FOR SKILLS LAB TRAINING: RESULTS OF A PILOT PROJECT IN PAEDIATRICS

RONNY LEHMANN<sup>1</sup>, STEPHAN OBERLE<sup>1</sup>, HANS MARTIN BOSSE<sup>1</sup>, CHRISTOPH NIKENDEI<sup>2</sup>,  
BURKHARD TÖNSHOFF<sup>1</sup>, SÖREN HUWENDIEK<sup>1</sup>

<sup>1</sup>University Childrens Hospital Heidelberg, Germany;

<sup>2</sup>University Hospital Heidelberg, Department of Internal Medicine, Germany

**DESCRIPTION:** Skills lab training requires small group teaching with a high demand of tutors for facilitation and supervision. Virtual patients (VPs) may provide a feasible tool for student preparation and time optimization.

A pediatric skills lab training was introduced to our faculty in a blended learning scenario with VPs. The training covers relevant paediatric procedural skills. VP scenarios present typical clinical cases on each procedure.

Students' opinions were surveyed using instruments developed within the electronic Virtual Patients Project in the categories of teaching presence, cognitive preparation, social presence, learning effect and an overall judgment.

The students rated the blended learning scenario overall as very successful, the teaching presence it offers as high and the cognitive preparation by the VP cases as effective. The social presence was perceived high as the scenarios provided a good learning effect.

In their comments students specifically valued the multimedia-based clarification of procedures. Tutors also indicated that the VP cases prepared students well for the skills lab training, allowing an efficient use of time in the training.

The results of this pilot study indicate that virtual patients offer an enjoyable, acceptable and useful tool to prepare for skills training.

## THE COMBINATION OF VIRTUAL PATIENTS AND SMALL GROUP DISCUSSIONS TO PROMOTE REFLECTIVE PRACTICE OF SPECIALIST TRAINEES

BAS DE LENG<sup>1</sup>, RENE VAN GENT<sup>2</sup>, JEROEN DONKERS<sup>1</sup>, JEAN VAN BERLO<sup>1</sup>,  
DANIËLLE VERSTEGEN<sup>1</sup>, FRANK HESS<sup>3</sup>, JÖRN HEID<sup>3</sup>

<sup>1</sup>Maastricht University, Faculty of Health, Medicine and Life Sciences, Department of Educational Development and Research, Netherlands; <sup>2</sup>Máxima Medical Centre, Department of Paediatrics, Netherlands; <sup>3</sup>Heidelberg University, Medical Faculty, Center for Virtual Patients, Germany

**DESCRIPTION:** Patient safety is likely to benefit from strategies to avoid cognitive errors when patients are being diagnosed [1]. Unfortunately, there are at present no effective methods available to teach medical students and specialist trainees how to avoid cognitive errors during clinical reasoning [2]. In an attempt to design such a method, we developed a training programme in diagnostic reasoning for paediatric trainees with a special focus on reducing cognitive errors. This training programme uses the strategy of 'diagnostic time-outs' [3], which means that a diagnostic team takes a 'time-out' to reflect on their current working diagnosis, in a controlled educational setting.

To make simultaneous individual workup of the same standardised cases possible we used virtual patients. The medical content was based on real cases where 'premature closure' had occurred. To promote reflection and discussion on data gathering and diagnostic reasoning during scheduled 'time-outs', we used a feedback tool. This instrument retrieved the

logged actions with the virtual patients and presented an aggregated overview to the group.

We piloted the use of the virtual patients together with 'time outs' with the feedback instrument in small group diagnostic reasoning sessions.

### References:

- [1] Graber, M. L., Franklin, N., & Gordon, R. (2005), Diagnostic error in internal medicine. *Archives of Internal Medicine*, 165(13), 1493-1499.
- [2] Regehr, G., & Norman, G. R. (1996), Issues in cognitive psychology: Implications for professional education. *Academic Medicine*, 71(9), 988-1001.
- [3] Trowbridge, R. (2008), Twelve tips for teaching avoidance of diagnostic errors. *Medical Teacher*, 30, 496-500.

## REPURPOSING LINEAR ‘PAPER’ CASES INTO INTERACTIVE ONLINE VIRTUAL PATIENTS FOR PROBLEM-BASED LEARNING: COMPARING THE IMPACT OF VPS ON EXAM PERFORMANCE

TERRY POULTON, SHEETAL KAVIA, CHARA BALASUBRAMANIAM, TRUPTI BAKRANIA,  
EMILY CONRADI

*St. George's University of London, United Kingdom*

**DESCRIPTION:** St George's University of London has a PBL curriculum for its undergraduate medicine course, using paper-based patient cases. To counter the limitation that paper cases did not allow students to consider optional routes through the case, interactive online VPs were repurposed from existing paper-based cases. These allowed students to consider options as cases unfolded, take decisions, and explore the consequences of their actions.

In a controlled trial, VPs were delivered to 72 students in 10 tutorial groups, with 5 groups each week receiving VPs with options (branching cases), and 5 receiving online cases without options. A comprehensive evaluation was carried out,

using questionnaires and interviews. The summative examination was constructed with several Short Answer Questions built around the option points in the cases, to establish whether the requirement to discuss and take decisions had improved the students learning/memory retention in these areas.

Tutors and students believed that the ability to explore options and consequences created a more engaging experience, encouraged students to explore their learning, and made the underlying knowledge base more memorable. This study will consider the impact that branching cases have upon the exam performance in knowledge areas that underpin the clinical reasoning.

## EVALUATION OF DIFFERENT CURRICULAR INTEGRATION SCENARIOS OF VIRTUAL PATIENTS: FIRST RESULTS USING THE EVIP EVALUATION INSTRUMENTS

BENJAMIN HANEBECK<sup>1</sup>, STEPHAN OBERLE<sup>1</sup>, RONNY LEHMANN<sup>1</sup>,  
CHRISTIAN ROGGENHOFER<sup>3</sup>, RALPH NAWROTZKI<sup>4</sup>, GEORG F. HOFFMANN<sup>2</sup>,  
BURKHARD TÖNSHOFF<sup>2</sup>, SÖREN HUWENDIEK<sup>1</sup>

<sup>1</sup>Department of General Paediatrics, University Hospital for Adolescent and Paediatric Medicine and Centre for Virtual Patients, Medical Faculty of Heidelberg University, Heidelberg, Germany; <sup>2</sup>Department of General Paediatrics, University Hospital for Adolescent and Paediatric Medicine, Heidelberg, Germany; <sup>3</sup>Department of Child & Adolescent Psychiatry, University Hospital Heidelberg, Germany; <sup>4</sup>Institute of Anatomy and Cell Biology, University of Heidelberg, Germany

**Introduction:** Virtual Patients (VP) are becoming more and more popular in medical education and are used in an increasing number of different educational scenarios. Many studies focus on VP design. Yet the curricular integration of VP is not in the focus of research, although it has a major influence on learning outcome of students.

**Methods:** We evaluated three different curricular integration scenarios in child and youth psychiatry, paediatrics and basic sciences. Scenarios included integration of VP after a lecture as wrap up and as an additional learning tool as a preparation for an exam, integration within a seminar and VP work followed by a tutor-led small group discussion. The eViP-evaluation instrument for curricular integration was used in all

settings, including a checklist completed by the curriculum designer.

**Results:** Evaluation results pointed out weaknesses and strengths of curricular integration scenarios, which will be presented in detail. Overall feedback was positive. Differences between scenarios and impact on evaluation results will be discussed, taking the curriculum designer's intentions into account.

**Conclusions:** Use of the eViP-evaluation instruments for curricular integration is a useful means for pointing out shortcomings and positive effects. Evaluations are ongoing in order to allow for statistical evaluations in the future.

## TO START FROM SCRATCH OR TO REPURPOSE: THAT IS THE QUESTION

ANDRZEJ A. KONONOWICZ<sup>1</sup>, ALEKSANDRA J. STACHOŃ<sup>1</sup>, MONIKA GURATOWSKA<sup>1</sup>,  
PAWEŁ KRAWCZYK<sup>2</sup>

<sup>1</sup> Department of Bioinformatics and Telemedicine, Jagiellonian University Medical College, Kraków, Poland <sup>2</sup> Chair of Anaesthesiology and Intensive Care Medicine, Jagiellonian University Medical College, Kraków, Poland

**Abstract:** The high cost of authoring e-learning resources is a well-known problem when introducing and using virtual patients in medical schools. A method investigated by the European eViP project for reducing these expenses involves “repurposing” existing cases from a common database in order to fit them into new learning environments and scenarios.

The goal of this study was to collect opinions on repurposing as a method of authoring educational cases. A questionnaire was sent to subject matter experts and learning technologists working on the eViP project at Jagiellonian University Medical College. The staff members had experience both in repurposing cases and creating virtual patients from scratch. A five-point scale for recording their preferences in the adaptation of virtual patients was introduced. By using open-ended questions the respondents had an opportunity to freely give their personal opinions on the pros and cons of adapted cases.

For the majority of staff members polled the repurposing of existing cases was a great chance to start introducing virtual patients at a university with no previous experience in using this method of teaching. However, limitations of repurposing were also detected which consequently caused some of our specialists to prefer the creation of new cases rather than repurposing.

### Introduction

Recent years have brought a large number of initiatives aimed at the sharing and reuse of e-learning resources. These include both the creation of technical specifications for the interchange of educational content [22] as well as the development of theoretical frameworks and guidelines for building exchangeable learning objects [18]. The purpose of these initiatives was to remove the barriers that hindered the introduction of new media in education (e.g. limited time, money and personnel resources), to build original, sophisticated digital content and to improve technical or instructional know-how in the development of e-learning resources.

Virtual patients (VP) [3, 14], defined as ‘interactive computer simulations of real-life clinical scenarios for the purpose of healthcare and medical training, education or assessment’ [6], may be regarded as examples of specialised reusable learning objects (RLO) and thus treated as subjects for exchange. This line of thinking is supported by the fact that the cost of authoring virtual patients is high (as shown in a study by Grace Huang et al [13]) and that this could be lowered by building common repositories of virtual patients [8]. Specifications for healthcare education standards developed by the MedBiquitous organisation [22] form the technical foundation for educational content transfer between medical universities. Initiatives

like the EC-supported project *electronic Virtual Patients* (eViP) [1] build communities and technical infrastructure to facilitate the exchange of virtual patients. Since the direct transfer of virtual cases between individual institutions is often not feasible due to language, culture, technical or instructional differences, the cases are adapted to the individual needs of institutions in a process called “repurposing”.

After its very promising initial phase, the process of exchange of virtual patients needs to be carefully examined to verify empirically its assumed benefits and drawbacks. Previous studies have already reported on the preliminary outcomes of different repurposing types at individual institutions [12, 19] within the eViP project. In progress are studies to compare the time efforts of repurposing virtual patients between different institutions [16].

The goal of this study was to collect opinions on repurposing as a method of authoring educational cases at Jagiellonian University Medical College, being one of the institutions involved in the eViP project. Unlike the previously mentioned studies it is not intended to touch upon the topic of measuring quantitative outcomes of the repurposing process (as e.g. time effort) or to survey students’ satisfaction with using repurposed virtual patients, but to focus on the group of people involved directly in the repurposing process. This paper presents their subjective opinions concerning the adaptation of virtual pa-



tients in comparison to creating them from scratch. Because of obvious limitations (e.g. a small, highly heterogeneous group of study subjects) this work should be qualified as a pilot study that prepares the ground for a larger, more rigid, cross-institutional evaluation of the repurposing process.

## Background

Involved in the European project eViP since September 2007, Jagiellonian University Medical College (UJ) has an interdisciplinary team that has repurposed 33 virtual patients from the project repository and created 26 new educational cases (until February 2010). Four different skill sets are required within the team: learning resource translator, subject matter expert, learning technologist and technical developer.

The translators transfer the text content of the repurposed cases from foreign languages (in our case English and German) into Polish. This requires not only language proficiency but also knowledge of medical terms. At UJ this role is played predominantly by final year medical students with previous experience in studying at foreign universities (Socrates-Erasmus exchange programme). Subject matter experts are medical or healthcare specialists working in most cases at the university hospital. Until now, it included specialists in Internal Medicine, Cardiology, Neurology, Haematology, Anaesthesiology, Allergology, Gynaecology, Nephrology, Radiology, Obstetrics, Nursing, Gastroenterology, Infectious Diseases, Ophthalmology and Oncology. As part of the repurposing process, subject matter experts read and correct the translated content of the virtual patient, adapt it to local conditions, update it to reflect the latest medical knowledge and suggest new elements to be included into the case. Learning technologists [20] liaise between subject matter experts and technical developers. Learning technologists on one hand understand the content of virtual patients and make it more suitable for teaching purposes, but on the other hand know the technical constraints of the virtual patient system used by the institution. Technical developers solve the IT problems in transferring virtual patients between different systems, work on the technical localisation of multimedia objects (e.g. adding language captions to movies or images), enrich the content by adding new multimedia and manage the technological issues (student accounts, learning outcome measurements etc). In some rare cases one person played more than one of the above described roles (e.g. translator and subject matter expert or learning technologist and technical developer) but in all cases one of the roles was always dominant.

UJ uses within the eViP project the linear virtual patient system CASUS® developed at LMU Munich by Instruct AG [9].

## Methods

The questionnaire study was carried out between October 2009 and January 2010 and included 22 staff members involved in the eViP project at UJ as translators (3), subject matter experts (15), learning technologists (2) and technical developers (2). The inclusion criteria for a person was that (s)he had to have been involved in the creation or repurposing of at least two VP cases. The majority of respondents had a medical background

(64%), including 11 practitioners (7 medical doctors, 2 nurses, 2 midwives) and 3 students in their sixth year of medicine. The two learning technologists had a biological background (anthropology) and the two technical developers were graduates in computer science.

A survey containing twenty eight questions regarding the preferences and difficulties in repurposing and creating new virtual patient cases was prepared for the purpose of the study. It included 19 five-point Likert-scale questions, 5 multiple choice questions, and 4 free-text questions. The questionnaire was implemented in Microsoft Word. All answers were collected in Microsoft Excel and a preliminary analysis was carried out with the Statsoft Statistica 8.0 package. Opinions were analysed using descriptive statistics and Spearman correlation coefficients ( $r_s$ ). The application of statistical methods was limited due to the small size of the sample. For calculating the descriptive measures (average, median) of Likert-questions the assumption was made that "Strongly Disagree"=1 point, "Disagree"=2 points, "Neutral"= 3 points, "Agree"=4 points, "Strongly Agree"=5 points. Answers not given were omitted from calculations.

## Results

The results obtained are shown in tables 1-5. Answers' frequencies on general questions regarding the repurposing and new VP creation process are presented in table 1. The majority of the respondents agreed that repurposing cases makes sense (68%) and that repurposing was for them an interesting experience (59% people strongly agreed and only one person disagreed). The process of creating new VP cases was an interesting experience for as much as 73% of respondents. The question directly surveying the preference for repurposing or creating new cases gave no clear answer (the percentage of people in favour of one method was almost equal to the proponents of the second method, the majority was either neutral or skipped that question). It is worth mentioning that 68% of staff members agreed that repurposing taught them how to create virtual patients. Half of the respondents agreed or strongly agreed (46%) that the process of adaptation left enough room for self-initiative, but 23% disagreed. The attitude of 45% was positive towards the future repurposing of their cases – only three respondents (14%) had a negative opinion.

The following statistical analysis suggested that there are significant correlations between the answers to some of the above questions and the number of cases repurposed by our staff members. In other words: the more cases an author had repurposed the more likely (s)he was to agree that repurposing makes sense ( $r_s=0,44$ ;  $p<0,05$ ) and that their cases would be repurposed by other authors in the future ( $r_s=0,82$ ;  $p<0,05$ ). We did not observe a correlation between the number of repurposed cases and positive answers given to the question regarding the educational potential of repurposing. This suggests that the repurposing of even two or three cases could be enough to develop sufficient skills to author new virtual patients.

Table 2 presents opinions regarding which VP elements can be transferred between different countries. The most popular were patient history, examination results and methods of history taking. By far the least popular answer was the litera-

ture references. Other unpopular answers included the selection of diagnostic methods and multimedia. However the difference in the average score between these two answers and the remaining answers was not as striking as in the case of literature references.

Table 3 summarises opinions regarding the overall content of the institutional virtual patient repository. The respondents had no strong opinion about whether it was better to have a specialised or broader scoped database (37% vs. 41%). The majority of people disagreed with the statement that VPs should present rare rather than common diseases: 68% disagreed and no one agreed. Most of the polled agreed with the opinion that VPs should be created by people involved directly in teaching (and not e.g. boards of experts or commercial companies): 14 (65%) agreed, no one disagreed.

In the opinions of respondents, the most time-consuming activities during repurposing and also during the creation of VPs from scratch were: the creation of knowledge questions with feedback, the description of diagnostic actions and therapeutic effects, and multimedia (table 4). These aspects of virtual cases require from specialists knowledge not only of their daily clinical practice, the newest medical advances (e.g. diagnostic and treatments methods that may not be available in their hospital) but also pedagogical skills. The same previously mentioned elements of virtual patients were perceived as the most problematic whether repurposing or creating from scratch. Additionally, respondents marked the selection of diagnostic methods as a troublesome activity when creating cases anew. The reason may be a lack of diagnostic and therapeutic standards as well as legal and financial limitations in availability of modern techniques in some of Polish hospitals.

Despite oft-reported problems with preparing multimedia objects, most of the authors enriched virtual patients by adding images (82%), tables (76%) and figures (65%). Half of them included patients' images, and several people included movies or audio files in the repurposed cases (table 5).

## Discussion

In general, respondents liked both creating new medical cases and repurposing. The fact that there was no clear preference for any method of acquiring VPs may be explained by one of the free text comments in the forms which indicated that the respondents' attitude towards repurposing depended strongly on the particular case. Some of the cases were easy to adapt, whereas repurposing others took more time than creating them from scratch. The important issue seems to be the difficulty with finding cases in the pool of VPs that meet the expectations of teachers and fitting them into an existing medical curriculum with defined learning objectives. Further studies could follow this lead and attempt to define criteria for assessing the usability of VP cases for repurposing before the actual adaptation begins.

Most of the cases were repurposed from German into Polish language and culture. Even though there are surely many differences in socioeconomic and medicolegal conditions between these countries, the differences are not as striking as reported in other studies (e.g. between Sweden and Colombia [10] or Scotland and Malawi [4]). This explains the fact that in our study the respondents rated the patient history as the

element that could most likely be transferred between different countries. However, this result is unlikely to be repeated in studies as described by Fors et al [10] or Dewhurst et al [4]. An objective study should compare different repurposing scenarios: nationally, between neighbouring countries on a similar development level, and long distance educational content transfers.

The low rating for the transfer of literature references is explainable by the presence of local national guidelines and the fact that Polish students are seldom encouraged to use international materials (published in English) for learning. This observation is also supported by the results of a Romanian study in which it was showed that even students who claimed to have very good English skills learned less efficiently from virtual patients presented in English than in their native language [10].

A very interesting point was raised in a free text comment by one of the respondents: that the repurposing of virtual patients makes sense only if the case comes with the full set of original medical data of the patient. This allows reasonable additions to be made to the case when repurposing. Otherwise, just by inventing different details the case loses authenticity and value. This statement is supported by another opinion from the questionnaire that the repurposing of images and multimedia is feasible only if they are available in a raw, editable format, without hard encoded captions or pointers. The concept of open source multimedia in medical learning objects has already been postulated in literature by Ellaway and Martin [7]. However we should be aware of the fact that storage and transfer of open source materials usually adds additional work for the authors of original virtual patients without giving them any clear incentive to do that.

Surprising at first glance but understandable after consideration was the poor opinion of multimedia as an element that could be transferred while repurposing. Time saved on developing multimedia was often regarded in literature as one of the greatest benefits of reusable learning objects (e.g. [5, 11]). However, if we consider the scenario of moving, for example, videos between different countries with different cultures (e.g. different languages, different hospital equipment) it becomes clear that lot of multimedia material cannot be reused or significantly loses value in a different context. On the other hand, the problem of repurposing foreign multimedia materials inspired some of the authors of adapted cases to enrich them with new images, movies, schemas and tables.

The lack of confusion regarding ownership and copyright issues was noticeable while evaluating free text comments regarding obstacles to reusing virtual patients and comparing them with previous studies which focused on attitudes to sharing digital teaching resources [23]. This could be explained by less rigid policies regarding the reuse of educational material at our institution compared to US schools, or by the clarifications made within the eViP project while developing Intellectual Property Rights Guidelines for creating and repurposing virtual patients [2].

The results of this study do not allow us to answer the fundamental question of whether repurposing or creation from scratch should be preferred. The answers collected do not show a clear tendency, and the results were additionally confused by the fact that the group examined contained small numbers of staff members from various backgrounds with dif-

ferent experience in virtual patient creation and repurposing. The study had clear limitations that were difficult to avoid in the setting of one project and one institution. Improvements should definitely include a method for acquiring staff member opinions. Even though the questionnaire enabled the insertion of free text answers, most of the respondents filled in the Likert-scale fields and skipped the opportunity to give free text comments. Qualitative focus group studies (as in [15] or [22]) would definitely help in assessing the opinions of staff members in more detail. However, the value of this pilot study lies in pointing the way for future large scale studies.

We intentionally did not investigate the most natural assumptions regarding the money and time savings of repurposing, leaving it to other studies to do this (e.g. [16]). However, what came out as an initially surprising but very positive side effect was the knowledge transfer of new instructional methods while repurposing virtual patients. After repurposing most of the staff members at UJ felt more confident in developing their own new cases. Even though attempts were made to introduce virtual patients at UJ before 2007 [17] it was the eViP project and the repurposing of cases from other more experienced partners that changed the attitude of many towards this learning method. In the personal opinion of the authors of this paper this benefit dominated the others that are anticipated to be shown in other studies. This observation is in line with other studies in which virtual patients have already been reported as a driver for change in medical and healthcare professional education [4, 21].

## Summary

This paper shows preliminary results from a pilot study into the preferences regarding the development or repurposing of new cases. For the majority of staff members polled, the repurposing of existing cases was a great way to start introducing virtual patients at a university with no previous experience in using this method of teaching, and on top of this, the respondents enjoyed creating new cases. Limitations of repurposing were detected, such as problems with access to source material, difficulties in transferring multimedia between different cultures, and strong dependencies on national guidelines which consequently caused some of our specialists to prefer the creation of new cases to repurposing. Because the study failed to give a clear answer concerning the preferences of teaching staff, further research is needed to investigate in more detail the reasons for difficulties in adapting virtual patients at local institutions. We hypothesise that the development of an evaluation tool that could assess the repurposing potential of a case could help in selecting the right content for repurposing, and in this way save time lost on working on VP cases that are not transferable. However, it is also possible that the value of repurposing diminishes with time and experience gained in developing virtual patients. Being very interesting at the beginning to learn the possibilities of a new tool, repurposing becomes limiting in further cases when the content author prefers to implement their own educational ideas.

## References

1. Balasubramaniam, C. & Poulton, T. (2008), eViP: Electronic virtual patients, The Newsletter of the Higher Education Academy Subject Centre for Medicine, Dentistry and Veterinary Medicine 01.16, 6-7.
2. Campbell, G.; Miller, A. & Balasubramaniam, C. (2009), The role of intellectual property in creating, sharing and repurposing virtual patients, *Med. Teach.* 31(8), 709-712.
3. Cook, D. A. & Triola, M. M. (2009), Virtual patients: a critical literature review and proposed next steps, *Med. Educ.* 43(4), 303-311.
4. Dewhurst, D.; Borgstein, E.; Grant, M. E. & Begg, M. (2009), Online virtual patients – A driver for change in medical and healthcare professional education in developing countries?, *Med. Teach.* 31(8), 721-724.
5. Downes, S. (2001), Learning Objects: Resources For Distance Education Worldwide, *International Review of Research in Open and Distance Learning*, 2(1).
6. Ellaway, R.; Candler, C.; Greene, P. & Smothers, V. (2006), An architectural model for MedBiquitous virtual patient, Technical report, MedBiquitous.
7. Ellaway, R. & Martin, R. D. (2008), What's mine is yours – open source as a new paradigm for sustainable healthcare education, *Med. Teach.* 30(2), 175-179.
8. Ellaway, R.; Poulton, T.; Fors, U.; McGee, J. B. & Albright, S. (2008), Building a virtual patient commons, *Med. Teach.* 30(2), 170-174.
9. Fischer, M. R. (2000), Use of computers in medical education (Part II), *Zeitschrift für Hochschuldidaktik*, chapter CASUS – An authoring and learning tool supporting diagnostic reasoning, 1, 87-98.
10. Fors, U. G. H.; Muntean, V.; Botezatu, M. & Zary, N. (2009), Cross-cultural use and development of virtual patients, *Med. Teach.* 31(8), 732-738.
11. Frey, C.; Hege, I.; Hinske, P. & Fischer, M.R (2009), Repurposing virtual patients within the electronic virtual patient (eViP) project, *Bio-Algorithms and Med-Systems* 5(9), 84.
12. Hanebeck, B.; Tönshoff, B. & Huwendiek, S. (2009), Repurposing virtual patients for clinical reasoning: development of a guideline and assessment of time and effort, *Bio-Algorithms and Med-Systems* 5(9), 69-72.
13. Huang, G.; Reynolds, R. & Candler, C. (2007), Virtual patient simulation at US and Canadian medical schools, *Acad. Med.* 82(5), 446-451.
14. Huwendiek, S.; de Leng, B. A.; Zary, N.; Fischer, M. R.; Ruiz, J. G. & Ellaway, R. (2009), Towards a typology of virtual patients, *Med. Teach.* 31(8), 743-748.
15. Huwendiek, S.; Reichert, F.; Bosse, H. M.; de Leng, B. A.; van der Vleuten, C. P. M.; Haag, M.; Hoffmann, G. F. & Tönshoff, B. (2009), Design principles for virtual patients: a focus group study among students, *Med. Educ.* 43(6), 580-588.
16. Kempkens, D.; Hege, I.; de Leng, B.; Fors, U.; Huwendiek, S.; Kononowicz, A. A.; Poulton, T. & Fischer, M. (2010), Estimation Of Time And Efforts For Repurposing Virtual Patients – Experiences From The Electronic Virtual Patient Project (eViP), 2nd International Conference on Virtual Patients & MedBiquitous Annual Conference, London.

17. Kononowicz, A. A.; Żabińska-Popieła, M.; Roterman-Konieczna, I. & Krzysiek, J. (2005), Wspomagany Komputerowo Wielościeżkowy System Egzaminowania Studentów Medycyny, *Bio-Algorithms and Med-Systems* 1(1-2), 165-170.
18. Koper, R.; Pannekeet, K.; Hendriks, M. & Hummel, H. (2004), Building communities for the exchange of learning objects: theoretical foundations and requirements, *ALT-J Research in Learning Technology* 12(1), 21-35.
19. Oberle, S.; Huber, S.; Tönshoff, B.; Nawrotzki, R. & Huwendiek, S. (2009), Repurposing virtual patients for the preclinical years – a pilot study, *Bio-Algorithms and Med-Systems* 5(9), 79-82.
20. Sejersen, R. & Zary, N. (2009), The Role of a Learning Technologist When Implementing Virtual Patients in a Health Science Curriculum, 1st International Conference on Virtual Patients & MedBiquitous Annual Conference, Kraków.
21. Smith, S. R.; Cookson, J.; McKendree, J. & Harden, R. M. (2007), Patient-centred learning – back to the future, *Med. Teach.* 29(1), 33-37.
22. Smothers, V.; Greene, P.; Ellaway, R. & Detmer, D. E. (2008), Sharing innovation: the case for technology standards in health professions education, *Med. Teach.* 30(2), 150-154.
23. Uijtdehaage, S. H. J.; Contini, J.; Candler, C. S. & Dennis, S. E. (2003), Sharing digital teaching resources: breaking down barriers by addressing the concerns of faculty members, *Acad. Med.* 78(3), 286-294.



Table 1. General question regarding the repurposing and new VP creation process

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Answer	Average	Median
VP repurposing makes sense	0 (0%)	2 (9%)	5 (23%)	<b>8 (36%)</b>	7 (32%)	0 (0%)	3,9	4
I prefer to repurpose than to create from scratch	1 (5%)	<b>6 (27%)</b>	<b>6 (27%)</b>	5 (23%)	1 (5%)	3 (14%)	2,9	3
I would like it if my VP is further repurposed by somebody else	0 (0%)	3 (14%)	5 (23%)	4 (18%)	<b>6 (27%)</b>	4 (18%)	3,7	4
Repurposing taught me how to create VPs	1 (5%)	0 (0%)	3 (14%)	<b>10 (45%)</b>	5 (23%)	3 (14%)	3,9	4
Repurposing was for me an interesting experience	0 (0%)	1 (5%)	4 (18%)	0 (0%)	<b>13 (59%)</b>	4 (18%)	4,4	5
Creating cases from scratch was for me an interesting experience	0 (0%)	0 (0%)	1 (5%)	4 (18%)	<b>12 (55%)</b>	5 (23%)	4,6	5
Repurposing leaves enough room for self-initiative	0 (0%)	<b>5 (23%)</b>	<b>5 (23%)</b>	<b>5 (23%)</b>	<b>5 (23%)</b>	1 (9%)	3,5	3,5

Table 2. Opinions on which VP elements can be transferred between different countries (ordered by the average score)

Element	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Answer	Average	Median
Patient history	0 (0%)	0 (0%)	2 (9%)	7 (32%)	<b>13 (59%)</b>	0 (0%)	4,5	5
Examination results	0 (0%)	0 (0%)	1 (5%)	<b>12 (55%)</b>	9 (41%)	0 (0%)	4,4	4
Methods of history taking	0 (0%)	0 (0%)	2 (9%)	<b>13 (59%)</b>	7 (32%)	0 (0%)	4,2	4
Expert comments	0 (0%)	0 (0%)	3 (14%)	<b>12 (55%)</b>	7 (32%)	0 (0%)	4,2	4
Questions with feedback	0 (0%)	0 (0%)	4 (18%)	<b>10 (45%)</b>	7 (32%)	1 (5%)	4,1	4
Description of diagnostic actions and therapeutic effects	0 (0%)	1 (5%)	4 (18%)	<b>13 (59%)</b>	4 (18%)	0 (0%)	3,9	4
Multimedia	1 (5%)	1 (5%)	5 (23%)	<b>8 (36%)</b>	7 (32%)	0 (0%)	3,9	4
Selection of diagnostic methods	0 (0%)	2 (9%)	4 (18%)	<b>12 (55%)</b>	4 (18%)	0 (0%)	3,8	4
Literature references	1 (5%)	<b>10 (45%)</b>	5 (23%)	4 (18%)	2 (9%)	0 (0%)	2,8	2,5

Table 3. Preferred content of the virtual patients database

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Answer	Average	Median
It is better to have a database with fewer disciplines with more VP cases in each discipline than more disciplines with fewer VP cases in it	1 (5%)	<b>7 (32%)</b>	5 (23%)	3 (14%)	6 (27%)	0 (0%)	3,3	3
VP should present rare rather than common diseases	4 (18%)	<b>11 (50%)</b>	7 (32%)	0 (0%)	0 (0%)	0 (0%)	2,1	2
VPs should be created by people involved in teaching	0 (0%)	0 (0%)	7 (32%)	<b>8 (36%)</b>	6 (27%)	1 (5%)	4,0	4



Table 4. Opinion on the effort required while repurposing/creating from scratch (Multiple selection permitted )

	A	B	C	D	E	F	G	H	I	n
What was most time consuming while repurposing a virtual patient	3 (18%)	0 (0%)	3 (18%)	5 (29%)	<b>10 (59%)</b>	9 (53%)	7 (41%)	5 (29%)	0 (0%)	17
What was most time consuming while creating a new virtual patient	4 (27%)	1 (7%)	4 (27%)	4 (27%)	7 (47%)	<b>8 (53%)</b>	6 (40%)	5 (33%)	1 (7%)	15
What was most troublesome while creating a virtual patient	0 (0%)	0 (0%)	3 (19%)	2 (13%)	<b>10 (63%)</b>	7 (44%)	7 (44%)	3 (19%)	1 (6%)	16
What was most troublesome while repurposing a new virtual patient	1 (7%)	1 (7%)	3 (20%)	3 (20%)	7 (47%)	<b>8 (53%)</b>	4 (27%)	7 (47%)	0 (0%)	15

A) Patient history, B) Examination results, C) Methods of history taking, D) Expert comments, E) Questions with feedback, F) Description of diagnostic actions and therapeutic effects, G) Multimedia, H) Selection of diagnostic methods, I) Literature references, n) Total number of respondents

Table 5. Types of multimedia added to virtual patients (Multiple selection permitted )

	A	B	C	D	E	F	n
What kind of multimedia have you added to the VP	8 (47%)	<b>14 (82%)</b>	11 (65%)	13 (76%)	3 (18%)	2 (12%)	17

A) Patient images, B) Other images, C) Figures, D) Tables, E) Movies, F) Audio, n) Total number of respondents



## COLLABORATIVE DEVELOPMENT OF VIRTUAL PATIENTS IN CLINICAL EDUCATION

NORMAN BERMAN, LESLIE FALL

*Institute for Innovative Technology In Medical Education, United States*

**ABSTRACT:** We have developed virtual patients in three medical disciplines (pediatrics, internal medicine, family medicine) that have achieved a very broad level of use in the US and Canada. We believe that the collaborative development and maintenance model is the key to success of these projects. This model recognizes that incorporating technology in medical education is primarily an educational, not a technological, challenge.

The collaborative model incorporates six key components: 1) multi-institutional authoring to achieve comprehensive coverage of a nationally accepted curriculum, 2) a consistent pedagogical approach within and across disciplines, 3) instructors resources for integrating the program in the curriculum, 4) maintenance of the content with nationally representative editorial boards, 5) support for the academic needs of medical educators, and 6) a stable support infrastructure that is financially sustainable.

The broad acceptance of these virtual patients achieves the goals of sharing of content, elimination of redundant work, and improved medical education. We believe that the collaborative development and maintenance model can and should be advanced in other areas of e-Learning.

### Introduction

With the development of computers and the Internet as a ubiquitous presence over the last two decades there has been great interest in using e-Learning in general, and virtual patients (VPs) in particular, in medical education. Getting VPs used broadly should be an obvious goal, but this has been more difficult to achieve than might have been expected 20 years ago (1), and does not appear to be the goal for many developers. Virtual patients are time and labor intensive to develop, despite the ready availability of the technology that enables development. As it turns out, the challenge is not technological – the challenge is in creating an effective teaching program that meets the educational needs of instructors and their students (2). The overall low-level of computer-assisted instruction (CAI) use suggests that this challenge remains an important one. Given the resources needed to develop quality CAI, the ultimate goal should be getting high-quality materials not only developed, but also shared across institutions.

We describe a successful model of collaborative development and maintenance of virtual patient programs in medical education that build upon other models for adoption an integration of technology, and which we believe can be used in other settings, including graduate medical education, continuing medical education, and other health professions fields.

### Collaborative Development and Maintenance Model

The collaborative model we propose incorporates six key components: 1) collaborative multi-institutional authoring to achieve comprehensive coverage of a nationally accepted curriculum, 2) a consistent pedagogical approach, 3) resources for integrating the program in the curriculum, 4) maintenance of the content, 5) support for the academic needs of medical educators, and 6) a support infrastructure.

### Application of the Collaborative Model

The Computer-assisted Learning In Pediatrics Program (CLIPP) program began development in 2000 with the goal of comprehensively covering a nationally developed curriculum in Pediatrics with a series of virtual patient cases (3). The CLIPP project was supported with funding from United States government grants from 2000-2006. By the end of the 2004-2005 academic year CLIPP virtual patient cases were being used in pediatric clerkships at more than 75 medical schools. During the 2005-2006 academic year, approximately 11,500 individual students completed 150,000 CLIPP case sessions. This broad adop-

tion and high level of use of a virtual patient program is unprecedented. Since the 2006 academic year, CLIPP has been supported and maintained by a fee-based subscription model, administered through the Institute for Innovative Technology In Medical Education (iInTIME), an independent, non-profit, educational institute. This model has proven successful, with the number of schools using CLIPP increasing significantly since the institution of subscription fees. Currently, CLIPP is in use in more than 100 medical schools in the US and Canada, and has been extensively integrated in their curricula. The typical student completes 20 of the cases, and spends 15-20 hours per clerkship working on CLIPP cases.

The collaborative development and maintenance model that began with CLIPP is now extended to virtual patient programs in Internal Medicine and Family medicine clerkships, through partnerships with their respective clerkship director organizations (Clerkship Directors in Internal Medicine and Society of Teachers of Family Medicine). In each discipline, a Project Development Group of 4 to 5 physician educators took the lead in developing virtual patient case outlines using their respective national curricula as blueprints to ensure comprehensive coverage of the content. Clerkship directors were recruited to author the virtual patient cases, and are supported through the development process with iterative feedback from the project leaders and from an editorial team. Authoring was supported using a custom developed wiki, which greatly facilitated the collaborative and iterative process. Cases developed using this model are currently available for use in Internal Medicine ("SIMPLE: Simulated Internal Medicine Patient Learning Experience"), and in their first year of release were implemented in 50 Internal medicine clerkships. Virtual patients are also currently being pilot tested in Family Medicine clerkships (fm-CASES: Family Medicine Computer Assisted Cases for Educating Students) throughout the US, with an expected release date in 2010. A similar model is being adopted by the Web Initiative for Surgical Education (WISE-MD) project. WISE-MD began with development at a single institution, but now has authors at several other medical schools providing content for new modules. A nationally representative editorial board oversees the project, which has the support of the Association of Surgical Educators and the American College of Surgeons.

## Discussion

### Standards and Repositories

Across the spectrum of medical education there are many examples of high-quality computer-assisted instruction resources that are not being used widely. This situation exists while there are educators wanting to adopt the exact resource in their course, but these educators are often unaware that such a resource exists, or are unable to implement or integrate the resource. In some cases, this has led to development of CAI modules that are redundant to ones that are already available. Two suggested approaches to increase sharing of CAI resources are the development of technical standards and repositories.

The proposed utility of technical standards and repositories are inter-linked. Technical standards are designed to make virtual patient content interoperable across different platforms and systems. This should hold equally true for materials that are already developed, or not yet developed. With technical standards in place, it would then be possible to have VPs developed at any institution placed in a common repository and shared across institutions. If this concept was fully developed, an educator at any institution, in any discipline, should be able to go to the repository, find the VPs that they need, and be able to use them. In an ideal world, this will also be at no cost to the educator or the institution, and would not require extensive support from programmers and IT specialists. Work is underway through the Medbiquitous Consortium to develop these technical standards for virtual patients (4) and repositories are being built or proposed to facilitate access to e-Learning resources (5, 6).

While these are good and very important steps toward increased sharing of valuable resources, the application of technical standards is primarily a post-hoc approach. Very few currently available VPs were developed to be compliant with technical standards so work must be done after development to bring these resources into full compliance with the standard if these resources are to be shareable. Additionally, standards are unable to address other potentially more problematic barriers in the way that VPs are actually used.

Sharing VPs is facilitated by standards and access is improved by repositories, but these do not give course directors incentive to adopt the teaching materials. The "Not Invented Here" mindset is prevalent in medical education and often prevents educators from adopting resources that are developed at another institution. When an individual, or even a group have worked developing material at a single institution, they are then likely to find that educators at other institutions are reluctant or unable to adopt these resources. Sharing of VPs via a repository does not solve the larger problems of assembling the needed resources into a teaching program, of meeting curricular demands, and of integrating resources that are developed with differing pedagogical approaches. It is easy to underestimate the challenge of assembling disparate resources into a coherent curriculum (7). Standards are a technical solution to sharing, but integration is an educational challenge, not a technical one.

Medical education resources cannot be static. Even if a fully interoperable technical solution is developed, all resources will still need to be updated on a regular basis. Updates to shared VPs in interoperable systems are clearly far more complex than for resources that exist in a single system. Even within a single system maintaining case content is a sizeable task, which requires a commitment of people's time, and therefore an ongoing source of funding is needed to maintain content. In the world of the Internet and e-Learning, the challenge of maintaining the technology is also significant and it is easy to underestimate this challenge. Open source solutions to educational content, tools and frameworks have been proposed (8) and offer some interesting and exciting potential, but ongoing funding remains a challenge. Repositories may provide educational content at no charge to the content user, but these repositories are not without significant underlying cost.

## Advantages of Collaborative Development

Collaborative development takes an alternative approach to promoting sharing of VPs. A process that builds the collaboration upfront can overcome each of the issues discussed above that are a barrier to actual sharing of VPs.

Collaborative development fosters broad adoption. Importantly, it is course and clerkship directors who make the decisions about use of e-Learning resources – not students or deans. With educators at a national level involved in development there also exists a group of educators nationally who are interested in seeing their work adopted. The resources developed in this manner are viewed as the intellectual property of the group, bypassing the reluctance to adopt resources that were developed at a single institution.

It is intuitively obvious that developing VPs to comprehensively cover a curriculum is sensible, but doing this at a single institution is virtually impossible. With collaborative development, covering an entire clerkship curriculum becomes feasible, and integrating the virtual patients in the curriculum is facilitated (9). There are additional efficiencies inherent in collaborative development such as shared administrative resources and shared ideas. Additionally, when resources are developed to comprehensively cover a curriculum, the course director will not face the challenge of compiling disparate resources to teach their curriculum.

The pace of change and advances in medicine is nearly impossible to keep pace with using a traditional publishing model, and although the Internet greatly facilitates the delivery of up to date content, maintaining that content remains a huge challenge. By harnessing the power of collaboration, the members of the collaborative are willing to contribute to maintenance efforts and there is a far better chance that the initial work in developing high-quality resources will not be lost.

Ongoing funding will continue to be an issue with any project. Start-up funding may often be easier to obtain through grants or other sources, but the money to keep a project going will often need to be obtained through end-user fees. This means that the project needs to demonstrate its usefulness to those end-users prior to the initiation of a charge for use.

## Conclusions

We believe that the ability to transfer successfully virtual patients from grant funding to sustainable and broadly used pro-

grams was a direct result of their collaborative development. The national involvement of educators in the development and ongoing maintenance created an environment in the program was and is viewed as the collective intellectual property of the national collaboration. Participants in the collaboration have an interest in seeing the projects succeed, and understand that the only way such broadly used programs can remain viable is with ongoing financial support. This model is giving clerkship directors greater impact on medical education by having them develop for themselves the methodology needed to deliver their curricula. We believe that the process of collaborative development we describe can be used in other learning environments and for development other types of e-Learning programs.

## References

1. Friedman R. (1996), Top ten reasons the World Wide Web may fail to change medical education [comment]. *Acad. Med.*; 71(9): 979-81.
2. Berman N.B., Fall L.H., Maloney C.G., Levine D.A. (2006), Computer-Assisted Instruction in Clinical Education: a Roadmap to Increasing CAI Implementation. *Adv. Health Sci. Educ. Theory Pract.* Nov 7.
3. Fall L., Berman N., Smith S., White C., Woodhead J., Olson A. (2005), Multi-institutional Development and Utilization of a Computer-Assisted Learning Program for the Pediatric Clerkship: The CLIPP Project. *Academic Medicine*; 80(9): 847-55.
4. Smothers V., Greene P., Ellaway R., Detmer D.E. (2008), Sharing innovation: the case for technology standards in health professions education. *Med. Teach.*; 30(2):150-4.
5. Reynolds R.J., Candler C.S. (2008), MedEdPORTAL: Educational scholarship for teaching. *J. Contin. Educ. Health Prof.*; 28(2): 91-4.
6. Candler C.S., Uijtdehaage S.H., Dennis S.E. (2003), Introducing HEAL: the Health Education Assets Library. *Acad. Med.*; 78(3): 249-53.
7. Cook D.A. (2006), Where are we with Web-based learning in medical education? *Med. Teach.*; 28(7): 594-8.
8. Ellaway R., Martin R.D. (2008), What's mine is yours-open source as a new paradigm for sustainable healthcare education. *Med. Teach.*; 30(2): 175-9.
9. Berman N., Fall L.H., Smith S., Levine D.A., Maloney C.G., Potts M., Siegel B., Foster-Johnson L. (2009), Integration strategies for using virtual patients in clinical clerkships. *Acad. Med.*; 84(7): 942-9.



## ESTIMATION OF TIME AND EFFORTS FOR REPURPOSING VIRTUAL PATIENTS – EXPERIENCES FROM THE ELECTRONIC VIRTUAL PATIENT PROJECT (EVIP)

DANIELA KEMPKENS, INGA HEGE, BAS DE LENG, UNO FORS, SÖREN HUWENDIEK,  
ANDRZEJ A. KONONOWICZ, TERRY POULTON, MARTIN R. FISCHER

*For the eViP consortium: Institute for Teaching and Educational Research in Health Sciences, Faculty of  
Medicine, Witten/Herdecke University, Germany*

**DESCRIPTION:** Background: Virtual patients (VPs) are tools for training clinical decision making, but they are often time-consuming and expensive to produce. Purpose of this study was to contribute to the decision whether repurposing of existing VPs is advantageous compared to the creation of new VPs, taking into account several confounding variables that impede this comparison.

**Methods:** Within the eViP project time efforts of repurposing approximately 250 VPs for different educational and cultural settings were collated using a standardized time effort sheet. Each of the nine collaborating partners contributed their work. Data was statistically analyzed descriptively.

**Results:** Results will be reported in different categories, e.g. VP system of repurposed case, metadata, copyright issues, case structure, and multimedia. Overall time effort needed for repurposing VPs, as well as time effort to address individual categories will be presented. Problems encountered during the tasks and applicable solutions will be discussed. Special attention will be paid to confounding factors during case authoring or repurposing.

**Conclusions:** The results of systematically recorded efforts for repurposing VPs are expected to lead to an empirically grounded best-practice guideline to those considering undertaking such a task in the future in their own institutions, aiding in cost-benefit calculations.

## TIME AND EFFORT OF REPURPOSING VIRTUAL PATIENTS FROM CASUS TO CAMPUS USING THE eViP STANDARD: AUTOMATED VS. MANUAL TRANSFER

BENJAMIN HANEBECK<sup>1</sup>, STEPHAN OBERLE<sup>1</sup>, JÖRN HEID<sup>2</sup>, FRANK HESS<sup>2</sup>, INGA HEGE<sup>3</sup>,  
MARTIN R. FISCHER<sup>4</sup>, MARTIN HAAG<sup>2</sup>, SÖREN HUWENDIEK<sup>1</sup>

*<sup>1</sup>Department of General Paediatrics, University Hospital for Adolescent and Paediatric Medicine and Centre for Virtual Patients, Medical Faculty of Heidelberg University, Heidelberg, Germany; <sup>2</sup>Centre for Virtual Patients, Medical Faculty of Heidelberg University, Heidelberg, Germany; <sup>3</sup>Ludwig-Maximilians-University München, Germany; <sup>4</sup>University Witten-Herdecke, Germany*

**DESCRIPTION:** Introduction: Developing new virtual patients (VP) is costly, making it reasonable to repurpose existing cases. However, different VP systems complicate transfer of VP from one system to another. For this reason the eViP-standard was established. Efforts, boundaries and benefits of transferring VP automatically from one system to another using this standard are, as yet, unreported.

**Methods:** VP were transferred from the CASUS system to the CAMPUS system (1) by manual transfer and (2) by importing an eViP-standard compliant VP export file into CAMPUS. The eViP-standard was extended by the QTI-format. Playback was done with an eViP-Standard compliant CAMPUS player.

Manual alterations were made if needed. All efforts were noted using the eViP repurposing effort sheet.

**Results:** Efforts of transferring VP manually were 11,3 hours in average. Automated transfer reduced this effort to 1,8 hours in average. Additional manual alterations of the automatically imported VP were necessary. Problems and obstacles will be discussed. However, resulting efforts were mostly of minor relevance as cases could be easily edited within the CAMPUS Authoring System.

**Conclusions:** Repurposing VP using the eViP-standard is saving time and effort. Manual alterations were making it reasonable to speak of a semi-automated repurposing process.

## **FACTORS FOR SUCCESSFUL COLLABORATIVE CREATION, ADAPTATION AND MAINTENANCE OF VIRTUAL PATIENTS FOR UNDERGRADUATE MEDICAL EDUCATION**

MARTIN R. FISCHER<sup>1</sup>, INGA HEGE<sup>2</sup>, KATJA RADON<sup>4</sup>, SÖREN HUWENDIEK<sup>3</sup>

*<sup>1</sup>Inst. for Teaching and Educational Research in Health Sciences, Faculty of Medicine, Private University Witten/Herdecke, Germany; <sup>2</sup>Medical Education Unit, Medical Faculty, Ludwig-Maximilians-University Munich, Germany; <sup>3</sup>Centre for Virtual Patients, Medical Faculty, University Heidelberg, Germany; <sup>4</sup>Inst. for Occupational, Social and Environmental Medicine, Medical Faculty, Ludwig-Maximilians-University Munich, Germany*

**Background:** Creation, adaptation and maintenance are key prerequisites for the effective and efficient use of virtual patients (VP's) in medical education. Only when these processes work seamlessly, integration of VP's to successfully support learning can result. Furthermore, long term support and sustainability models for VP-projects depend on management of case creation and updating.

**Methods and Results:** Factors that foster and impede successful use of VP's as learning materials in undergraduate medical education on the basis of 15 years of experiences

in various national und international projects with the learning environments CASUS and Campus were identified. The factors will be exemplified and discussed to promote best-practice models of future case creation, adaptation and maintenance efforts.

**Conclusions:** The use of future VP projects should take empirically identified factors for provision of cases into account. Further data on the characteristics of sustainable VP projects are needed.

## EDUCATIONAL CONTENT ORGANIZATION AND RETRIEVAL VIA A SOCIAL NETWORK

ELENI KALDOUDI<sup>1</sup>, NIKOLAS DOVROLIS<sup>1</sup>, STATHIS KONSTANTINIDIS<sup>2</sup>,  
PANAGIOTIS BAMIDIS<sup>2</sup>

<sup>1</sup>*Democritus University of Thrace, Greece;* <sup>2</sup>*Aristotle University of Thessaloniki, Greece*

**DESCRIPTION:** Nowadays there is an abundance of up-to-date overspecialized medical educational content created by medical and health related academic institutions and available in digital form on the internet. Such educational content includes learning objects of conventional types, content unique in medical education and a variety of alternative educational content types, either reflecting active learning techniques and tacit knowledge building experiences and/or stemming from newly introduced Web 2.0 technologies. Such content is often shared among different educators and is enriched, adapted and in general repurposed so that it can be re-used in different con-

texts. Here we demonstrate a novel approach to content repurposing via social networking. The proposed social network can be viewed as two distinctive and interacting networks. The first one is a conventional network of persons, including authors, potential authors and final users of educational resources (students, or teachers or others, e.g. educational managers, etc). The second is a network of published educational resources with interactions with other learning resources as well as with persons. These interactions are variable and dynamic, thus create an evolving, user centric and goal oriented organization of resources and persons, based on social dynamics.

## THE ROLE OF SOCIAL NETWORKING IN THE EVIP PROGRAMME

SIAN CLAIRE OWEN

*The University of Warwick Medical School, Coventry, United Kingdom*

**DESCRIPTION:** A key objective of the eViP Programme is to disseminate information and distribute content to those interested in virtual patients and wider medical e-learning topics.

When developing the eViP website [www.virtualpatients.eu](http://www.virtualpatients.eu) our dissemination strategy used social networking tools such as Twitter, LinkedIn, Facebook and Wikipedia, often referred to as 'Web 2.0' tools.

We chose this approach to raise awareness of the eViP programme and to use new methods of communication to engage directly with the people who will use our resources.

This was a steep learning curve for us, and we quickly realized that some Web 2.0 tools were better than others at communicating with our target audiences.

Different tools engage people in different ways, and individuals have their own preferred method of receiving new information. Coupled to this, Web 2.0 tools are still unfamiliar to many. However, we believe that our social networking strategy has been successful at helping raise the profile of the eViP website.

During this presentation we will highlight the success of our social networking strategy, we will outline some important 'dos and don'ts' we picked up along the way, and hopefully show ICVP 2010 delegates how they can benefit from using online communication more effectively.



## USING WEB 2.0 IN CULTURAL IMMERSIVE HEALTH EDUCATION

HUNG THE NGUYEN

*Northern Territory General Practice Education, Australia*

**Abstract:** Developing empathy is one of several key principles in working in general practice and is of particular importance in the cross-cultural environment. Arguably it is more difficult to empathize with patients from another culture whose viewpoint differs based on their cultural and social experiences.

Cultural immersion and plunges is a well-researched and documented approach in solving the issues of empathy and cross-cultural interactions. Cultural immersion involves participants being placed in an unfamiliar cultural environment; and participants are guided to reflect on their experiences through proposed activities before, during and after the immersion event.

This paper will outline and discuss:

1. The cultural immersive activities at NTGPE for health students, junior doctors and GP registrars in Australian Aboriginal communities
2. The use of Web 2.0 also known as the “social web” to allow learners to generate, publish and share content more easily including reflective writing which are crucial in cultural competence training.

### Background

Developing empathy is one of several key principles in working in general practice and is of particular importance in the cross-cultural environment. Arguably it is more difficult to empathize with patients from another culture whose viewpoint differs based on their cultural and social experiences.

Practical educational models in Indigenous cultural and health education that actively enlist Indigenous people to develop health professional empathy towards Indigenous people and their situation often involve one or more of the following:

1. cultural immersion – placements within a community context [2]
2. narrative – learning through story telling of a personal account [1]
3. site visits – camps in areas of significance to Indigenous people e.g. missions, traditional land, remote communities, community health services [5] or
4. a combination of the above.

In these situations participants take the active step of going into a community.

Cultural immersion is not new, and involves the placement of students in a context, environment and culture that is different to their own. Differences between the cultural experience of the student at the time, and the community they are immersed in, are one of the key facilitators for increased awareness and sensitivity to divergent worldviews. The greater the difference, the greater the challenge for students. This does not necessarily equate to greater learning. A key element of cultural immersion that improves learning outcome is to ensure that activities are planned, guided, supported and personal reflection is promoted.

Without a reflective activity, there will be limited gains in the cultural immersion process and potential professional and personal development may not be realised.

There have been discussions around the theories on how cultural immersion actually works as an education tool. Readers should consult the paper by Scott [4], for in-depth discussion where he drew on the works of Boud and Walker and Schon, amongst other educators. Scott discusses the non-linear stages of learning: ranging from experience to attending to feelings that they engender. The stages include: preparation – where learners are given knowledge, strategies, tools and skills to promote learning; experience then becomes the foundation to stimulate reflection in action; and finally, reevaluation which involves reflection, integration of experiences, validation of experiences and owning the experiences.

### The Northern Territory Context

The Northern Territory of Australia (‘the NT’ or ‘the Territory’) is defined by low overall population (approx. 200,000 people; 50% of these live in remote areas), low population density (0.1 person/km<sup>2</sup>), and high proportion of Indigenous people (30% of the population with the 90% living in remote area). These are key issues affecting the delivery of health care services and education programs in the Territory.

Northern Territory General Practice Education (NTGPE) is recognised nationally and internationally for its progressive approach to Aboriginal health education. NTGPE’s Indigenous Health Training (IHT) team plans and develops the cultural education component of all its core programs which include:

1. General Practice Registrar cultural and medical education;
2. Medical Student Placements in rural and remote general practices, Aboriginal communities and hospitals;
3. Junior Doctors cultural and medical education;
4. International Medical Graduate Education and Support.

NTGPE places students, Junior Doctors and Registrars in health services across the Northern and Central Australia, and maintains very strong relationships with Aboriginal Health Services in the Territory.

### Cultural Immersion Program for Medical Students

Medical students come to the NT from all major medical schools in Australia and are placed in indigenous communities

and health services by NTGPE. Annually, NTGPE places about 170 students. This number varies, though there is increasing pressure to place more from feeder medical schools. A small proportion of students are from international universities. Upon placements, students participate in a cultural immersive program which involves:

1. A 3 day intensive orientation: which include cultural, clinical and contextual orientation to the unique aspects of working, training and living in rural and remote Northern Territory. The program has been documented in [3] and is delivered by Aboriginal cultural Educators, Medical Educators and the Program Coordinator.
2. Four to eight weeks placement of students in regional and remote clinics and communities: Rural means regional towns with a population of 5000 people or more. The closest town to the capital city Darwin is 330 kilometers and the furthest 1,500 km. Remote refers to isolated



Fig. 1. Placement locations for program participants. Darwin is the capital city and is considered an outer regional town. The rest of the NT is considered remote (Australian Standard Geographic Classification – Remoteness Areas (ASGC-RA) systems.)

discrete Aboriginal communities and other towns. The usual population ranges from 600 to 2000 people. About 89% of the indigenous population lives in rural and remote locations.

3. A weekly teleconference for students dispersed over the NT to discuss their experiences. The topic is directed by students and may include their experiences in the clinical, cultural, remote, health systems and geographical issues.
4. Access to NTGPEConnect, which is a social networking tool (see below).
5. An individual debrief session with an Aboriginal Cultural Educator, Medical Educator and Program Coordinator. This meeting or series of meetings foster thoughts, reflection and feelings about the placement experience away from the community and with guidance from the above staff.
6. Students are then asked to complete an online survey or evaluation of the program.
7. Access to Program Coordinator for placement and wellbeing issues.

## NTGPEConnect

NTGPEConnect (powered by WordPress) was created in 2009 to enhance student reflection on their experiences. NTGPEConnect is designed to connect medical students amongst their peers and with NTGPE program staff. It allows students to contribute supplementary local information and support for other students in the NT. Content is created mainly by students and are categorised and stored on the website. Future stu-

dents are able to access valuable insights into past student experiences (based on location of placement as well as territory wide), tips and suggestions as well as increase their excitement and motivation for placement through the above reading and uploaded photos. This was not possible or had limited effect when paper-based or in teleconference forums.

Consideration was given to setting up a public social network account for the above activity. However, due to potentially sensitive information discussed by students about Aboriginal communities, remote clinics, Aboriginal culture and their own personal feelings and details, a publically accessible social networking platform was deemed inappropriate. NTGPE reserved the right to monitor and withdraw inappropriate materials. Only students and NTGPE program staff have access to the website. This excludes the clinics, communities and students' supervisors.

The main features of NTGPEConnect are principally:

Student profiles allow student to search and find out more about current and past students in the program. They can then network with each other as friends

Community profiles are created by student from their special experience during their immersion.

Reflective writing is a compulsory activity of the program. Reflective writing is posted on NTGPEConnect. Students can request for their reflection not to be made public.

Resources repositories are contributed by students and educators. In most situations it is driven student need.

Students are able to upload and share photos of their community experience.



Fig. 2. NTGPEConnect's home page



### Student feedback so far:

Results presented here are available from 70 students. Not all students answered every question.

### Student demographics:

Students are mainly under the age of 27 years of age – 23-27 years (54%); 18-22 years (31%); 28-37 years (15%). They tend to be female (73%). The program only takes in senior medical students in their clinical years. Students voluntarily apply to be placed in the program (45%). Those who are placed as part of the medical school program make up 28% of the cohort. A minority is placed as part of a scholarship program (27%).

A sizeable portion of the cohort lived in an Australian rural and remote location previously (47%). The majority of students originated from all Australian major cities and 6% from international universities. Students are placed in either remote community clinics (46%); rural Aboriginal clinics (20%) or rural hospital (24%).

### What students think of the program

When students were asked to rank whether the program helped them achieve their objectives, the majority thought the placement allowed them to achieve their personal (excellent 44% and above average 38%) and university learning objectives (excellent 28% above average 36%).

Students did not feel that the placement was stressful (no 43% and mildly 53%).

There was an increased interest in rural practice with 70% of students wanting to work in rural areas and 72 % wanting to work remotely (53 respondents).

Students were asked to rank educational and support activities (70 respondents). Percentage of students ranking orientation, teleconferences and community supervision as being above average or excellent were 72%, 27% and 63% respectively.

### What students thought about NTGPEConnect

NTGPEConnect's overall rating was highly ranked (out of 45 respondents) and acceptable to student as an educational and social networking tool within the cultural immersion program (see figure 3). The primary activities (> 50% of students) on NTGPEConnect were to search for other students; view members' profiles and read peer reflections. Secondary activities (40-50% of students) included accessing resources and browse community profiles and information. Other activities (20-40% of students) were sending messages, viewing forums, and adding reflections. Students were least likely (<10% of students) to participate in a forum, comment on a post, add wire message and photos. About 17% of students "did nothing" on NTGPEConnect.

### Student reflection excerpts:

There are number of recurring themes in student reflective writing.

#### 1. The workplace is different...

Similarly, without the gamete of allied health staff we are accustomed to having available to refer patients onto, or coordinate community programs, the roles of remote clinic staff are not as well defined as in other workplaces. The job of Remote Area Nurses, in particular, is clearly an advanced form of prac-

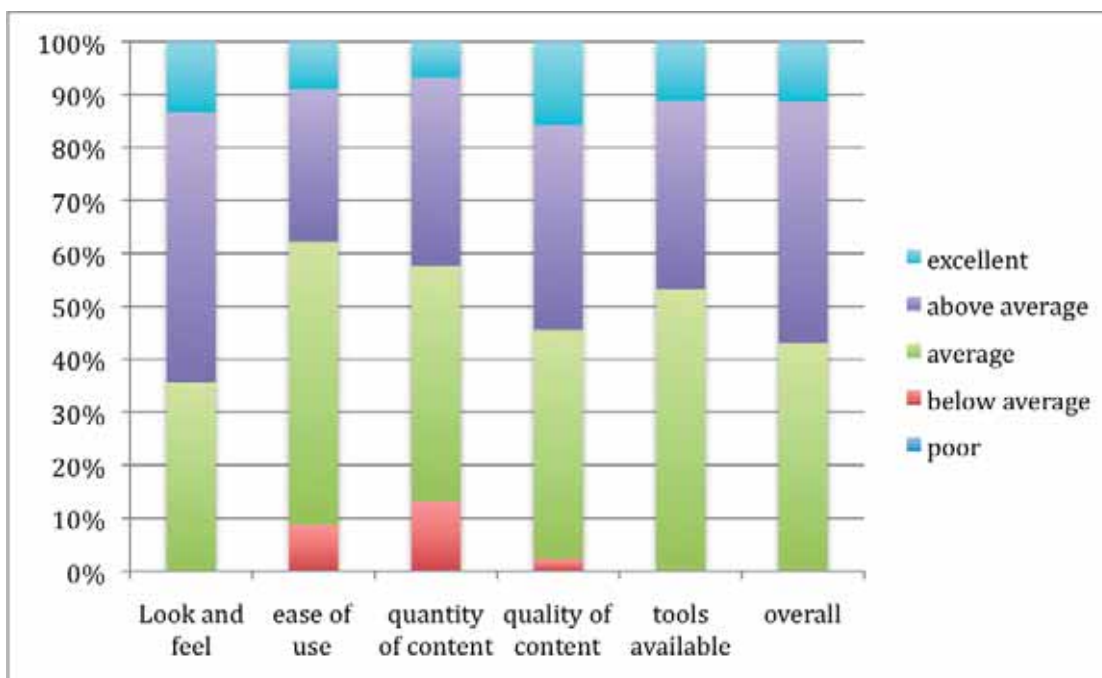


Fig. 3. Rating of NTGPEConnect

tice, described by one RAN to be “...doing social work without being social workers, community development without being community development officers and prescribing drugs without being a doctor.” It is therefore unsurprising that the current reliance on short-term contract and agency staff, with swift orientation and limited ongoing support, leaves inexperienced staff overwhelmed and reluctant to sign to permanent contracts. At least this health centre has the advantage of two doctors available to review patients if nurses feel a patient's problem is outside their scope of practice; at some clinics the only backup is a doctor at the other end of the phone in Darwin.

*Medical student placed in a top end remote Aboriginal community, 2009*

## 2. More than a GP placement...

The placement reinforced my understanding of the systematic issues in Indigenous health, and has given me many more examples to use with friends who question why we are not making more rapid progress to close the gap in health status between Indigenous and non-Indigenous Australians. Despite the focus of this report, my time in [remote Aboriginal community] was not all doom-and-gloom. I had many good experiences such as:

- Sitting in on consultations with [the resident GP]; assisting visiting surgeons with minor procedures;
- Making a head start to next years curriculum by working with the midwife and mental health nurse;
- 'Taking it to the streets' by delivering the swine flu vaccine from the back of the ambulance, and a park bench in front of the shop;
- Friday night jam sessions with [the GP] and several RANs on guitar and harmonica;
- And in particular, the privilege of being taken to Redcliff, the traditional country of one of Adrian, the clinic driver. I was taught to identify bush tucker, and catch mudcrabs as well as enjoying gorgeous bushland and appreciating Adrian's spiritual connection to the land.

*Medical student placed in a top end remote Aboriginal community, 2009*

## 3. Developing empathy...

A. I feel much more aware of the reality of the health problems faced by certain Indigenous populations, and the difficulties that need to be overcome on a day-to-day basis, which is so far removed from what the policy makers may think can be implemented. I learnt the value of asking, of listening to each individuals story and avoiding the trap of bringing any preconceived judgments or assumptions to a consultation. I learnt a lot about the way I deal with challenging situations, whether it's a different culture, language barriers, medical emergencies or just being away from mates. But all those obstacles just made this an even more valuable, stimulating and rewarding five weeks.

*Medical student placed in a top end remote Aboriginal community, 2009*

B. Over time I opened my eyes and things once very different and confronting softened. I began to appreciate the hues of sunset, the smell of fires at night time, the stand offs between dogs and donkies and the natural tan of red dust. I feel like I've seen a very different approach to life. I started this placement unsure of what to expect and now embrace the motto expect the unexpected.

*Medical student placed in a desert community, 2009*

C. And that's probably why it has come to seem so normal to me. Because it is normal for the people here. Unlike me, they've lived here (or on another community) all their lives, and they haven't seen how in other places things are different. How, where I come from in Melbourne, most children are not likely to get scabies and otitis media before their first birthday. How people don't often get Type 2 Diabetes in their 30's.

*Medical student in urban Aboriginal community, 2009*

## How Students Use NTGPEConnect

### 1. Network with friends

Hey [friend],

hear you're having a great time down there. was hoping you might make it to the teleconf today. i won't be at the debrief on friday morning but should see you back at the accomodation. i was just keen to touch base to see if you had plans for fri night/sat.

### 2. Talk to educators

Hi [medical educator],

Spent some time looking at the Bush Book stuff in between patients today. Very interesting. We've had a few conversations about this sort of things in the last week... Will be good to talk to everyone about it on Wed.

I'm not sure what I was expecting when I arrived in Jabiru. Part of me definately thought that its close proximity to Darwin, large non-Indigenous population and high tourist load would mean that elements of the experience may not be that disimilar to what I was used to. I couldn't have been more wrong.

### 3. Provide tips for current and future student peers

A. I did my John Flynn placement here last year in Nov/Dec. I was at the Tennant Creek Hospital. It was a fantastic clinical experience. Make sure you go out to some of the remote Aboriginal communities with any visiting specialists that come up from Alice Springs because those experiences are invaluable. I went with the audiology guy to check the hearing for three days, then flew out another day with the paediatrician to some other communities. If you make friends with the young locum doctors and the people in the path lab you'll have heaps to do when you're not in the hospital.

B. If you're at Wurli you'll be in the 2BR unit right in the middle of town. Usually shared with a junior doctor if there is one around. Everything you need is there but computer access is only available at the clinic. If you need after hours bring a lap-top – for music too

C. Loads to do in and around Katherine. If you can get access to a car that will help as most big things are 20-50km out of town, but if not don't despair. The gorge: See the gorge. A bus runs three times a day and is \$12 each way, book at Transit Centre or Nitmiluk NP Office

### 4. Post and share thoughts and feelings

So I've just finished my first week of my placement on [remote island community]. The [Health Centre] is awesome. The people are amazing and I am overwhelmed by what they do here! I have already had some fantastic experiences...but more importantly the indigenous people here are so wonderful and friendly. Their smiling faces and their gorgeous children are so much fun to be around (even though we're in a clinic!!). The Aboriginal Health Workers are incredible at their jobs... and the nurses and doctors are passionate about what they're



doing...it's really inspiring. There's something about this island that has already gotten under my skin...the top end (especially up here above East Arnhem Land) is so beautiful and at the moment I can't think of a place I'd rather be!!!

### 5. Sharing photos



Fresh Kangaroo for tea



Basket weaving with the family



Magpie goose hunting



Remote Aboriginal Community Clinic



Prepare for the terrain



Typical student accommodation in remote aboriginal communities



Don't swim and yes there are crocodiles in the water (yaka = no).



Health promotion and cooking class

### Future Activities

In less than one year, NTGPEConnect has proven to be a valuable additional resource in the NTGPE Cultural Immersion Program for medical students placed in remote communities for 4-8 weeks. Students valued its role in allowing social networking and the opportunities to share experiences. For the first time we are able to capture and document students' professional and personal experiences. These writings are sought after by their peers.

There are areas where NTGPEConnect could further develop and some areas where improvements can be made to enhance learning outcomes. Educational and support aspects of the culture immersive process will evolve as NTGPEConnect changes. Areas that require work include:

1. Making the resource easier to use by keeping it simple.
2. Ensuring students are orientated to NTGPEConnect and know how to adequately use it before they are placed in their community. There has been the assumption that all students are familiar with social networking and blogs.
3. Improvements in quantity and quality of content provided by NTGPE are planned. This is where NTGPE may start to help students orientate and understand the community they will be, or are, placed in.
4. Increase cultural content and discussion. Aboriginal Cultural Educators (ACEs) have lower online literacy and are less likely to participate. To improve this we will need to plan more intensive training, support and guidance for ACEs.
5. Qualitative evaluation focusing on students' experiences of NTGPEConnect and its ability to enhance reflection will need to be planned and implemented. We need to gain students views on the educational activity, online tools, processes and repositories of information on NTGPEConnect. We also need to explore factors that may impede reflection. Some issues are reflections are accessibility to NTGPE staff and the public; and the nature of NTGPEConnect within the student group.

### Conclusion

Cultural immersions and plunges are well-researched and documented approaches in solving issues of improved empathy and cross-cultural interactions. The use of Web 2.0 can enhance these educational processes for medical students placed in remote Aboriginal communities in Australia's Northern Territory.

### References

- [1] DasGupta S. et al. (2006), Teaching cultural competence through narrative medicine: intersection of classroom and community. *Teaching and Learning in Medicine*; 18(1): 14-17.
- [2] Kamaka M.L. (2001), Cultural immersion in a cultural competency curriculum [abstract]. *Acad. Med.*; 76: 512.
- [3] Morgan S. (2006), Orientation for general practice in remote Aboriginal communities: A program for registrars in the Northern Territory. *Aust. J. Rural Health*; 14: 202-208.
- [4] Scott C. (2006), Giving voice to the learning experiences of adults participating in a multicultural immersion programme. *Int. J. Learning and Intellectual Capital*; 3(1): 74.
- [5] Takayama J.I., Chandran C., Pearl D.B. (2001), A one-month cultural competency rotation for pediatrics residents. *Acad. Med.*; 76(5): 514-5.

## WORKFLOW MODELING SIMULATION IN SECOND LIFE: A CASE STUDY

JULIANA J. BRIXEY, JUDITH J. WARREN

*University of Kansas School of Nursing, United States*

**DESCRIPTION:** It is imperative that health informatics students develop workflow modeling skills to design and implement health information systems. Workflow models guide the development of systems that fit clinicians' existing work rather than adjusting their work to a new information system. During a workflow modeling activity, designers collect data about the flow of work in the current system. Data collection often involves direct observation of the process during which designers sequence work processes, identify persons directly involved in the performing of the work, plus pinpoint information handoff occurrences. This is a challenging activity for students to complete in fast-paced clinical settings or when read-

ing text-based case studies. Second Life (SL) can be used to simulate a clinical environment without the time pressures and variations between healthcare organizations or the imagination required to interpret a text description. A standardized simulation in SL facilitate students' observations of the workflow for a staff nurse and director of nursing using a pencil and paper tool to assess patients' falls risk. Students subsequently design an automated clinical information system for that tool. Faculty provides constructive feedback thus replicating the experience of working with end users. Students report the SL simulation as a rich, positive learning experience.



## VERSE: WORKFLOWS FOR SIMULATION AND VIRTUAL WORLD TELEMETRY AND CONTROL

RACHEL ELLAWAY, ROGER SANCHE, CRAIG SYMINGTON, DAVID TOPPS

*Northern Ontario School of Medicine, Sudbury, Ontario, Canada*

**Abstract:** Simulation involves learners engaging in practices that replicate real-world practice. Feedback and other educational benefit is derived both from direct observation and from the analysis of data capture representing learner actions. Many if not most information systems generate logs and other records of their use but these are usually stored in or in close proximity to the device or system itself. A number of newer systems provide some kind of API (application programming interface) for accessing and controlling them from elsewhere.

Telemetry is the remote recording and analysis of data and information. The VERSE project (Virtual Educational Research Services Environment) has been funded by the Canadian Fund for Innovation to develop virtual reality research infrastructure. The project has focused on two areas: a) creating a centralized system for capturing telemetry from multiple and heterogeneous devices and b) distributed control of authoring and the execution of simulation activities using OpenLabyrinth and Second Life. This presentation will explain and demonstrate the work of the VERSE project and describe the data models and workflows for the remote capture of simulation telemetry and how a game state engine can be used to control events and interactions in a virtual world platform.

### Introduction

Simulation in healthcare education involves learners engaging in activities that replicate aspects of the real-world practice. Feedback and other educational benefits are derived from direct observation and analysis of data generated by learner (inter)actions. While much has been done regarding direct debriefing and feedback, the generation and analysis of objective metrics has hitherto been difficult to achieve.

Most information systems generate logs and other records of their use but these are usually stored on the device or system. A number of newer systems provide some kind of API (application programming interface) for accessing and controlling the system remotely although this approach is still new and relatively unexplored.

This paper outlines the work of a research infrastructure project (VERSE) that has developed data models and workflows to use telemetry for the remote capture of simulation data and the integration of different simulation devices to create new hybrid applications.

### Telemetry for Simulation

Telemetry is the remote measurement, transmission, recording and analysis of data. The concept implies at least two separate but linked systems: the provider and the consumer of the infor-

mation. In a complex system, there may be many providers and consumers. Telemetry is key to distributed systems and is an essential component of the modern intensive care unit as well as underpinning telehealth. The use of telemetry in simulation for healthcare education has been somewhat limited although some use has been made of simulating real-world telemetric environments [1].

Simulation telemetry (rather than the simulation of telemetry) becomes important where:

1. Simulation devices are able to transmit data arising from learners actions and interactions
2. Simulation devices or their users are geographically distributed
3. Simulation devices are used in combinations that require data to be shared to create new hybrid applications

There are some parallels with telemetry used in telehealth (such as remote control of sensors and instruments) but there are also many differences. For example, the telemetry may be used to make observations about the operator rather than as a real-time exchange of robotic controls. Telemetry from a number of devices might also be combined to extract by triangulation some indications of operator performance. The interpretation of simulation telemetry is the end goal of this process as the data is applied to supporting the evaluation process for individuals and groups. However, the construction, validation and application of such models is beyond the scope of this paper. We shall simply concentrate on the infrastructure

and technical implementation of an environment that can support simulation telemetrics.

The work described here was conducted as a part of the 'Lakehead University Virtual Centre for Advanced Research in Teaching and Training' project (LUV CARTT) that was funded by the Canada Foundation for Innovation (CFI) to develop infrastructure to support virtual reality research. VERSE (Virtual Educational Research Services Environment) was the last phase of the LUV CARTT Project. The project has focused on two areas: 1) creating a centralized system for capturing telemetry from multiple and heterogeneous devices and 2) distributed control of authoring and the execution of simulation activities using OpenLabyrinth and Second Life.

### Architecture 1: Telemetry Core

The full design for the telemetry capture mechanism is set out in the separate 'Services for Telemetric User Data Input and Output (STUDIO)' specification. We will reprise the design for this paper as follows. Effectively, devices connect to a central online data hub made up of a software application that manages connections, security, data translation, registration and other workflows, and a database for storing the device profiles and telemetric data. The essential component in connecting a device to the STUDIO hub is the use of a device connector, a middleware widget that:

- Connects to a specific device and communicates with it in whatever way the device is able to support
- Supports the configuration and pairing processes required to register a device on the hub
- Communicates with the *STUDIO Management* system using a standard messaging protocol
- Manages and responds to any messages (including actions) passed to it

Figure 1 sets out a flow diagram for the key components within the system:

There are two workflows involved with using a device with STUDIO:

- *Device connection*: this involves the implementation of a device connector keyed directly to a new device.
- *Device registration*: this involves a pairing process to ensure security and exchange of data once the device is registered. A data key is generated by the STUDIO application and stored on the device connector to be used to authenticate data streams.
- *Device profiling*: this involves registering the parameters that will be sent (such as x/y position, heart rate or time) and typing them (integer, string etc) so that an incoming stream can be validated. A device may have multiple profiles.
- *Data capture*: this involves data being transferred from the device through its connector to the STUDIO application and database. This can happen in several ways:
  - *Real-time*: data is sent either on a regular cycle such as every n seconds or in response to a user interaction or a change in internal state. A data set is therefore made up of multiple data transfers corresponding to a single user session with the device.
  - *Bulk transfer*: data is sent as a whole session collection of parameter/value pairs along with a timestamp for each one that collectively represent a user session. This is done when sending data as a real-time stream may be too complicated or otherwise create an inappropriate load on the device's host computer(s) and/or infrastructure

For the VERSE project the STUDIO implementation involved:

- A single STUDIO hub server built in C# and MS SQL Server
- A generic connector widget intended to be adapted to connect to as yet unspecified devices – note that the device-facing part of the widget always needs to be paired with its device as there are no standards or even common methods for devices to express their telemetry at this time
- A number of devices were connected to test different modalities and kinds of data:

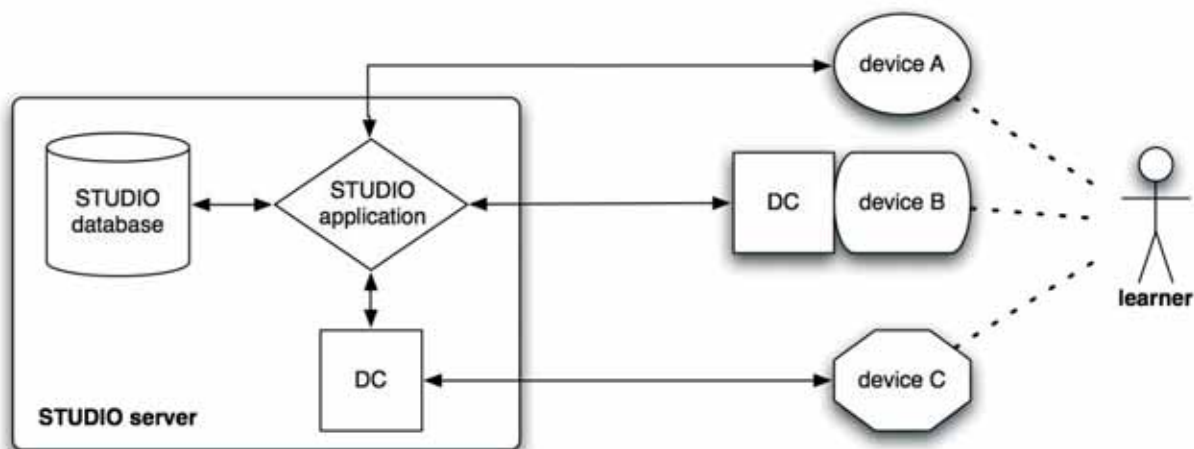


Fig. 1. components and connections in a STUDIO telemetry capture environment. Different devices can connect in different ways. Device A is able to connect directly over the Internet by implementing the STUDIO telemetrics data exchange model. Device B has a device connector (DC) located on the same machine as the device – for instance to allow the DC to access log files saved on the computer. The DC for device B also communicates with the STUDIO server over the Internet. Device C connects to the STUDIO server to access a remote DC.



- *Second Life*: a heads-up device (HUD) was developed to extract telemetry from the Second Life synthetic world. Any Second Life avatar can wear the HUD. When activated, it streams a predefined set of telemetry about the avatar wearing the HUD to the STUDIO hub. The data included the avatar's X, Y and Z coordinates, their location and movement, the direction faced, their current actions (walking, running, flying etc), text chat dialogs, and proximity to other avatars and objects. Because Second Life only supports open HTTP traffic its device connector differed from others by requiring the DC to translate between Second Life messaging and the XML format required by STUDIO.
- *OpenLabyrinth*: this is an open source serious gaming engine used for educational designs such as virtual patients. One OpenLabyrinth server can contain many labyrinths, any one of which can be run independently by any number of users at any time (including synchronously). All user interactions are tracked. Data is sent as bulk once a session is complete and includes user and session information, the sequence of nodes clicked, a timestamp for each click and the values of all counters at each node click.
- *Haptics*: we connected an OMNI Phantom stylus-based haptic controller. This device provides touch and force-feedback interactions with virtual computer based models. The data comprises regular samples of the stylus location ("in space" and image contact), image touch feedback (surface deformation and magnetism) and actions based on "click" events (grabbing and moving the image). During early development, data was captured using a live stream. However, because the device was sampling at millisecond intervals, this slowed the host computer too much. It was switched to a bulk upload model where the device connector processed the log files for a session once it was complete.
- Some preliminary work was also undertaken with connecting Circle Twelve DiamondTouch light surfaces but this was not completed due to time constraints.

## Architecture 2: Virtual World Core

Second Life is a massively multiplayer synthetic world from Linden Labs. It offers a wide range of APIs and other controls to support customization and new features but, other than the world itself, it has no specific purpose – that is provided by those who work within the world. We leased a private island within Second Life (called 'Nossum Island') to give us the required control over what happens there. The functionality we describe here could not be implemented on the Second Life mainland due to access rights and security restrictions.

Using Second Life as a navigational and presentation environment supports a rich immersive experience but the base capabilities of Second Life do not support complex predefined simulation scenarios. Daden Limited have previously created the open source PIVOTE toolset to allow SCORM packages that use the MedBiquitous virtual patient specification to be run in-world. The activity is controlled through a six-button interactive heads up display (HUD) [2].

A limitation with the PIVOTE model was the dependency on a whole activity being expressed at once. There is little or no state modeling or dynamic execution in response to user interactions. The VERSE Project addresses this by providing a set of APIs and tools, collectively called 'Ariadne', to connect OpenLabyrinth to Second Life. This allows dynamic pathway-based activities to be authored and run in-world whilst being controlled from OpenLabyrinth.

Ariadne is an open source (<http://code.google.com/p/nosm-verse/>) middleware application for connecting OpenLabyrinth to Second Life using components of the PIVOTE player. Ariadne surfaces a set of tools with OpenLabyrinth and controls messaging and data exchange between the two systems. The in-world Ariadne interface allows groups of objects (props, environments, animations) to be realized according to parameters sent by OpenLabyrinth – see figure 2 for a diagram of the components in this architecture.

There are two user interfaces:

- Authoring tools surfaced within OpenLabyrinth to allow Second Life functionality such as scenery, props, anima-

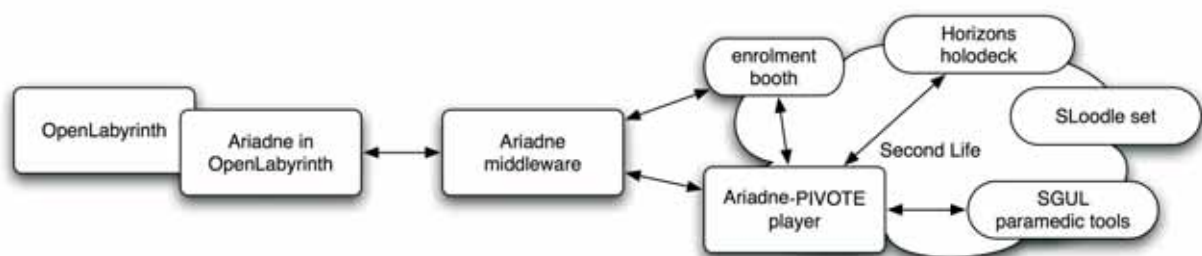


Fig. 2. diagram of the OpenLabyrinth – Ariadne – Second Life integration architecture

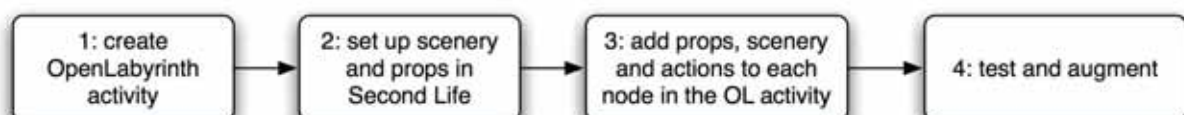


Fig. 3. Ariadne workflow

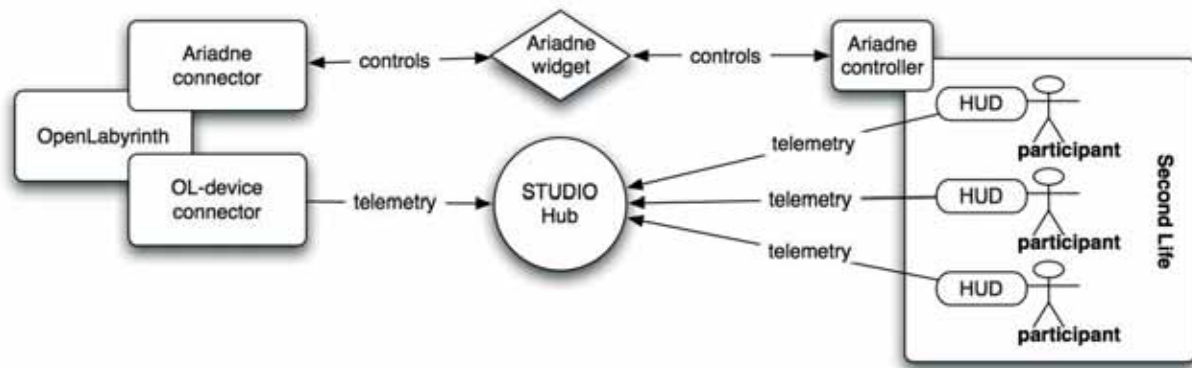


Fig. 4. Ariadne-enabled multidimensional telemetry

tions, interactive objects and other resources to be added to each node in a labyrinth activity

- In-world rendering engines such as an adapted PIVOTE player and the Horizons holodeck for changing scenery and props; an enrolment booth to equip player avatars with the appropriate tools and information; and a series of pre-defined active props and tools to support the main activity.

The workflow in preparing a labyrinth to be rendered in Second Life is shown in figure 3

It is worth noting that the telemetry from a multi-user Ariadne activity can easily be made multidimensional by having each participant avatar wear a STUDIO tracking bracelet. This tracks their movements and interactions, which is then cross-matched with the session data from OpenLabyrinth – see figure 4.

## Discussion

The primary purpose for the CFI funded work described here is to create infrastructure that enables and supports research by using the many aspects of virtual reality. We have interpreted this as including technology-enabled simulation as this certainly makes multi-modal use of many virtual realities – to date each modality has only been able to run inside its own immediate technical environment. By creating connectors to stream or collect the telemetrics generated by a range of different simulation devices, we enable a number of research streams.

For instance, having a single database of telemetry and logs from multiple simulation devices supports the development of modeling and benchmarking research around individual and group performance. Whether it be triangulation, factor analysis or variations in performance between devices or over time the opportunities seem many and broad. Furthermore this work is intended to contribute to a set of interlocking projects

developing the capacity to create simulation continua across multiple devices [3].

An important aspect of educational evaluation is the documentation of objectively observed activities. However, in today's litigious world, sub-standard performance evaluations are often challenged and subjective and witness commentary is known to be faulty. Detailed tracking of actual movements, actions, communications and procedures increases the power and reliability of the tools used for high stakes examinations.

## Acknowledgements

This work was carried out as part of the LUV CARTT project funded by the Canadian Fund for Innovation (CFI) as a partnership between the Northern Ontario School of Medicine and Lakehead University.

## References

1. Blasak, R., Starks, D., Armel, W., Hayduk, M. (2003), Healthcare process analysis: the use of simulation to evaluate hospital operations between the emergency department and a medical telemetry unit. Proceedings of the 35th conference on Winter simulation: driving innovation, New Orleans, Louisiana, 1887-1893.
2. Conradi, E., Kavia, S., Burden, D., Rice, A., Woodham, L., Beaumont, C., Savin-Baden, M., Poulton, T. (2009), Virtual patients in a Virtual World: Training Paramedic students for Practice, *Medical Teacher* 31(8): 713-720.
3. Ellaway, R., Kneebone, R., Lachapelle, K., Topps, D. (2009), Connecting and combining simulation modalities for integrated teaching, learning and assessment, *Medical Teacher* 31(8): 725-731.

## STUDENT E-LEARNING INITIATIVE: STUDENTS AS EDUCATORS AND PARTNERS IN THE DELIVERY OF UNDERGRADUATE MEDICAL EDUCATION

JANE WILLIAMS, DOMINIC ALDER, WILL DUFFIN

*University of Bristol, United Kingdom*

**DESCRIPTION:** Many undergraduate medical students at the University of Bristol enjoy developing e-learning materials as part of an initiative to produce online, interactive learning resources. These electronic materials are developed as part of the Student Selected Components (SSCs) programme providing opportunities for independent study. Students begin to develop a range of skills including knowledge and application of learning and teaching practice through the development of learning resources thus fostering at an early stage the skills for becoming future medical educators.

The student e-learning initiative is now in its sixth year with approximately 10% of the student cohort participating. We will present the student e-learning initiative highlighting

selected resources to illustrate the innovative ways in which students have used technology to teach complex areas of the curriculum. We will describe the support and quality assurance framework which underpins the student-teacher collaboration including pedagogical, legal, ethical and technical issues. Finally, using short reflective stories from students and staff with e-learning examples, we will provide evidence to support the notion of students as educators and partners in the delivery of undergraduate medical education.

### References:

1. Mumford, D.B. (2007), Clinical academies: innovative school-health services partnerships to deliver clinical education. *Acad. Med.* 82(5), pp. 435-40.



## TASTEOFMEDICINE.COM – INNOVATIVE USES OF E-LEARNING TECHNOLOGIES TO WIDEN ACCESS AND SUPPORT SOCIAL EQUITY

KENTON LEWIS<sup>1</sup>\*, KIRSTY WADSLEY<sup>2</sup>

<sup>1</sup> Head of Widening Participation & Student Recruitment, St George's, University of London;

<sup>2</sup> College Liaison Officer, St George's, University of London

**Abstract:** St George's, University of London takes a lead in widening access to medical and healthcare education for those from socially disadvantaged backgrounds. This includes such measures as social class (derived from parental occupation), state funded education, disability, ethnicity, experience of the social care system and low family income.

Among a wealth of initiatives ranging from primary school through to adult learners (SGUL 2010), ongoing developments to [www.tasteofmedicine.com](http://www.tasteofmedicine.com) include the construction of four distinct micro sites, that form a family of resources mirroring the student lifecycle model and supporting the educational development of potential students.

Our evidence has shown a considerable impact on potential students and has formed a central part of our efforts to recruit medical and healthcare students from a broad and diverse range of backgrounds.

This paper explains how the site was developed as well as the reasoning behind its creation. We also offer details of the range of innovative ways in which this web resource is to be developed over the coming years and explain how, as an approach to reaching hard to target audiences, there is significant scope to develop similar resources outside of the UK.

### Context

A key strategic aim at St George's, University of London is a commitment to offering medical and healthcare training to as broad a cohort of students as possible. In order to ensure this, we undertake many programmes aimed at increasing awareness, boosting aspiration and raising attainment among younger students from disadvantaged backgrounds who would not otherwise consider Higher Education as an option. The students St George's works with are the National Health Service employees of tomorrow, and as such we must ensure that the workforce we train is as representative as possible of the community it will serve.

Medicine and the professions allied to medicine have been identified as one of the worst performing subject areas with respect to widening access (Hilton and Lewis 2004) with there being strong perceptions of medical schools in particular as elitist and catering for a traditional 'type' of person (Greenhalgh et al. 2004). When this is combined with the concept that medical education provides a workforce for supporting the community, the necessity to ensure Widening Participation (WP) in medicine and the professions allied to medicine becomes clear.

This broad area of work follows a student life-cycle model, engaging with individuals at all stages of their educational de-

velopment through primary and secondary schooling, Further Education and sixth form colleges, academic and pastoral support during Higher Education studies, and encouragement of mature students returning to formal education. Collectively this forms the St George's WP strategy; a commitment to encouraging those from sectors of society currently under represented in Higher Education.

This interactive, educational and engaging website, targeted specifically at early secondary school students (aged 12 upwards), is a core element of our WP strategy that is able to reach a large number of students at an age when they are experiencing educational transition. The move into secondary school is a point at which many of those in the social groups we wish to target become disengaged from their education – it is important that we work to reduce this disengagement as much as possible.

It is a completely free to use resource that specifically aims to support those from sectors of society currently under represented in Higher Education (such as first in their family to go to University, lower socio-economic groups, state funded education, ethnic minority groups) by challenging inaccurate stereotypes and ensuring transparent and appropriate information, advice and guidance is available in a format that is appealing and accessible.

Initially developed as a CD-ROM in 2003 with a distribution of 8,000 units, it quickly became clear that demand for the resource was extensive. A further print run of 59,000 CD-ROMs soon followed, but it was evident that even producing at this

\* Corresponding author: Kenton Lewis, [klewis@sgul.ac.uk](mailto:klewis@sgul.ac.uk), + 44 (0) 208 725 5879





Fig. 1. "Getting started" home page – the landing site for the first of four micro sites on [www.tasteofmedicine.com](http://www.tasteofmedicine.com) – specifically aimed at younger students



Fig. 2. Experts' reflections – an example of the talking head style video clips featured in "Getting Started", offering users a chance to hear directly from senior healthcare staff

greater scale, demand was far greater than we could supply in this format. By this time, advances in Macromedia Flash video technology and the increased numbers of people with broadband access gave us the opportunity to satisfy this greater demand with redevelopment of the CD-ROM based application for online use.

Two central themes formed the foundation of this development:

- Stereotypical views of medical students being only from privileged backgrounds is inaccurate and should be challenged
- All individuals should have the opportunity to apply for medical education irrespective of their social or cultural background.

Both of these statements are central to the ethos of the WP Unit at St George's, and therefore form a core element of all of the activities and projects we develop.

In collaboration with our design company, Interactive Solutions, we therefore set out to develop an online learning resource that was able to:

- raise the audience's aspirations towards higher education
- raise the audience's interest in medicine and the allied healthcare professions
- challenge inaccurate stereotyped views of healthcare
- raise the audience's understanding of the interdisciplinary nature of healthcare
- raise the audience's understanding of the wide range of careers in healthcare.

Inherent within this was a recognition of the importance of personal and institutional identity in any work with disenfranchised youth. If committed to ensuring fair access to medical and healthcare education, it is essential to communicate effectively with students at a young age and to support them as they progress through secondary education, as it is through these



Fig. 3. Challenging stereotypical views – a key component of the “Getting Started” micro site is the explicit and direct challenging of stereotypical views of the type(s) of people suited to a career in healthcare

interactions that individuals construct their own educational identity. By ensuring that medical and healthcare education, and therefore by extension medical and healthcare careers, are seen as achievable, students are far less likely to form negative views that disassociate them from the medical profession. In other words, working to ensure that they see the benefit of higher education, see it as an achievable goal, and see it as an environment in which they can feel settled and successful. It is through this that we wanted to counteract such thinking as “I’m not a University type” (Greenhalgh et al. 2004).

### Summary of analysis linked to training need

During the development process, pilot schools were identified and classes given access to the resource. These students were then asked to participate in focus group research to ensure appropriateness of tone and content as well as usability. After completion of the development work and the launch of the resource, formal analysis was undertaken as follows.

The aim of the resource was to illicit changes in aspiration, interest and understanding – factors that are challenging to measure. However we were able to develop an appropriate methodology (Sapsford 1996; Sapsford 1999; Sapsford and Jupp 1996). Through online pre and post exposure questionnaires with an appropriate sized sample we were able to identify attitudinal changes in the target population.

Initially, class groups were asked to undertake a healthcare themed online questionnaire at the end of an ICT or science lesson. The class groups were given access to the site during an entire ICT or science lesson the following week, and asked to complete a second online questionnaire at the end of that lesson.

The post exposure questionnaire of every member of the sample population was paired with their corresponding pre exposure questionnaire to ensure we were measuring the specific

attitudinal changes of individuals. We successfully paired the responses of 789 participants (having excluded the responses of individuals who had only completed one of the pre and post exposure questionnaires).

61% of the sample strongly agreed that healthcare workers made a difference to people’s lives (compared to only 42% pre-exposure).

40% of the sample strongly disagreed with healthcare workers needing to be ‘boffins’ (compared to 27% pre exposure).

Prior to exposure only 37% of the sample thought healthcare workers were well paid, but post exposure that figure had risen to 57%.

35% strongly disagreed with the statement that having a parent as a doctor increased your chances of admission to medicine, compared to only 11% prior to exposure.

Similarly, 45% strongly disagreed with the statement that those from private school would make better doctors, compared to a pre exposure figure of 29%.

It was clear across all of the data that we had been successful in our aims of increasing aspiration, interest and understanding – we had successfully influenced the way that these students perceived a career in medicine.

### Development opportunities

It is clear from the analysis above and the testimonials below that this resource has been highly successful, but we will not be resting on our laurels. With a strong reputation for educational innovation, the St George’s WP Unit is well placed to explore opportunities for further development of the resource as well as the franchising of the site for other market areas.

We have already begun discussions with a number of Higher Education Institutions in Canada and Australia with an aim to re-purposing the existing content for their own use. Widening Participation and social equity within Higher Education is fast becoming a core element of educational policy



Fig. 4. Launch page of the main site – this figure shows the landing page for [www.tasteofmedicine.com](http://www.tasteofmedicine.com) and the direct link to each of the four current micro sites

within Australian policy and there is great potential to build on the success of [www.tasteofmedicine.com](http://www.tasteofmedicine.com) by developing a resource to support Aboriginal and Torres Strait Islanders, as well as rural Australians. In discussion with McGill University in Montreal, we are considering development of the site in both French and English to support student within Quebec.

With regard to further development for the UK market, we are already working on a suite of similar resources that complement the student lifecycle model. Our plan is to build on the well established Taste of Medicine brand by creating four distinct, yet linked sites, all available through the Taste of Medicine portal and each tailored to a different age group and need. These will be:

“Getting Started” – the originally developed [tasteofmedicine.com](http://tasteofmedicine.com) resource

“Experiencing It” – a new site to support students in finding medical and healthcare work experience placements. This will also facilitate their development of critical reflection, allowing them to gain much more from their experiences. This second product within the [tasteofmedicine.com](http://tasteofmedicine.com) suite was officially launched at the House of Lords on 20 January 2010.

“Scrubbing Up” – a re-purposing of an existing DVD resource pack for online use that, through either individual or group participation, allows students to gain an insight into the often confusing world of medical interviews whilst additionally facilitating development of their broader communication skills.

“Virtually there” – a new site offering an introduction to the range of innovative ways in which teaching and learning occurs in a Higher Education environment with particular focus on the use of Virtual Patients – an area in which St George’s is a leading light.

Feedback from e-learning professionals, communication professionals, teachers and pupils

Taste of medicine is fresh and innovative! I was particularly impressed by the high quality resources within the website that

could potentially be customised by other institutions too. The site demonstrates a great balance of engagement and interaction intertwined with key take-home messages for potential students. The interface is easy on the eye and intuitive enough to navigate without pausing for too long. What I like most about it is that it’s not just another online page turner and I’m constantly pleasantly surprised every time I click a button. 10 out of 10 for user engagement!

*Charavanan Balasubramaniam, Project Manager, e-Learning Unit, St George’s, University of London*

The taste of Medicine website is bright, fun and engaging, pitched perfectly for its target audience. It makes clear, simple statements reinforced through interactive scenarios, games and quizzes. The website makes excellent use of multimedia incorporating sound, video, and animations to convey its message clearly and in a way that really holds the attention. The site is user-friendly with clear navigation and free of over complicated menus or other unnecessary distracters.

*Emily Conradi, Project Manager, e-Learning Unit, St George’s, University of London*

At Burntwood School, students regularly use this website to find out about careers in Medicine and Healthcare. Students are directed to the site as part of the curriculum, both in Science and PSHE lessons, as it is relevant to both subject areas. As an e-learning tool, students find the format easy to use and the content is both informative and entertaining. It provides a fun and engaging way to access information and students particularly enjoy the interactive features of the site.

Students are introduced to St George’s, University of London, in Year 7 through their excellent Experiments Roadshows programme. Therefore, they are already familiar with the University when they come to use the website in Years 8 and 9. This prior knowledge, combined with the proximity of the University to Burntwood School, makes students feel that the information provided on the site is relevant to them. Furthermore, St George’s Healthcare NHS Trust is one of our community’s largest employers and as such, ‘A Taste of Medicine’ is



a valuable addition to our Careers and Work Related Learning programme.

The site is successful in helping students to realise that careers in Medicine and Healthcare are accessible to them. They often comment that after exploring 'A Taste of Medicine' they feel better informed about the wide range of career options available to them within the NHS and have a better understanding of the route into these careers. Therefore, 'A Taste of Medicine' is also successful in raising students' aspirations towards Higher Education.

*Charles Harper, Deputy Principal and Director of Specialism at Burntwood School*

This interactive website has been a very useful tool in providing a route into schools that can be developed from a very clear starting point. The site is engaging, stimulating, informative and fun! Learners in the borough have commented on the design and high level of interactivity – it certainly reaches students through the media they are using in their everyday lives with social networking and the explosion of digital media now available to our young learners. The design of this resource has allowed great flexibility in its use. It has been introduced in Wandsworth to stretch the most able students during Gifted & Talented enrichment classes, provided the basis for a series of lessons in science, been used as a resource during summer schools, been the focus of year group assemblies, introduced students to the medical professions through careers and promoted home study by engaging students in active ICT participation. The cross curricular activities and range of information on the site allows teachers to manipulate it to their advantage across a range of subject areas to produce stimulating and realistic lessons using the website as a classroom resource.

Students have commented on the 'fun' they have had using the resource and teachers the 'depth and usefulness' the website has provided them with. In Wandsworth the value of the site is underlined by its extensive use across the borough.

The website has been used in a variety of ways and impacted on students almost unconsciously, raising their aspirations, dispelling the myths around medicine and sowing seeds in their minds that further study and a career in the health professions is truly a viable option for them."

*Alex Purssey, Manager, Wandsworth City Learning Centre*

I am writing this short letter to praise you on the influence your website has had on me.

I am a GCSE student and like many I was extremely stuck on which career I wished to pursue and your website made me realise that being in the medical profession may be just what I want to do. I was particularly interested in what medical university life was like and you made me realise that it isn't as hard as I thought. Quite obviously being in the medical profession alone will certainly be difficult however I hope to pursue my ultimate dream in becoming a Doctor.

Than you for the information you offered in your website. It had an extremely positive impact on me.

*Anisha Harrar, Year 10 student*

A Taste of Medicine is a great way to inform young people about the wide range of careers available in medicine and healthcare. It provides them with important facts and offers



Fig. 5. "Experiencing It" Section 1 – Screen shot from the sub section *Getting Good Experience*



Fig. 6. "Experiencing It" Section 2 – Screen shot from the sub section *Making the Most of It*



Fig. 7. "Experiencing It" Section 3 – Screen shot from the sub section *Giving a Great Interview*

student insight to help them make an informed decision about their future career.

From St George's perspective, a web presence is central to the way we communicate with hard to reach potential students from non traditional backgrounds. It lets people know who we are and what we can do for them, so when they come

to make their life choices, starting a career in medicine and the healthcare professions at St George's is a real possibility."

*Helena Clay, Senior Press Officer, St George's, University of London*

## Summary

In conclusion, this site has been developed to combine information and exploration for prospective students in an interactive, animated and engaging format. Most specifically it has been produced to support the educational and aspirational development of prospective students from hard to reach sectors of society. By providing support and encouragement, and reinforcing the idea that an individual's social background should not, and does not, hinder their development in the healthcare professions, we are demonstrating our commitment to widening access and social equity.

We are confident in our evidence that this approach is successful and are keen to encourage other providers of medical and healthcare higher education to consider the issue of new media to this end. The resource that we have developed is one that has great potential to be transferred into similar settings outside of the UK.

## Other Notes

www.tasteofmedicine.com was designed by an external agency called Interactive Solutions (The Media Centre, 7 Northumberland Street, Huddersfield, HD1 1RL, 01484 487900, Dayn Wilkins, Managing Director, dayn@interactivesolutions.co.uk)

## References

1. Greenhalgh, T., Seyan, K., and Boynton, P. (2004), „Not a university type”: focus group study of social class, ethnic, and sex differences in school pupils' perceptions about medical school. *British Medical Journal*, 328(7455), 1541.
2. Hilton, S., and Lewis, K. (2004), Opening doors to medicine. *British Medical Journal*, 328(7455), 1508-1509.
3. Sapsford, R. (1996), *Extracting and Presenting Statistics*, in: R. Sapsford and V. Jupp (eds.), *Data Collection and Analysis*. London: Sage.
4. Sapsford, R. (1999), *Survey Research*, London: Sage.
5. Sapsford, R., and Jupp, V. (1996), *Validating Evidence*, in: R. Sapsford and V. Jupp (eds.), *Data Collection and Analysis*. London: Sage.
6. SGUL (2010), *Widening Participation at St George's, University of London*. www.sgul.ac.uk.



## MOBILE MOODLE: A MOBILE EXTENSION TO THE MOODLE VIRTUAL LEARNING ENVIRONMENT

SUPRIYA KRISHNAN, NARAIN RAMLUCHUMUN, CHARA BALASUBRAMANIAM, TERRY  
POULTON, STEVEN MALIKOWSKI

*St George's University of London*

**Abstract:** The advent of mobile technologies has created opportunities for delivery of learning via devices such as PDAs, mobile phones, laptops, and PC tablets. Collectively, this type of delivery is called mobile learning (m-learning). While m-learning can be thought of as a subset of e-learning (which is web-based delivery of content and learning management), the emerging potential of mobile technologies tends to indicate that m-learning, while mostly situated within the e-learning framework, also has links directly to the “just enough, just in time, just for me” model of flexible learning, and is therefore just one of a suite of options that can be adapted to suit individual learning needs (Peters K<sup>1</sup>, 2007). The aim of this St George's University of London project is to develop mobile learning for mainstream education and training, the implementation of which entirely depends on the framework, mobile device and the technology adopted in delivering the content. This paper reflects on various stages in the implementation of a mobile learning system at St George's. The study includes a detailed analysis of a mobile learning system which can be integrated to the existing e-learning system used at the University.

**Keywords:** Mobile, Moodle, VLE, m-learning, Mobile Phone, Mobile Devices, e-learning

### Introduction

Since the start of the current millennium, experience and expertise in the development and delivery of mobile learning have blossomed and a community of practice has evolved that is distinct from the established communities of “tethered” e-learning (John Taxler<sup>2</sup>, 2007). The impacts of pursued studies and researches in the field of mobile learning made us move in the same path and as a result, carried on with a view to implement a mobile learning strategy within St George's. A comprehensive mobile learning survey was performed by the students at the university, thereby enabling us to figure out certain relevant facts regarding the student usage of mobile devices, in accessing the learning resources to supplement their studies. Due to overwhelming support, the decision was taken to offer a mobile extension to our current web-based virtual learning environment, Moodle. The paper reflects on the progress of the various undergone phases during the implementation of Mobile Moodle, with particular reference to the usability findings and the survey results.

### Phase I: Exploring the current issues

As a first step, a detailed analysis was performed on the existing studies since it helped us to clarify certain facts regarding the challenges that might be faced on the way towards ‘learning through mobile devices’. The limitations of mobile learning

are a combination of technical and educational challenges which widely ranged from delivery of learning materials to cost and data security. Attempts were made to overcome a few of these for which, the inspiration came along with the realisation of some of the recent developments in creating “interfaces” for online learning environments. Adapting a mobile version for an existing web based learning environment was found advantageous in the initial stage.

The next step was to investigate more on the mobile version of Moodle, which was free and open source. It was also identified that the mobile interface or the Mobile Learning Engine (MLE) plays the intermediate role between the mobile device and the Moodle system, which was an assurance of transfer of content to mobiles. There exist two different ways by which the content could be accessed on mobiles – (1) Through a custom Java application which is capable of running on a majority of the modern mobile phones and (2) Through a standard web/browser-based interface – of which we found the second method more feasible and advantageous as an initial step, thereby decided to have a mobile browser version of existing Moodle.

### Phase II: Implementing the method of solution

The advantages pointed out in preferring the browser version were as follows:

1. No need to install a full application on the phone (the application needs about 600KB) to go through a single quiz or a survey.
2. No need to synchronize or update the learning content since the data accessed is online each time and nothing is stored on the mobile phone.
3. The look & feel, layout, etc could be customised and could add logos or slogans on the start-page. In fact, it is possible to change/add anything in Mobile Moodle with the help of an IT expert.
4. The source files were free to download which enabled a lot of chances to customise Mobile Moodle to fit into needs and tune it to what was actually needed.

Mobile web browsers are optimised so that they display web content most effectively for small screens on portable devices. The browser version of Mobile Moodle was tested with some of the web browsers namely Internet Explorer, Safari, Mozilla, etc. The customisation process of the browser version was carried out in the following areas:

**Access Link:** Normally, Mobile Moodle automatically configures a web link which consists of alphabets and numerals (e.g. <http://bit.ly/41ZITU>). Realising the difficulty in remembering the link address, it has been changed to something simple and easy to remember (<https://moodle.sgul.ac.uk/mobile>).

**Categorisation:** The categorisation of courses according to the Moodle was performed as the next task, which was ordered just like in our Moodle home page. The categories and sub – categories were divided in such a way that they could be accessed out quickly from the home page.

**Navigation:** The issue persisted with the 'back' navigation of the pages in Mobile Moodle was fixed in the source files.

**Unwanted Links and Categories:** All the unwanted categories and links that already existed in Mobile Moodle were removed.

Figure 1 shows the home screen of Mobile Moodle through Safari browser on iPhone. Users access their home screen using Moodle username and password and they can browse to different options as shown in Figure 1. With the browser version, the same content was accessed, the only difference being the learning content could be accessed only with the help of a network connection where as it may not be necessary through the application. The course/learning material one is enrolled in could be accessed from the course screen as depicted in Figure 2.

Another important benefit in choosing the browser version was that, for those handsets that cannot install the Java application to access Moodle, the web/browser-based interface could still be used. This provide students probably a relief if they wish to access Moodle but unable to install Java on their phones. The web version is also useful if one is using a friend's phone to quickly check the online course materials. Considering all these advantages, the browser version of Mobile Moodle was implemented at St George's.

### Phase III: Forming surveys and usability tests

In the third and final stage, surveys and usability tests were conducted to study the performance of Mobile Moodle. An online survey was constructed in SurveyMonkey<sup>3</sup>, a commercial

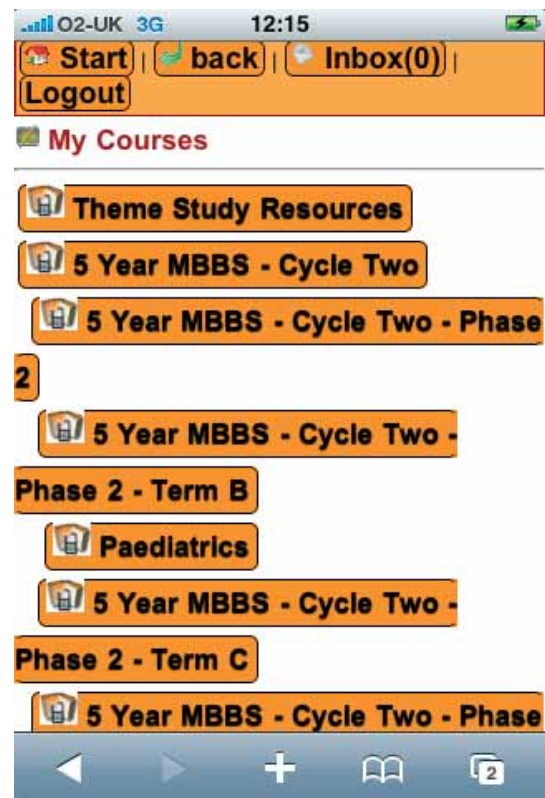


Fig. 1. Home Screen

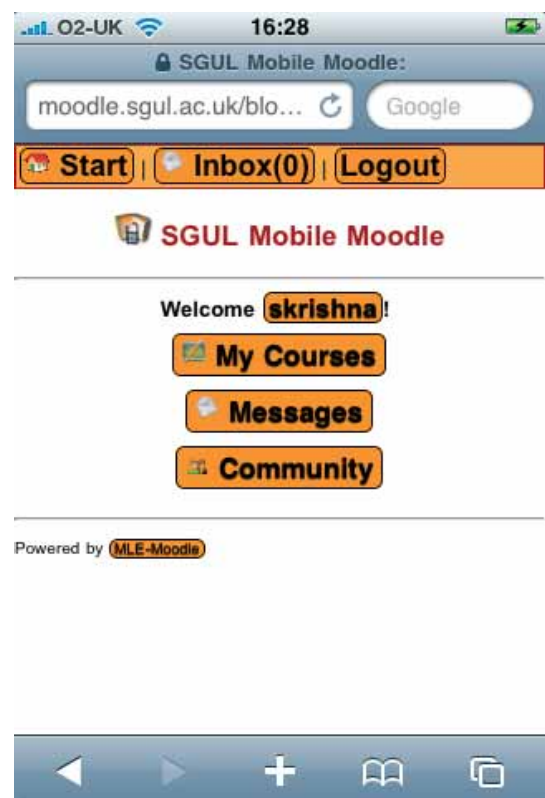


Fig. 2. Course Screen

survey and data analysis service, in order to analyse the student's approach towards learning through mobile devices. The survey was divided into 5 sections:

1. An introduction describing the purpose of the survey and briefly explaining the sections the student needs to go through
2. Questions relating to the student's personal information including the year of study, course, etc
3. Questions relating to the mobile phone characteristics including brand, provider, contract, etc
4. Questions relating to the student's mobile phone use
5. Questions relating to the student's mobile phone use in learning

The survey was taken by students of almost all courses in our institution, the results of which are covered later during the course of the paper.

Another important step in the evaluation phase is the Usability Test which was carried out among Mobile Moodle users. The participants are asked to perform some typical tasks or to use a particular system and the person who conducts the test evaluates the usability of the given task or the system. The evaluation criteria could be different from person to person. The evaluator could have a series of check boxes – with options from excellent, fair, good, poor and could tick the appropriate box during the inspection. Written comments could be taken from the participants on the usability of the system and the evaluator could have a general analysis based on the given data.

### Usability Test Result

As part of the initial evaluation, Mobile Moodle Usability Test was conducted with five users, and they were asked to complete a few tasks. The tasks were categorised as a mixture of a few simple and difficult ones and these varied from accessing a particular course to checking the speed of accessing the learning content. The test was carried out on Mobile Moodle browser version and it was accomplished as follows:

1. An expert user was created as a start off, who was assumed to be more familiar with Mobile Moodle and its content, which also implied that this user could access the course content rapidly compared to other first time users.
2. The time taken to complete each task by the first time users was recorded.
3. The average of the times taken by first time users was then compared with that of the expert user.
4. A graph was then created based on these data as shown in Figure 3.

The *x*-axis represents the number of tasks and the *y*-axis represents the time taken in minutes. The yellow line on the graph represents the average time taken by the expert user and the red line represents the average of time taken by all the first time users. Based on the graph in Figure 3, the following observations were made:

1. Simple tasks remained more or less easy for both expert and first time users (Tasks 1, 2 and 7 were simple tasks).
2. Difficult tasks remained difficult for the first time users whereas it was easy for the expert user to complete (Tasks 3 – 6 were difficult tasks).

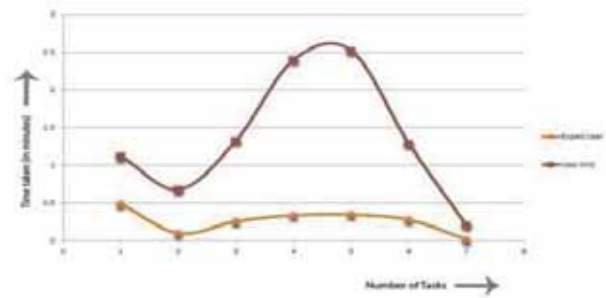


Fig. 3. Mobile Moodle. Usability Test Results

3. First time users took more time to complete the tasks than the expert user.

Hence, we arrived at a conclusion that once first time users become familiar with Mobile Moodle, the time taken to access the content will decrease and gradually the curve will come down and be parallel with that of the expert user.

### Survey Result

The survey is still open and till date, around 384 responses have been collected online, with 372 of respondents answering every question. The SurveyMonkey system allows downloads of these responses which can be displayed and analysed both as percentages and graphically.

### Analysis and comments on some of the important questions

One of the survey questions from "phone characteristics" section was:

*"When you purchase mobile phone(s), how important are the following factors?"*  
(375 responses, 9 respondents skipped this question)"

'Possibility to connect to internet' was found to be very important (139 responses out of 375). While, 'taking pictures' was the second most important factor for 48.1% of the students, 38.8% were interested in having memory cards in their phones as shown in Figure 4. The result clearly pointed out the importance of internet which was helpful for the accomplishment of our browser based project, Mobile Moodle.

Another question from the same section was:

*"Please use the drop down list below to select your mobile phone brand"*  
(375 responses, 9 respondents skipped this question)"

24.5% (92 students out of 375) owned a Nokia mobile phone, and 18.7%, a Sony Ericsson. Samsung and Apple took the third and fourth places respectively as seen in Figure 5. The results show that most of the students own a smart phone with almost all the multimedia capabilities which are required for the implementation of the project.

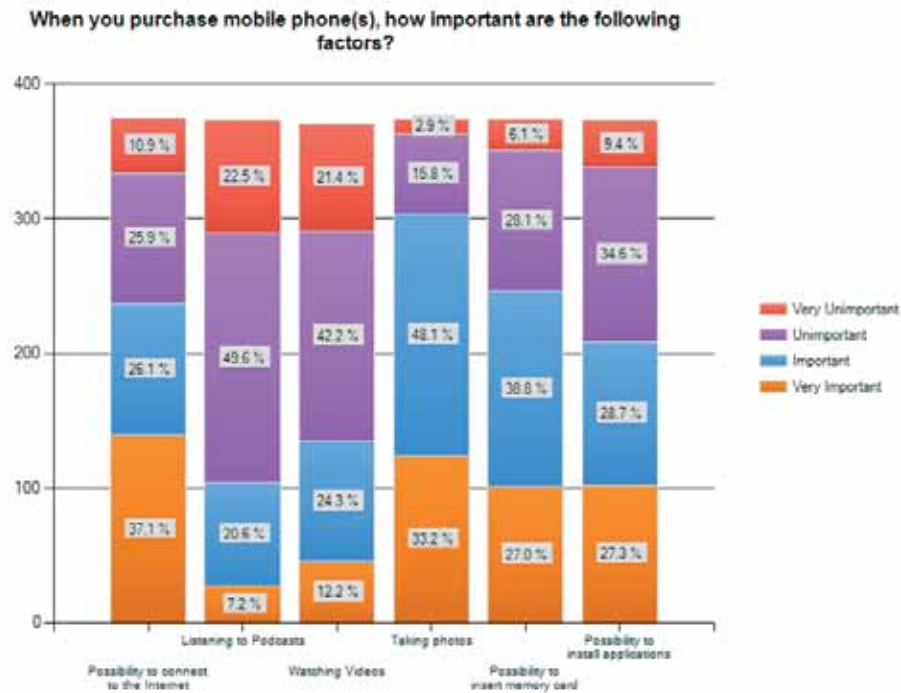


Fig. 4. Importance of internet, memory cards, photos etc in purchasing mobile phone

"This question addresses specific uses of mobile learning. In the next year, how likely is it that you will use your phone or mobile device for the following items?  
(368 responses, 16 respondents skipped this question)"

The 1<sup>st</sup>, 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> year students (27.3 %, 30.5 %, 28.0% and 33.3% respectively) are interested in listening to podcasts and watching educational videos on their mobile phones in the future which is a very good indication to release the same in Mobile Moodle. While the 1<sup>st</sup> year students are also likely to complete quizzes on their mobiles, students in the final years

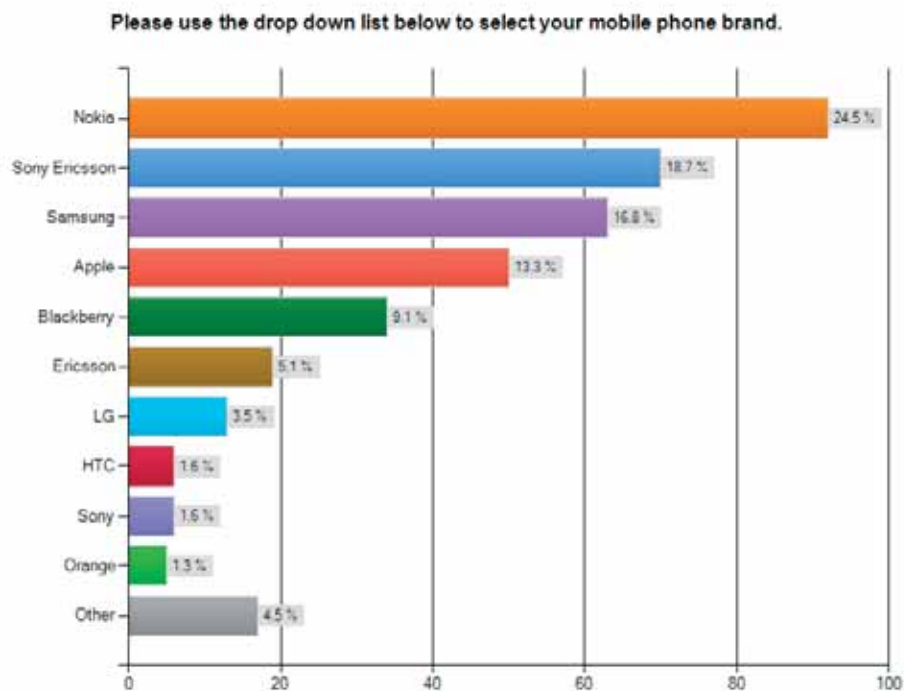


Fig. 5. Most used mobile phone brand

are not interested. The options such as viewing and downloading power points are considered “less likely to use” by most of the students.

*“Which of the following mobile devices are you likely to use in the future?”*

(371 responses, 13 respondents skipped this question)”

A very high percentage (90.3%) of the total students has indicated they will use a mobile phone next year. Around 77.4% (2<sup>nd</sup> year students being the highest in number) will go for a digital camera and 50.6 % (1st year students being the highest in number), an iPod Touch in the future. These are interesting results at the stage of the project and will help strengthen the later implementation phases.

## Conclusion

The survey and usability test results allowed us to identify further improvements and take mobile learning implementation

at St George's into a new experience. Students will soon be able to access their bespoke Moodle course contents using their own mobile phones anytime and anyplace. Implementing Mobile Moodle has been a real help to students at St George's, it has proved to be popular with students and is establishing itself as an effective way of delivering e-learning resources that embrace new technologies and 'learning on the go'.

## References

1. Peters K. (2007), M-learning: Positioning Educators for a Mobile, Connected Future. International Review on Research in Open and Distance Learning (IRRODL), 8/2, 11.
2. Taxler J. (2007), Defining, Discussing and Evaluating Mobile Learning: the moving finger writes and having writ... International Review on Research in Open and Distance Learning (IRRODL), 8/2, 1.
3. Finley R.: SurveyMonkey.com, Portland, Oregon USA, <http://www.surveymonkey.com/>.



## CONTENT COLLABORATION ACROSS MULTIPLE SYSTEMS: HOW THE AMERICAN COLLEGE OF CARDIOLOGY IS CREATING A UNIFIED APPROACH TOWARDS LIFELONG LEARNING

LYNNE M. GALIATSATOS<sup>1</sup>, ANDREW RABIN<sup>2</sup>, GARY S. RAE<sup>2</sup>, DAVID S. RAIMIST<sup>1</sup>

*<sup>1</sup>American College of Cardiology, United States; <sup>2</sup>CECity.com, Inc., United States*

**DESCRIPTION:** The American College of Cardiology (ACC), a national medical association, and CECity are working together to provide ACC's members with a personalized Lifelong Learning Portfolio that enables performance improvement, professional development and collaboration. The ACC provides services and products to its members that contribute to lifelong learning including traditional education as well as targeted educational interventions through performance improvement modules. While many of these are developed by the ACC, there are also relationships with external content providers.

ACC will have access to a centralized database to support its needs as a CME provider for compliance, needs assess-

ment and outcomes, along with a unified transcript and curriculum to be able to serve the needs of the members while moving towards lifelong learning and continuous maintenance of certification.

The ACC and CECity are using MedBiquitous standards in support of this initiative. The Healthcare LOM, Activity Report, and Medical Education Metrics Standards are part of the various integrations between CECity's Lifetime and CME360 platforms, ACC's new Sitecore platform, and various 3rd parties.

Our presentation will review the overall project, how the MedBiquitous standards were employed to solve ACC business challenges and the realized benefits to the member.

## A CASE STUDY OF REPURPOSING MEDICAL EDUCATIONAL MATERIAL TO THREE DIFFERENT CONTENT TYPES

ELENI DAFLI, PANAGIOTIS BAMIDIS, COSTAS PAPPAS, NIKOLAOS DOMBROS

*Aristotle University of Thessaloniki, Greece*

**DESCRIPTION:** Background: Contemporary medical education exhibits a considerable variety of content types. Thus a common aim of repurposing is to change a learning object from one type to another.

**Summary of work:** The aim of this work was the repurposing of digital educational content, insisted of clinical scenarios to different forms. The initial educational material was in PPT form and available through video files so as to be presented in academic lessons. The next step was the design and implementation of a virtual patient case based on the previous context. Two programs, complementary to each other, VUE and OpenLabyrinth were used. Finally, the content was repurposed again so as to be available through a 3-dimensional environ-

ment with the participation of educators and trainees in an educational procedure through a virtual world. For that reason the OpenSim platform was utilised.

**Results:** Three separate formats – Office presentation, Virtual Patient, 3D Virtual Environment – of electronic educational content were created by repurposing existing educational material in the fields of Cardiology. These can be used from educators/trainees according to the learning objectives.

**Conclusions:** Repurposing among different formats of content types offers the opportunity of reuse and exchange of educational material according to special needs and expected learning outcomes.

## OSTEOPATHIC CONTINUOUS CERTIFICATION PROCESS IS SIMPLIFIED BY MEDBIQUITOUS STANDARDS

ANNETTE VAN VEEN GIPPE<sup>1</sup>, ANDREW RABIN<sup>2</sup>

<sup>1</sup>American Osteopathic Information Association, United States; <sup>2</sup>CECity, Inc, United States

**DESCRIPTION:** Background: Osteopathic Continuous Certification (OCC) ensures osteopathic physicians are current in their specialty. The components are:

1. An unrestricted licenses to practice medicine
  2. Lifelong learning (Continuing Medical Education)
  3. Cognitive Assessment (certification/recertification exam)
  4. Practice Performance and assessment (Clinical Assessment Program)\*
  5. AOA membership
- \*Adding to current process.

Using the CECity Platform that is already in place the Clinical Assessment program includes chart evaluation (pre and post) that measures performance improvement against national standards. This information is reported using the MedBiquitous Activity Report standard to the AOA database that employs the MedBiquitous professional profile standard. This information will then be distributed to the certification boards and the AOA Bureau of Specialists as required for the program.

### Work done:

This system is already in place for the existing Clinical Assessment Program (CAP) and will be expanded for the OCC.

## MEDEDPORTAL: PEER REVIEWING, PUBLISHING, AND DISSEMINATING E-LEARNING

ROBBY REYNOLDS<sup>1</sup>, MICHAEL SALEH<sup>2</sup>, CHRISTOPHER CANDLER<sup>3</sup>

<sup>1</sup>Association of American Medical Colleges, USA; <sup>2</sup>Association of American Medical Colleges, USA;  
<sup>3</sup>The University of Oklahoma College of Medicine, USA

**Abstract:** Medical educators devote significant time and effort into creating all types of high quality e-learning resources including virtual patient (VP) cases. Peer-review and sharing of such resources encourages the creation of high quality educational scholarship and promotes adoption of innovative materials in the health education community. The Association of American Medical Colleges (AAMC) developed MedEdPORTAL ([www.mededportal.org](http://www.mededportal.org)) to serve as a prestigious publishing venue and dissemination portal through which educators and learners from around the globe can share educational works. MedEdPORTAL is an international free service available to the general public that peer-reviews, publishes, hosts, and disseminates all types of e-learning resources relevant to health education. Participants will learn about the submission to publication process as well as the sophisticated evaluation tools available to published authors to compile user feedback and track satisfaction, activity, user preference for particular resources, and information about how users are applying the resources in practice.

### Introduction

Medical educators devote significant time and effort into creating all types of high quality e-learning resources including virtual patient (VP) cases. Peer-review and sharing of such resources encourages the creation of high quality educational scholarship and promotes adoption of innovative materials in the health education community. The Association of American Medical Colleges (AAMC) developed MedEdPORTAL ([www.mededportal.org](http://www.mededportal.org)) to serve as a prestigious publishing venue and dissemination portal through which educators and learners from around the globe can share educational works. MedEdPORTAL is an international free service available to the general public that peer-reviews, publishes, hosts, and disseminates all types of e-learning resources (e.g. tutorials, virtual patients, simulation cases, lab guides, videos, podcasts, assessment tools, etc.) relevant to health education. Users can access quality, peer-reviewed teaching material and assessment tools in both the basic and clinical sciences in medicine and in oral health.

With MedEdPORTAL, users can download or access the majority of the published resources directly from the website. Published authors retain their original copyrights and indicate on the MedEdPORTAL website how others may use the materials. In addition, all third-party copyrighted materials and patient privacy issues are addressed during the submission process so users can download and utilize any and all of the published resources for educational purposes without legal infringements.

### Overview

From its conception, MedEdPORTAL was designed to serve as a prestigious publishing service through which educators can receive scholarly recognition for their educational works. Structured like a traditional print-based journal, MedEdPORTAL:

- Maintains an Editor and an Editorial Board.
- Follows a peer-review policy that mirrors practices employed by traditional print-based journals.
- Employs a rigorous peer-review process based on accepted standards of scholarship using invited expert reviewers to conduct all reviews.

While MedEdPORTAL is not a typical journal, all submissions that are successfully peer-reviewed are considered formal publications that may be referenced by a standard citation. MedEdPORTAL publications are comparable to peer-reviewed research manuscripts published through traditional journals. Publications in MedEdPORTAL are considered compelling scholarly contributions by many institutions and may be used to support promotion and tenure decisions [1].

A fully integrated content and digital asset management system enables the MedEdPORTAL Web site to host the vast majority of published resources online. Restricted materials such as assessment tools, for which special clearance is required, are guarded behind a human firewall. For access to these materials, user credentials must be verified as positions of faculty or administration at a health education institution or organization. International users must identify an individual sponsor representing an AAMC or ADEA member institution or organization for credential verification. Once a user is cleared,

they will be granted access to all special clearance items within the collection.

Published authors retain their original copyrights. During the submission process, prospective authors create and associate a Creative Commons License with their resource thereby indicating how all future users may utilize the materials. In addition, all third-party copyrighted materials and patient privacy issues are addressed during the submission screening process so users can download and utilize any and all of the published resources in accordance with its associated Creative Commons License without legal infringements. MedEdPORTAL also collects significant end-user data that supports authors in demonstrating the measured impact and utilization of their published materials.

## Scope

MedEdPORTAL currently only accepts submissions for educational or assessment materials that are relevant to the continuum of medical and/or dental education (e.g. undergraduate, graduate, and continuing medical/dental education). MedEdPORTAL will accept interprofessional educational materials as long they are also applicable to medical or dental education. In addition, MedEdPORTAL accepts faculty development and professional development materials (e.g. how to give effective presentations, using audience response systems to enhance learning, successfully using visual aids in presentations, etc) that support medical and/or dental education.

All submissions to MedEdPORTAL must include an Instructor's Guide that will be packaged and disseminated with the resource following publication. An Instructor's Guide is typically 1-3 pages in length and at a minimum includes the following components:

- List of all the resource files included in the submission.
- Explanation of when, how, and the order in which to use each resource file.
- The purpose/goal of the resource including specific educational objectives.
- The conceptual background regarding why and how the resource was created.
- Practical implementation advice such as the materials needed, length of session, faculty/facilitator needs, preparation needs, etc.
- A description of how the material has been successfully deployed including common pitfalls, tips for success, etc.
- A self-reflecting list of limitations for implementing the resource and ideas for improving/expanding the materials.

## Submission Standards

MedEdPORTAL considers acceptance of submissions which manifest the traditional principles of educational scholarship. Authors are strongly advised to consider whether or not their resource submission addresses the following:

- Is it generalizable?
  - The resource may be useful to you at your institution but does the submission contain enough guidance to be understood and used by other faculty at other institutions?

- Did you include all the supplemental documents and forms that will assist others who use the resource?
- Does it represent scholarship?
  - Resources should address the tenets of educational scholarship as conveyed through the MedEdPORTAL Peer Review Form and the MedEdPORTAL Educational Scholarship Guide.
  - Use the MedEdPORTAL submission form (and the Instructor's Guide) to convincingly show the reviewers exactly how your work represents scholarship and contributes to the field.

A superficial course syllabus, workshop outline, or basic PowerPoint presentation usually fails peer review. In addition, static biomedical reference materials (e.g., static textbooks, pocket cards, etc.) which have little or no instructional focus typically fail to fall within the scope of the MedEdPORTAL collection.

## Copyright and Patient Privacy

All MedEdPORTAL submissions must be free and clear of all copyright infringements before moving forward with the peer review process. MedEdPORTAL Screeners review all embedded photos, images, charts, graphs, cartoons, text and URL links to determine if appropriate copyright permissions have been obtained for any materials not created by the author or co-authors. Written permissions must acknowledge that the material is intended to be incorporated in a MedEdPORTAL submission where, if published, it will be globally distributed as part of the published resource in accordance with its associated Creative Commons License for free of charge, indefinitely. Alternatively, if there are items where the author(s) are not known, or it will be difficult to receive the necessary permission, the materials may be simply removed from your resource or replace with non-copyrighted content.

MedEdPORTAL Screeners also search for potential patient privacy (any "personally identifying information") violations such as photos, imagery, charts, graphs, lab values, radiographs or medical/dental records of real patients. If personally identifying information is found embedded within a resource then the author must comply with one of the following two options:

- Provide written permission from each patient or actor granting permission to incorporate their personally identifying information in the submission
- Ensure all personally identifying information (i.e. picture of patient's face, name, date of birth, social security number, address) have been removed or blacked out in compliance with HIPAA from any photos, imagery, charts, graphs, lab values, radiographs, or medical/dental records included in the submission.

If permission cannot be obtained under the aforementioned terms, the third-party items must be removed from the resource in compliance with MedEdPORTAL standards. Alternatively, such items can be replaced with those that reside in open-access digital repositories. Each searchable image featured within these repositories is associated with an author-generated Creative Commons License detailing how the image may be used. Imagery that meets MedEdPORTAL standards and policy are outlined as non-restrictive and can be found under these specific terms: free and unlimited use, reproduction, and



modification. Prior to publication, these Creative Commons License citations must be attributed and affixed to each image featured in the MedEdPORTAL submission. MedEdPORTAL encourages authors to visit the Health Education Assets Library (HEAL) ([www.healcentral.org](http://www.healcentral.org)) and Flickr ([www.flickr.com](http://www.flickr.com)) digital source libraries to identify and select substitute imagery for their resource under the aforementioned license terms.

## Intellectual Property Policy

MedEdPORTAL respects the original ownership of all submissions and does not pursue ownership in any materials it receives or publishes. To protect the rights of authors, MedEdPORTAL requires that the corresponding author answer the following three questions to create a Creative Commons copyright usage license which legally governs how their material may be used by others.

- Will you allow commercial uses of your work?  
[Yes | No]
- Will you allow modifications of your work?  
[Yes | Yes, as long as others share alike | No]
- What is the jurisdiction of your work?  
[Select Country]

If the submission is accepted, the MedEdPORTAL system associates the author generated Creative Commons License with the resource and request that all users maintain an association between this License and the resource they download.

Authors are welcome to submit resources that have already been published elsewhere. It is important to note that while many authors have published articles that describe an educational resource, they are usually free to publish the actual resource or tool on MedEdPORTAL because such resources were not technically part of the prior publication. A prospective author is required to review his employment agreement and his institution's copyright policies to ensure that he has the rights to make this work available under the associated Creative Commons License.

## Publication Policy

Following publication in MedEdPORTAL, an author may not retract his/her publication. Once a resource is published in MedEdPORTAL, it will remain searchable and available to the public for free, indefinitely. However, all time-sensitive resources are identified and labeled as such during the submission and peer review process. Three to five years after publication, time-sensitive resources are flagged as inaccurate, obsolete or irrelevant on the MedEdPORTAL Web site. If a resource has already been published in MedEdPORTAL and the author would like to revise or update his/her published resource, we encourage him/her to contact MedEdPORTAL staff to discuss the various options. Typically, if the planned changes are merely cosmetic and do not impact the content of the resource, MedEdPORTAL staff will simply replace the published resource with the revised version. However, if the update significantly impacts the content of the resource (e.g. adding additional content or taking away content from the resource), we encourage the author to submit the revised resource as a new submission to MedEdPORTAL. This resource will be identified and flagged

as a second version and will undergo the formal peer review process. If published, the second version of the resource will be labeled as publication version 2. The original publication will not be removed from MedEdPORTAL and the system will automatically reference the most recent version of the publication, showcasing the lineage of the scholarly resource.

## Submission to Publication Process

An educational resource successfully peer-reviewed and published through MedEdPORTAL is considered a publication and is comparable to a peer-reviewed research paper published through a reputable print-based journal. Authors who publish through MedEdPORTAL benefit from the AAMC's authority and credibility, and have access to an audience drawn from its broad membership. Publications in MedEdPORTAL are considered compelling scholarly contributions suitable for supporting promotion and tenure decisions.

Any medical or dental educator or learner may submit materials to be considered for publication in MedEdPORTAL. Students and educators may submit resources even if they are not associated with accredited teaching institutions. However, all submitted resources are subjected to the same rigorous peer review process and must meet MedEdPORTAL's established criteria before they are eligible for publication in MedEdPORTAL. The MedEdPORTAL submission to publication process is as follows:

**Submission:** All submitting authors must complete the online MedEdPORTAL submission form located on the MedEdPORTAL Web site menu bar labeled Submit Resource. The information collected on the form is used, in part, by reviewers as they evaluate the submission. Reviewers will be interested in both the quantity and quality of information that is provided. The submission form should be considered a mechanism to help the author(s) make a compelling case for how their submission meets the MedEdPORTAL standards.

**Screening:** All submissions are screened by MedEdPORTAL staff to ensure they meet the minimal scholarship requirements and do not violate any copyright or patient privacy standards or laws. It is MedEdPORTAL policy that all submissions are free and clear of any copyrighted materials before moving forward with the peer review process. This includes all text, diagrams, articles, cartoons, and multimedia. If third party or copyrighted material is incorporated into the submission, MedEdPORTAL requires that prospective authors obtain written permission to include these items. Alternatively, if there are items in the submission where the originating author(s) are not known, or it will be difficult to receive the necessary permission, the materials must be removed from the resource or replaced with non-copyrighted content.

**Peer Review:** All items submitted by authors that successfully clear the screening process must also pass through the MedEdPORTAL peer review process, which mirrors the traditional journal model of peer review. Two qualified external reviewers are selected by the Editor or Associate Editor and may issue one of the following four publication recommendations:

- Accept with Acclamation
- Accept
- Revisions Required
- Reject

The Editor evaluates the submitted reviews and makes the final publication decision. A formal decision email is sent to the primary author regarding the publication decision and includes comments and recommendations from the reviewers.

**Catalog:** Each resource that passes the MedEdPORTAL peer review process enters a cataloging stage where MedEdPORTAL staff identifies additional keywords and disciplines that should be associated with the publication in addition to formatting the submission form for consistency and accuracy. Keywords are standardized using Medical Subject Headings (MeSH) from the US National Library of Medicine controlled vocabulary database; which is traditionally used for indexing publications.

**Publish:** Following cataloging, MedEdPORTAL staff formats and prepares the resource for final publication in MedEdPORTAL. This publishing process involves verifying all co-author submission agreements and copyright forms are on file, formatting the abstract appropriately for publication, and uploading the final resource files to the MedEdPORTAL site.

When the aforementioned items are complete, the resource is formally published and becomes both searchable and downloadable on the MedEdPORTAL Web site.

## Publication and Usage Stats

MedEdPORTAL currently receives over 50 new submissions each month and has received over 8,000 submissions since 2005. The current publication rates are: 6% accepted without revisions, 68% require extensive revisions, and 26% are rejected.

There are currently over 1,600 successfully peer reviewed publications in MedEdPORTAL. Over 500 publications are downloaded each week by users in 180 countries. The top 10 countries downloading MedEdPORTAL publications are: United States, Canada, United Kingdom, Australia, India, Egypt, Malaysia, Philippines, Saudi Arabia, and Germany.

## Conclusion

MedEdPORTAL is a rapidly expanding service striving to meet the needs of health educators and learners around the globe

while promoting educational scholarship. The benefits of publishing in MedEdPORTAL include:

- Receive recognition for peer-review of scholarly work that may be considered by promotion and tenure committees.
- Obtain feedback from peer reviewers on how to revise and enhance their resources.
- Expand the audience of potential users of their work beyond their own discipline.
- Receive a copyright license during the submission process for their work and they retain ownership of the materials submitted.
- Generate usage reports listing all users that downloaded their published resources through MedEdPORTAL.
- Receive a formal citation for MedEdPORTAL publication.

The benefits of utilizing MedEdPORTAL publications include:

- All resources published in MedEdPORTAL are formally peer reviewed.
- All copyright and patient privacy issues were addressed prior to publishing.
- Copyright permissions are already granted to use the published resources for educational purposes.
- Users can find high-quality resources to develop lectures, courses, and curricula.
- Users can access self-study materials to facilitate learning.
- Users can locate valuable assessment tools.

For more information about MedEdPORTAL and to review the resources currently published and available please visit [www.mededportal.org](http://www.mededportal.org).

## References

- [1] R. Reynolds, C. Candler, (2008), MedEdPORTAL: Educational Scholarship for Teaching, *Journal for Continuing Education in the Health Professions*, 28(2).

## **ORGANISING OPEN EDUCATIONAL RESOURCES: THE HIGHER EDUCATION ACADEMY SUBJECT CENTRE FOR MEDICINE, DENTISTRY AND VETERINARY MEDICINE**

SUZANNE HARDY, MEGAN QUENTIN-BAXTER

*Higher Education Academy Subject Centre for Medicine, Dentistry & Veterinary Medicine,  
United Kingdom*

**DESCRIPTION:** A Subject Strand project led by MEDEV was awarded to a consortium of 18 UK Higher Education Institutions (HEIs) as part of a one-year £5M OER pilot programme, funded by the Higher Education Funding Council for England and administered by the Joint Information Systems Committee and the Higher Education Academy.

**Intended outcomes:** This non-technical workshop will explore policies, challenges, barriers and solutions to releasing teaching materials as Open Educational Resources (OER) on the Internet. These include copyright and IPR, patient consent, institutional policy, quality and pedagogy status, and resource discovery and re-use.

You will explore and evaluate the practical interactive toolkits, in relation to your own situation, contribute advice and expertise to enhance these free tools, and become part of a community interested in releasing teaching materials as OER in an international discipline specific context.

You will receive these toolkits, plus a pack of teaching resources, contributed by consortium partners which can be freely used in your own teaching.

**Structure:** There will be short talks introducing the context, small group work exploring key issues, toolkit presentations and discussion, sharing of good practice and networking.

**Intended audience:** Academic and clinical staff interested in releasing teaching materials as OER.

## CHALLENGES, RESTRICTIONS AND OPPORTUNITIES IN LICENSING ONLINE EDUCATIONAL MATERIAL

MARIA NIKOLAIDOU<sup>1</sup>, STATHIS KONSTANTINIDIS<sup>1</sup>, PANAGIOTIS D. BAMIDIS<sup>1</sup>,  
ELENI KALDOUDI<sup>3</sup>, NIKOLAOS DOMBROS<sup>1</sup>, MARINOS PAPADOPOULOS<sup>2</sup>,  
DIONYSIA KALLINIKOU<sup>2</sup>

<sup>1</sup>*Aristotle University of Thessaloniki, Greece;* <sup>2</sup>*National and Kapodistrian University of Athens, Greece;*  
<sup>3</sup>*Democritus University of Thrace, Greece*

**DESCRIPTION:** A large amount of educational material is currently made available online by numerous Higher Education institutions worldwide; content sharing solutions and mechanisms are being created to make the content widely accessible, and available for retrieval through technical solutions. However, authorship and intellectual property are issues of great importance for academic teachers who wish to make their material publicly available, without jeopardizing their integrity,

credibility and confidentiality. It is also strongly associated to the way educators outline their teaching files and material. This work will demonstrate some of the challenges, restrictions and opportunities that educators of the Medical School of Aristotle University of Thessaloniki are facing when licensing online medical educational material. Work is carried out by means of a focus group. The advantages and drawbacks of existing licensing schemes will be discussed.

## SUSTAINABILITY OF DIGITAL EDUCATIONAL RESOURCES: VIRTUAL PATIENTS

ANGELA MILLER<sup>1</sup>, GABRIELLE CAMPBELL<sup>2</sup>, CHARA BALASUBRAMANIAM<sup>3</sup>,  
TERRY POULTON<sup>3</sup>, MARTIN R. FISCHER<sup>4</sup>

<sup>1</sup>St George's, University of London, United Kingdom; <sup>2</sup>Association of American Medical Colleges, United States; <sup>3</sup>The eViP Programme, The E-Learning Unit, St George's University of London, United Kingdom, <sup>4</sup>Inst. for Teaching and Educational Research in Health Sciences, Faculty of Medicine, Private University Witten/Herdecke, Germany

**DESCRIPTION:** The use of new technologies to deliver and develop educational resources is rapidly becoming standard practice. The advantage associated with electronic Virtual Patients (VP) has resulted in increased use in the training of medical and healthcare practitioners. However, these electronic educational resources are expensive to generate, dictating the need for medical institutions to share resources. At the same time sharing of digital content within the Healthcare care sector raises many potential obstacles that need to be addressed, consideration also needs to be made towards sustainability. Sustainable business models need to be developed that ensure existence of the resource and its respective intellectual property rights without jeopardising the educational resource.

The Electronic Virtual Patient (eViP) project consists of a European consortium of e-learning medical and healthcare establishments, led by the eLearning Unit at St George's University of London. The aim of the three-years programme is to create a bank of repurposed and enriched multicultural Virtual Patient cases from across Europe. Using this project as a case study, this presentation outlines the findings and approach explored when developing and sharing digital resources such as VPs.

The eViP programme illustrates that it is possible for institutions to develop, share and sustain digital educational resources.



## PIVOTE: VIRTUAL PATIENTS FOR VIRTUAL WORLDS

DAVID JOHN HARVEY BURDEN

*Daden Limited, United Kingdom*

**DESCRIPTION:** PIVOTE is an open source training authoring system based on the Medbiquitous Virtual Patient standard, but designed to support medical and non-medical training exercises in virtual worlds such as Second Life – as well as providing the ability to play exercises on the web and mobile phones. Developed originally with St George's Hospital as part of the PREVIEW project, PIVOTE was put into open source in 2009 and has now been downloaded over 100 times and use

reports are coming in from as far afield as South America and Australia.

This presentation will provide a brief demonstration of the PIVOTE system, including the latest upgrades to support natural language dialogue interaction (aka chatbots) and other changes, and will summarise some of the projects currently using PIVOTE for medical and non-medical training.

## **A MIXED REALITY VIRTUAL PATIENT BREAST SIMULATOR WITH AN INNOVATIVE FEEDBACK SYSTEM IMPROVES COMMUNICATION AND BREAST EXAMINATION SKILLS**

AARON KOTRANZA<sup>2</sup>, BENJAMIN LOK<sup>2</sup>, KYLE JOHNSEN<sup>3</sup>, JENNIFER IRONS CARRICK<sup>1</sup>,  
CANDELARIO LASERNA<sup>1</sup>, BRENDA ROSSON<sup>1</sup>, MARY ANNE PARK<sup>1</sup>, D. SCOTT LIND<sup>1</sup>

<sup>1</sup>Medical College of Georgia, United States; <sup>2</sup>University of Florida – Gainesville, United States;

<sup>3</sup>University of Georgia – Athens, United States

**DESCRIPTION:** Many health professions students and providers lack confidence in communication and breast examination skills. Unfortunately, current methods of teaching and assessing these important skills are limited by competing clinical demands of teaching faculty and the availability of real or standardized patients (SP) with breast abnormalities. Through a multi-institutional, interdisciplinary effort involving computer scientists, medical students, breast cancer patients and health-care providers, we have created a mixed reality human interaction (MRH) combining an interactive virtual patient (VP) with a mannequin containing breast pressure sensors providing real time feedback regarding communication and breast examination skills. In the current study, we demonstrate

that this MRH tool improved communication skills and breast examination competency.

After fully informed consent and voice recognition training, participants underwent a MRH with a breast complaint (VP). Participants received feedback regarding their skills using a color-coded touch map and their communication. Next, participants completed a pre and post MRH encounter survey regarding their confidence in these clinical skills and the value of the simulation. In a repetitive learning study, a subgroup of medical students underwent an initial SP interaction (SP wore a breast vest containing a breast mass) followed by three MRH interactions then followed by another SP interaction



## PROGRAMMABLE PATIENTS: SIMULATION OF CONSULTATION SKILLS IN A VIRTUAL ENVIRONMENT

LUKE BRACEGIRDLE, STEPHEN CHAPMAN

*School of Pharmacy, Keele University, United Kingdom*

**Abstract:** The School of Pharmacy has developed 3D characters in a virtual environment to simulate interaction between the learner and a virtual patient. Interaction with the patient is possible through the use of multiple choice questions or 'natural' free text questions. Each patient can be programmed with different scenarios and medical history from a Windows-based interface to 'program' a patient without the need for programming skills.

Free text input allows Virtual Patients to 'grow' in intelligence. The patient's knowledgebase is located on the internet, which provides the ability for virtual patients to respond to new questions. 3D animation and audio for new responses are also updateable across this medium.

At the centre of each virtual patient case is a 'decision tree' providing clinical experience and published evidence basis for a case. It also provides a mechanism to assess the learner consistently against learning outcomes. The virtual patient gives an animated audio response to the learner at the conclusion of a virtual consultation.

This demonstration offers the opportunity to explore our virtual patient technology, the description of a patient case and its decision tree. It will also draw on the pedagogical background and experience of using this system for our undergraduate MPharm.

Modernising the practice of pharmacy, from the traditional supply and dispensing role to enhanced clinical services, requires a substantive increase in the clinical content for undergraduate pharmacy students. For qualified pharmacists there is an equal requirement for structured continued professional development to develop and assess clinical competence. In order to do so, both students and qualified professionals alike need access to both an up to date evidence base for their practice and suitable patients to provide the clinical case studies. Such cases need to challenge both the technical medicines knowledge and the ability to apply this knowledge in a practical setting using appropriate diagnostic and communication skills [1].

The particular challenge for educators in an undergraduate and postgraduate setting is providing access to the right type patient at a convenient time then attempting to standardize the student experience. Ensuring consistency can be difficult as it is highly unlikely that a patient will respond the same way to the first and the twentieth student they see in a day [2]. The alternative is running Objective Structured Clinical Examinations (OSCEs) using staff members to role play patients [3] [4]. The potential drawback of this approach is that the "patients" may be known to the student so this can be somewhat artificial.

We started from a platform of paper based distance learning postgraduate materials, which then evolved into eLearning materials, primarily based on treatment algorithms and decision trees with static photographs to illustrate the cases. The drawback of this system was that it mainly required multiple choice answers, which unavoidably guide the student to a restricted set of responses and do not assess or replicate

the behavioral issues or emotional engagement experienced with a real patient. So, although we could start to standardize a case we needed to find a way of building in soft skills and emotional intelligence.

To address the latter we have developed a new eLearning system that uses a computer generated programmable patient, or avatar<sup>1</sup>, to simulate a clinical scenario in a three dimensional (3D) environment. The character responds to the decisions made by the learner and is currently used for training pharmacists to apply practical skills and to examine their performance in clinical environments. The avatar itself gives feedback at the end of the consultation.

One important feature is that the system does not correct mistakes. The student continues the consultation unaware, but then has to deal with consequences of the error. For instance, if consulting on a chest infection and the student fails to check for penicillin allergy, then treats with penicillin V, the avatar could break out in a rash and collapse. The avatar then gives structured feedback.

Experiencing the consequences of a clinical mistake is a potent learning tool. Similarly, poor communication can pro-

<sup>1</sup> We frequently use the term "Avatar" in this paper with reference to a computer generated programmable patient. The term is normally used to describe a computer generated character representative of a human operator. We feel this definition is true of the computer generated programmable patient we use, although technically it is controlled by the computer. However, as it simulates behavioral attitudes and possesses limited knowledge representative of human performance in an OSCE, the term avatar is used in this context.

vide challenges to the student and produce a difficult consultation [5].

The system can be used in a large class-room based setting, small group setting, one-to-one or on a home computer system providing a 'patient on demand' to practice skills. It can be accessed multiple times for practice, or limited to a pre-specified number of attempts before an assessed attempt, thus combining formative and summative elements.

## Designing a Programmable Patient

Before we started to develop a bespoke system for the School of Pharmacy, we evaluated existing "virtual patient" systems, either proprietary or open source. A varying degree of low-to-high fidelity systems were found, ranging from static clinical case notes accompanied with photograph/video to larger systems that use a fully immersive 3D environment that invite the user to explore a patient externally or internally. However we found very few high-fidelity systems that provided an environment to converse with a 'patient', to program a patient behaviour based on clinical evidence and to add or 'grow' its database of responses without expensive redevelopment work.

Therefore we decided to develop our own system to address the following three key attributes we required for a virtual patient system.

1. An electronic database ("the brain") that can record verbal or behavioural responses in a systematic way to represent real-world evidence for a given clinical topic. The system should allow a clinical educator to program patient responses, without the need for a programmer or software re-development.
2. A computer generated graphic ("the body") representative of a human that can express audio and visual responses

and non-verbal gestures, giving immediate feedback to the user.

3. A system ("the heart") to supply data from "the brain" to the "the body", providing the mechanism for a real-time, immediate response from the avatar when a user asks a question or when the brain is re-programmed to respond to new question types.

## Creating the Electronic "Brain"

The "brain" of the avatar is based on a Markov model or clinical decision tree. Such interactive decision trees have been shown in practice to improve adherence to clinical guidance and thus, by implication the implementation of evidence based practice [6]. In clinical practice, a health care professional responds to prompts to guide them to the most suitable intervention for the patient [7].

For our programmable patients, the same evidence based principles are used to design the decision tree, but rather than direct the health care professional to the best decision, all options are left open and the student progresses through the "tree" based on textual responses. The avatar driven feedback tool monitors the key decision nodes, records and finally, reports both good and poor decisions back to the student. If there has been a poor decision the avatar can "speak" to the student with an animated response why it was a poor decision, or refer to further reading to give more detail.

The electronic brain is a database structured to simulate a decision tree. It can be located on a remote location, such as a web server. This allows for clinical educators to add responses into a single shared brain, and thus add to the knowledge-base of a programmable patient. Each time a student launches the software, it can be set to download the latest brain, and

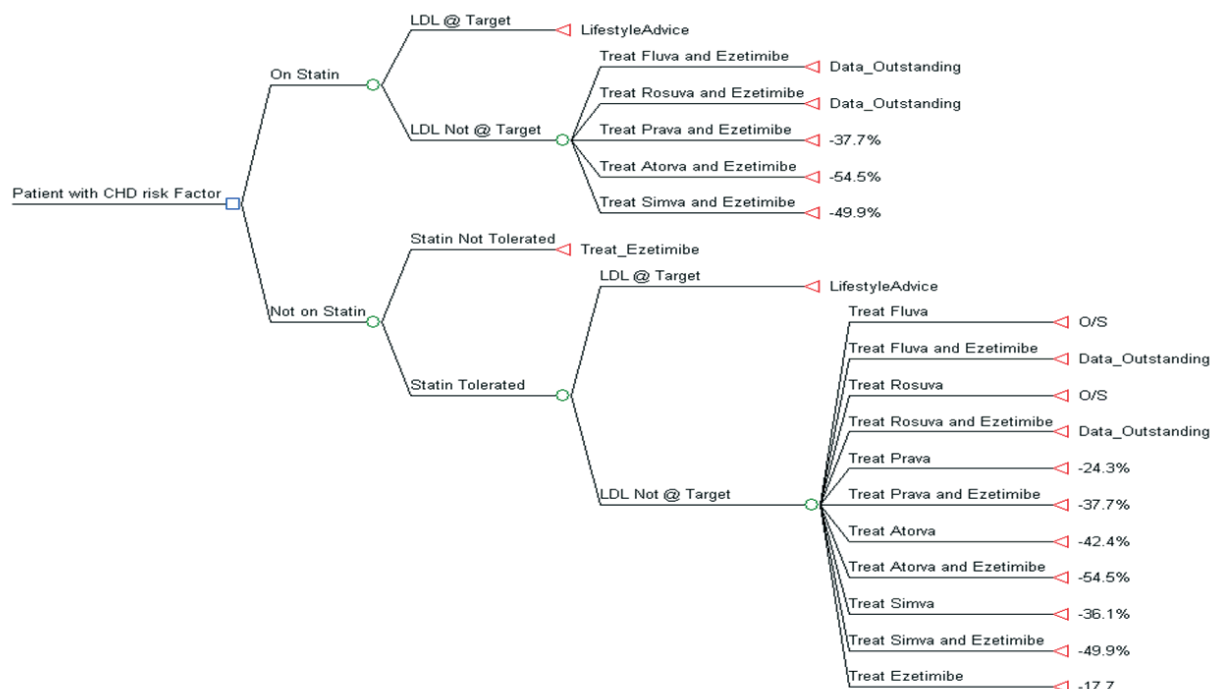


Fig. 1. An illustrative decision tree output showing relative risk nodes



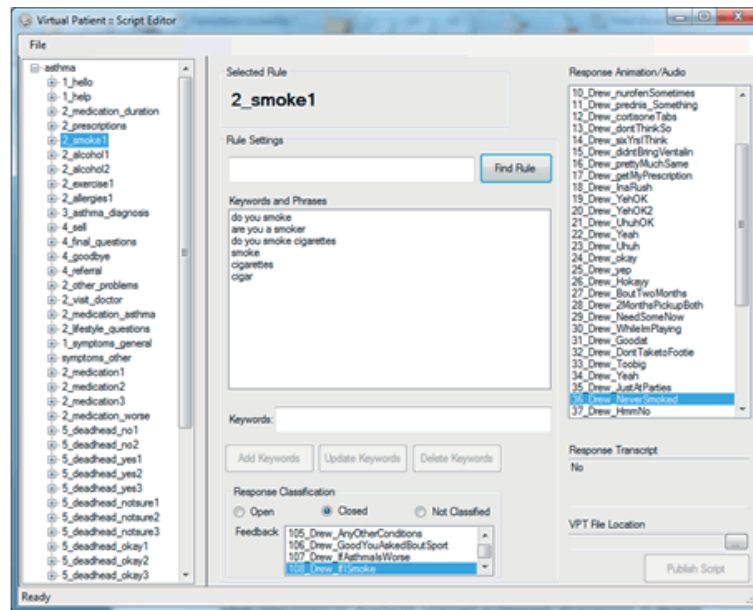


Fig. 2. Windows-based software tool for clinical educators to add responses

change the audio visual behaviour of the avatar accordingly. This allows for a communication network to be formed amongst a distributed group of clinical educators who wish to use and grow the intelligence of the patient without having to redesign the software after each update.

The student interacts with the programmable patient by typing free-text questions (they may also select multiple choice questions or use predictive text).

The software allows a question to be sent to the avatar and this is followed with an animation and audio response imme-

diately. There are two major types of questions a student may ask.

### Initial Questions

By default, all questions are initial questions and are stored in “the brain”. This allows the avatar to respond to the questions entered by the student without the need of any additional information. For example, a pain scenario might cause the avatar

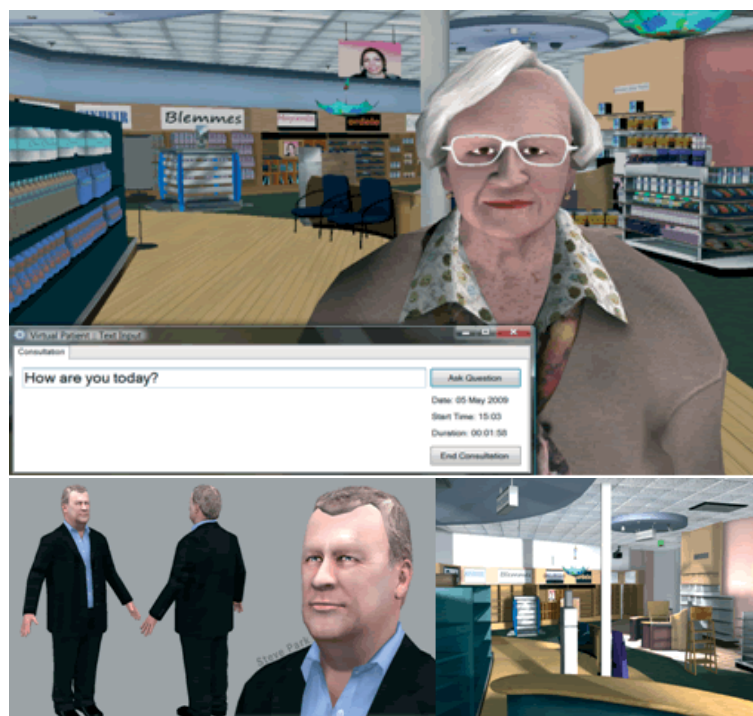


Fig. 3. Interacting with a Programmable Patient

to say to the student “I keep getting a throbbing headache”. The student might then follow up by asking “is it worse on one side of the head or the other?”. This process continues until all the learning objectives for a scenario have been identified by the student, or the consultation is concluded.

## Follow-up Questions

Follow up questions require the student to establish the context of the question beforehand. This allows for questions to be asked that follow on from the previous question. The student might ask, “Are you taking any medication” as the initial question. A follow-up question of “anything else” in this context of medication is understood, and the student gains a little more information regarding the avatar’s medical history. This principle can be applied to any initial question and any number of follow-up questions.

## Question Classification

The “brain” allows for the classification of each question presented to the avatar. Questions are classified based on the response of the avatar. For example, the educator may wish to know if the student asked questions about the avatars medical history, lifestyle or family history. Based on the responses from the avatar and where they appear in the decision tree, it is possible to record statistics on this data for feedback. The avatar “speaks” to the student at the end of the consultation if they didn’t ask many lifestyle questions, for example.

## Scope of Questions

When we design a new case, we need to define the boundaries of what the avatar should respond to. If a question is not recognised by the system, the student is given an opportunity to submit their question and how they feel the avatar should have responded. This feedback is then collated, added to the “brain” and “pushed” out to all users of the software next time the software is executed.

## Feedback

The avatar “speaks” to the student at the end of the consultation, reporting which areas of the learning objectives they have successfully identified. A feedback screen is also displayed at the end of consultation, allowing the student to email, print or save a transcript of their feedback, along with their statistics and a list of repeated questions and avatar responses. It is possible to adapt the feedback report to match the learning objectives of the scenario, providing a consistent mechanism to feedback to the student.

## Re-useable Programmable Patient Components in the “heart” and “body”

The “body” of the patient is designed with proprietary 3D modelling software. When designed to connect to our “heart” component (a proxy object that communicates the outputs from the brain with animations in the body) it provides a reusable interface to animate the avatar from a library of animations to show behavioural characteristics or basic responses generic to various clinical topics. For example the response to “Do you smoke” is often required for many clinical cases.

It is also possible to reuse code from external sources and cases already developed. For example, the appropriate response from the avatar is assisted with the use of artificial intelligence (AI) software. Therefore, the free-text input system does not look for a string of text to match. Rather we use a combination of proprietary and open-source AI software to achieve this, so clinicians only input keywords and key phrases when programming the avatar to respond appropriately. For example, the question “Do you smoke” could be entered by the student as “are you a smoker”, “how many cigarettes do you smoke”, “have you ever smoked” and so on. However it would not be necessary to enter all alternatives for the question to be correctly identified. Such alternatives can be reused in other cases that use different avatars, but still require a similar response. As the aim of this paper is to describe the higher-level hierarchy and our approach to designing programmable patients, we do not attempt to describe these lower level components further, but include it here as part of the discussion for completeness.

## Pedagogical Use of Programmable Patients

The School of Pharmacy at Keele University, have been using programmable patients for undergraduate teaching, as part of their communication skills module. The teaching session expected undergraduate students to use the WWHAM<sup>2</sup> model to phrase questions to an avatar (patient) presenting in a community pharmacy. The following question topics were programmed for use with a patient when requesting over-the-counter medication:

- Who is the medicine for?
- What is the medicine for?
- How long have the symptoms been present?
- Action already taken?
- Medicines taken for other reasons, prescribed or otherwise?

This model was used to construct questions the student should be asking, along with suitable alternative questions that fit the criteria. Questions outside the scope of this model, were programmed to result in the avatar responding with “I’m not sure that is relevant”, “I’m sorry I don’t understand” or display non-verbal body language to show impatience with the student for not dispensing the drug requested.

<sup>2</sup> WWHAM is a mnemonic to ensure a sufficient level of communication occurs during the dispensing of medication in a community pharmacy setting [8].

At the conclusion of the exercise, the student was given the transcript of their consultation, along with feedback directly from the avatar as an animated audio visual dialogue. This provided the student with areas of the WWHAM model where they performed well and how they might have asked other questions. Additionally they were given the opportunity to save, email or print their own transcript to compare and contrast their performance in a future session with the avatar.

## Results and Conclusions of Development and Educational Activity

Our educational use and evaluation of the avatar is at an early stage but anecdotal feedback show some emotional engagement from students, reporting they were "worried about upsetting" the avatar. Transcripts of sessions with the avatar show how questions asked by students were phrased using natural language formulated by the student and applied to the avatar, rather than selecting questions from published course materials.

Two cohorts of 90 students used the avatar based on the WWHAM model. Academic staff felt the session would have not run in this format when asked if they could run the session with human actors or real-life patients instead. It was also felt that the technical challenge of giving a large number of actors the same script as the avatar for consistent responses, would have been difficult and the marking of the feedback would not have been immediate, which we felt corresponded with other research studies [2] [3].

There did seem to be a paradox amongst some groups of students and academic staff. The perception of free-text input by some students was the avatar should have responded to all their questions, even if they were outside the scope of the case. Some students felt that the use of text-language ("are u ok btw?") should have gained a response. In contrast the move away from Multiple Choice Questions was very much favoured by academic staff and the ability to "switch-off" responses for the use of unprofessional language and questions outside the scope of the exercise.

The use of the avatar is planned to be repeated, with a formal survey of input methods for the user interface and user acceptance levels. We hope to plan a research project to contrast student experience and knowledge gained using multiple choice questions and compare this with another cohort that use free-text input.

In conclusion, we feel the development project has fulfilled the three key attributes we required of a virtual patient system. Our educational use of the tool has helped us frame how we might effectively assess its use for teaching and learning. A wider research project is planned to compare our use of the tool with other external University student cohorts, who now use our programmable patients as part of their eLearning activities.

## References

1. Parry R. H., Brown K. (2009), Teaching and learning communication skills in physiotherapy: what is done and how should it be done? *Physiotherapy*, 95(4): 294-301.
2. Lurie S. J., Mooney C. J., Nofziger A. C., et al. (2008), Further challenges in measuring communication skills: accounting for actor effects in standardised patient assessments. *Med. Educ.*, 42(7): 662-8.
3. Munoz L. Q., O'Byrne C., Pugsley J., et al. (2005), Reliability, validity, and generalizability of an objective structured clinical examination (OSCE) for assessment of entry-to-practice in pharmacy. *Pharmacy Education*, 5(1): 33-43.
4. Rider E. A., Hinrichs M. M., Lown B. A. (2006), A model for communication skills assessment across the undergraduate curriculum. *Med. Teach.*, 28(5): 127-34.
5. Bleakley A., Bligh J. (2008), Students learning from patients: let's get real in medical education. *Adv. Health Sci. Educ. Theory Pract.*, 13(1): 89-107.
6. Chapman S. R. (2007), Developing decision support systems for nurse prescribers. *Nurse Prescribing*, 5(6): 251-255.
7. Schauer D. P., Arterburn D. E., Livingston E. H., et al. (2010), Decision modeling to estimate the impact of gastric bypass surgery on life expectancy for the treatment of morbid obesity. *Arch. Surg.*, 145(1): 57-62.
8. Watson M. C., Bond C. M., Grimshaw J., et al. (2006), Factors predicting the guideline compliant supply (or non-supply) of non-prescription medicines in the community pharmacy setting. *Qual. Saf. Health Care*, 15(1): 53-7.

## Further Information

Luke Bracegirdle is IT Development Director for the School of Pharmacy, Keele University. As the technical designer for Programmable Patients, his role involves the software development of the system and providing a technical lead for a 3D media development team. He has over 12 years programming experience and is a qualified Microsoft Certified Technology Specialist in Web, Windows and Distributed Applications. He also leads on IT development initiatives for a range of educational and NHS clients developing web-based media and electronic information delivery systems.

Stephen Chapman is Professor of Prescribing Studies and Head of the School of Pharmacy at Keele University. As well as providing the academic lead on issues such as implementing evidence based medicine, prescribing databases and health service prescribing policies, his current projects include decision analysis support and virtual patients for training of healthcare professionals. Professor Chapman's career spans the pharmaceutical industry, the Health Service and academia. He has published widely in peer group reviewed journals and edited 85 bespoke prescribing reports. He is a member of the core scientific committee for the European Quality Indicators Group. He has undertaken international consultancy work in Albania, Belgium, Bosnia, Russia, Sweden, Poland, Denmark, USA HMOs, Canada and South Africa.

Website: <http://www.keele.ac.uk/pharmacy/vp/>

Email:

Luke Bracegirdle ([l.bracegirdle@mema.keele.ac.uk](mailto:l.bracegirdle@mema.keele.ac.uk))

Prof. Stephen Chapman ([s.r.chapman@mema.keele.ac.uk](mailto:s.r.chapman@mema.keele.ac.uk))



## **SIMODONT, A HAPTIC DENTAL TRAINING SIMULATOR COMBINED WITH COURSEWARE**

**PEPIJN KOOPMAN, JAAP BUIS, PAUL WESSELINK, MARJOKE VERVOORN**

*Institute of Dental Education, Academic Centre for Dentistry Amsterdam, The Netherlands*

**Abstract:** To answer drawbacks associated with preclinical training on plastic teeth and extracted human teeth ACTA embarked on a quest towards a virtual clinical lab. In collaboration with Moog Inc. an innovative haptic dental training simulator, the Simodont, was developed to improve the methodology of dental education. The simulator utilizes a virtual reality setting allowing students to practice manual dexterity skills. The operation of Simodont is conducted with courseware, providing the educational context of the training. Simodont offers several significant advantages for learning dental procedures. To integrate theory and practice and to place the exercises within a clinical context, virtual patients are presented to the students. Using a virtual patient authoring system teachers are able to easily distribute virtual patients. Further research on the benefits and feasibility of compliance with the MedBiquitous Virtual Patient specification will be done. To conclude, some success factors in educational virtual reality projects are identified.

### **Introduction**

At the Academic Centre for Dentistry Amsterdam (ACTA) dental students have to train their clinical skills on phantom heads at the preclinic before they are allowed to treat patients. Learning to drill on plastic teeth and extracted human teeth has some drawbacks:

- Just a small part of extracted teeth is suitable for use at the preclinic. Because there is a shortage of suitable extracted teeth it is hard for students to train and assess all skills taught in the preclinic.
- Many preclinical exercises are done on plastic teeth which don't contain pathology while important aspects of dental pedagogy at ACTA include clinical reasoning and a patient centered approach.
- The preclinical situation doesn't support the integration of theoretical education in the preclinical exercises.

Additionally the use of water cooled dental drills imposes hygienic threats (legionella) and maintenance of hand pieces and dental units result in high costs.

To answer these drawbacks ACTA, in collaboration with Moog Inc., started the development of Simodont: a haptic dental training simulator combined with courseware.

The purpose of this article is to give a general description of the Simodont as an implementation of the virtual clinical lab. Some educational advantages of Simodont are briefly discussed and a description of the virtual patients in Simodont is given.

### **The virtual clinical lab**

Traditionally students receive theoretical education next to practical education in the preclinical lab. The integration of the theoretical and practical education only takes place in the clinic. Thus the step between the preclinical lab and the clinic is rather big, making the transition from preclinic to clinic quite complicated to the student. The aim of introducing the virtual clinical lab is to decrease this gap by adding more realistic scenarios in the preclinical training environment to embed integration of the theory in the preclinical phase and to stimulate further theoretical inquiry as a result of virtual clinical experiences.

In the traditional preclinical lab students use standardized plastic teeth without pathology. They use a real drill and work without a clinical context. In the clinic on the other hand students work in a clinical context with patients with unique dental pathology. In the virtual clinical lab it is possible to simulate standardized patients with teeth with pathology. Because Simodont is a virtual reality (VR) system students work with virtual patients and the treatment process and the clinical context are simulated.

The advantage of the virtual clinical lab is combining standardization of exercises, as in the present preclinical environment, with realistic scenarios and teeth with pathology as in the clinic. On top of that there are VR-related advantages like the possibility to assess the complete drilling process instead of just the end result and the possibility to repeat the same exercise over and over without using materials like drills and plastic teeth.



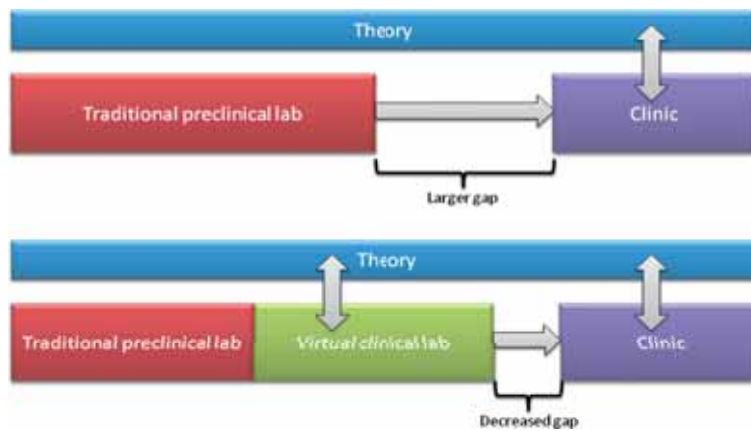


Fig. 1. The virtual clinical lab integrates theory and decreases the gap to the clinic

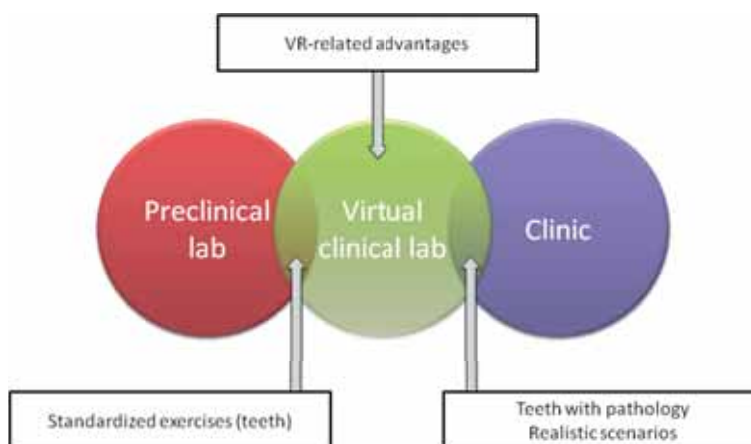


Fig. 2. The virtual clinical lab features advantages of both the preclinical lab and the clinic

Of course the virtual lab has some limitations as well. Not all procedures are equally fit for training in a virtual clinical lab. Tooth filling procedures like applying the material, matrix bands and wedges procedures for instance might be hard to train virtually. Also feeling and handling of teeth in virtual reality is not as rich and versatile as it is in the real world. The virtual clinical lab is an extension and improvement of the preclinical lab.

their decisions and their skills to develop the necessary competences. By means of a small projection screen the mouth and teeth of the patient are visible. Because the user is wearing 3D glasses, the stereo images show depth.

### Implementation of a virtual clinical lab: Simodont

Simodont is a high quality, high fidelity simulator allowing future dentists to be trained in operative dental procedures in a dedicated virtual reality environment while receiving haptic, visual and audio sensory information. Simodont offers the opportunity to train dental students in dental procedures from a problem based perspective by incorporating pathological dental conditions within the system.

Students using Simodont practice their manual skills in a realistic virtual environment and receive realistic feedback on



Fig. 3. The Simodont

Simodont offers a realistic model of the behavior of the drill. The speed is controlled by a foot pedal, the use of a force sensor in the haptic hand piece allows realistic rendering of drill and contact force, the sound of the airrotor is faithfully rendered by a built in sound module. The student can also use a mirror to work with indirect view.

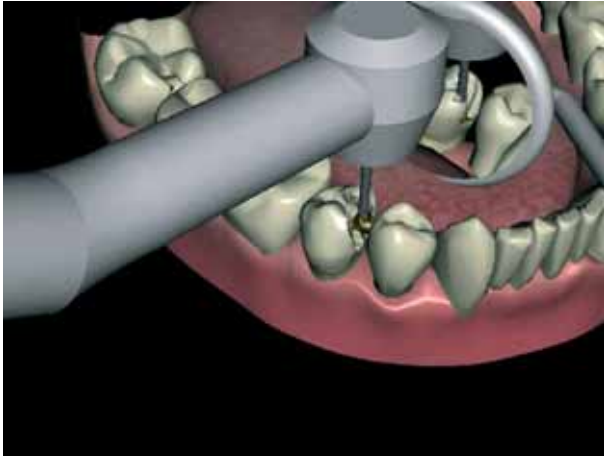


Fig. 4. Screenshot of the virtual mouth in the Simodont

### Advantages of Simodont

The operation of the Simodont is accompanied by courseware, providing the educational context of the training. The combination of courseware and simulator offers several advantages for learning dental procedures.

### Clinical context

The integration of theory and practice is achieved by placing the exercises within a clinical context. Each exercise can be coupled with a virtual patient, representing specific history, needs, circumstances, and approach. Such contextual setting allows students to practice clinical reasoning, decision making, and critical thinking.

### Intelligent feedback

By providing intelligent feedback on the quality of performance, the simulator allows students to become more self-critical and less dependent on teachers for assessment and evaluation. Rewards on progression are built in the courseware to create a challenging and enhanced learning environment.

### Bookmarks

While practicing complex procedures, key moments in the drilling process can be "bookmarked". This allows users to return to the bookmark and start practicing from that point. Thus allowing users to learn to identify significant events in their working process and repeat the training efficiently.

### Assessment

When using Simodont, teachers are not only able to assess the final product but also the process of the procedure. Such

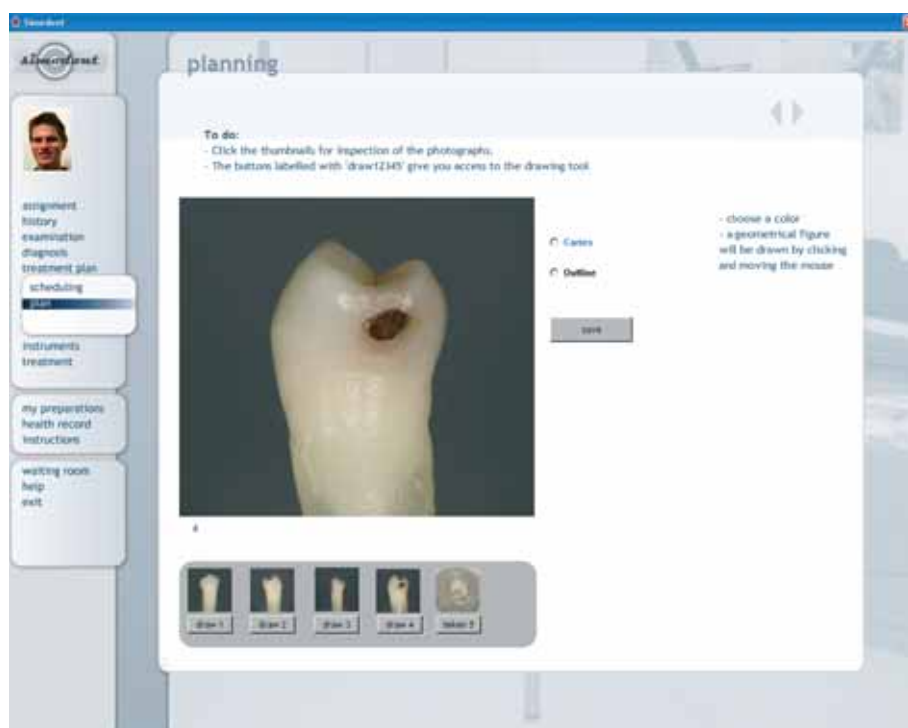


Fig. 5. Screenshot of the courseware

evaluation can promote a more detailed understanding of difficulties and solutions. The system thus provides more dimensions within one learning experience.

## Virtual patients in Simodont

In the courseware virtual patients are displayed within a waiting room, thus providing the clinical context of the exercises.

## Virtual patient data

The Simodont data specification of the virtual patients is based on a standardized ACTA procedure for decision making and treatment of patients. This standardized procedure consists of the following seven universal steps:

1. History
2. Examination
3. Diagnosis
4. Recognition of main problems
5. Analysis of possible solutions
6. Proposition of treatment plan
7. Execution of treatment plan

These seven steps are followed by an evaluation which is either the last step of the procedure or the first step of a new procedure.

The virtual patient data in the Simodont consist of files in a folder structure which is derived from this procedure. These folders can contain text files, images and video files.

The Simodont courseware is bilingual: the text in the data files can be entered in Dutch and in English. The first character in the filename signifies the language in which the text is entered in the file.

## Modes of interaction

The data in each of the above folders can be delivered to the student in three different modes:

1. Read only  
All data are given to the student. There is no interaction.  
For example: Diagnosis: Caries in tooth 45 (FDI identification).
2. Multiple choice  
Data is presented as a multiple choice question.  
For example: Investigation>Intra oral>Cariology aspects: How do you determine the vitality of a tooth? a) anamnesis or b) hot-cold test or c) drilling
3. Edit  
The student has to fill in the data in a text field.  
For example: Fill in the treatment plan.  
Each of the folders can have a different mode of interaction. For example, the history could be completely given to the student (mode is read only), the examination could be presented as a set of multiple choice questions and the student could be asked to fill in the diagnosis.

## Virtual patient authoring system

The definition of the virtual patients is separated from the courseware application itself. The courseware application can be regarded as a framework in which different self contained virtual patients can easily be inserted. This provides the possibility for teachers/experts to use a virtual patient authoring system to create virtual patients which can then be distributed to the courseware applications.

Folder	Subfolder	Subfolder	Text	Image	Video
History	Personal data		✓	✓	-
	Patient problem	Patient problem	✓	✓	✓
		Dental history	✓	✓	-
		Medical history	✓	✓	-
		Psychosocial history	✓	✓	-
		ASA	✓	✓	-
Examination	Extra oral		✓	✓	
	Intra oral	Indicators of oral health	✓	✓	✓
		Indicators of periodontal health	✓	✓	✓
		Cariological indicators	✓	✓	✓
		Functional and relational aspects	✓	✓	✓
Diagnosis	Differential diagnosis		✓	-	-
	Etiology		✓	-	-
	Diagnosis		✓	-	-
Treatment plan	Treatment plan		✓	✓	-
	Preparation plan		✓	✓	-
Instruments			✓	✓	-

Fig. 6. Folder structure of virtual patient data in Simodont

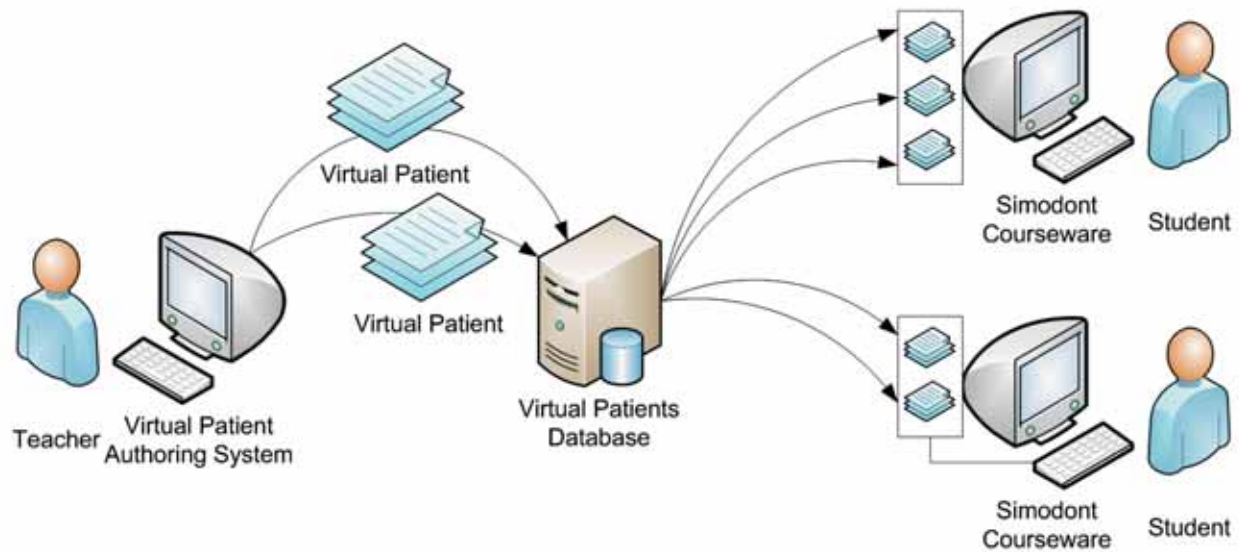


Fig. 7. Virtual patients created with the VP Authoring System are distributed by the VP Database

### The MedBiquitous Virtual Patient (MVP) specification

At the moment the Simodont uses a custom made data specification of the virtual patients. The benefits of compliance with the MedBiquitous Virtual Patient (MVP) specification<sup>1</sup> are being investigated. The main benefit would be the improved possibilities to exchange virtual patients with other developers.

Simodont courseware in relation to the MVP components  
The MVP specification consists of five components:

1. Virtual Patient Data (VPD)  
The VPD provides the personal and clinical data that is relevant to the clinical scenario being simulated.
2. Media Resources (MR)  
The media resources are all of the images, animations, videos, audio files and any other discrete digital objects that are associated with the virtual patient at any point during the simulated patient scenario.
3. Data Availability Model (DAM)  
This component expresses the aggregation of VPD and MR elements for exposure through the Activity Model.
4. Activity Model (AM)  
The AM encodes what the learner can do and how they engage with the virtual patient.
5. Virtual Patient Player (VPP) Functional Specification  
The Virtual Patient Player presents the virtual patient to the learner and gathers and parses learner input.

In the Simodont courseware these five components also exist but they are distributed between the virtual patients in the folder structure described above and the courseware application itself.

### SCORM compliance

The MVP specification is compliant with the Sharable Content Object Reference Model (SCORM)<sup>2</sup>. That means that a virtual patient can be stored as a content package (zip-file) with a XML

manifest file which contains information about where and what everything else in the content package is. SCORM compliance allows a virtual patient package to be imported and run within any SCORM-compliant Virtual Learning Environment (for example Blackboard). The profit and feasibility of making the Simodont courseware SCORM-compliant will be looked into.

### Collaboration and system borders

A virtual reality project in education can only be successful if the development meets a clear demand from end users while keeping a sharp focus on the system boundaries.

For a virtual reality application to be successful it is of paramount importance that the development is demand driven

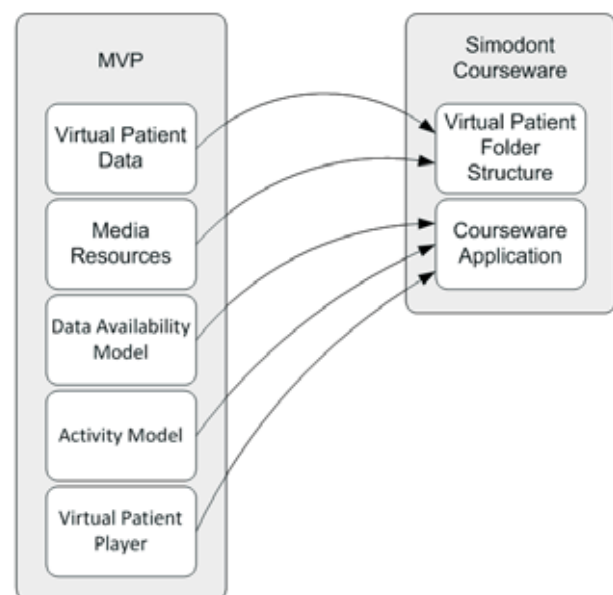


Fig. 8. Distribution of the MVP components between the Simodont VP folder structure and the courseware

instead of technology driven. This demand from within a discipline can lead to collaboration with a technical manufacturer in which both parties have a common goal. In this case a dental department (ACTA) had the need for preclinical training in a virtual reality environment and started a collaboration with Moog Inc. to develop a dental training simulator with a realistic simulation of dental procedures using both force feedback and stereo imaging.

During the development it is important to keep a close watch on the feasibility and the system borders. When faced with the limitless possibilities of virtual reality it is hard to withstand the temptation to develop possibilities in the virtual world which do not directly serve the educational demand. In the Simodont project the system borders were restricted to a dental arch with teeth within the framework of a total virtual patient in which various pathologic conditions are offered.

## Conclusions

The introduction of the Simodont in the preclinical lab has the following advantages:

- Offering a structured learning environment integrating technique and theory.
- Unlimited practicing in a safe and almost real-life situation.
- Reduction in the cost of materials and maintenance.
- Evaluation of drilling process in addition to evaluation of the product.
- Time independent (laptop work station).
- Level of skill can be easily adapted.

## References

- 1 [http://medbiq.org/std\\_specs/specifications](http://medbiq.org/std_specs/specifications)
- 2 <http://www.adlnet.gov/Technologies/scorm>



## OPEN SOURCE COMPETENCY-BASED REPOSITORIES IN ACTION: AN AMERICAN SOCIETY FOR CLINICAL PATHOLOGY AND UNIVERSITY OF VIRGINIA PARTNERSHIP

JOHN VOSS<sup>1</sup>, CHITRA SUBRAMANIAM<sup>2</sup>, YE CHEN<sup>1</sup>, BONNIE JEROME-D'EMILIA<sup>3</sup>,  
MICHAEL FELDMAN<sup>2</sup>, VLADIMIR GOODKOVSKY<sup>1</sup>, JOHN JACKSON<sup>1</sup>

<sup>1</sup>University of Virginia, United States; <sup>2</sup>American Society of Clinical Pathology, United States; <sup>3</sup>Rutgers University, United States

**DESCRIPTION:** Medical educators now seek to organize learning programs and resources within a competency-based framework but often lack the instruments, methods and practical skills to create competency-based repositories. We describe collaborative work between the American Society for Clinical Pathology (ASCP) and the University of Virginia (UVA) to develop a functioning, validated curriculum repository for ASCP faculty to use to develop and manage competency-based educational resources for continuing professional development.

Using ASCP and UVA (X-CREDIT) open source platforms, we developed a competency repository for clinical pathology that permits educators to develop, map and peer-review educational resources and curricula. This software features the

ability to describe resources, attach keywords, citations and other metadata and to upload files to this competency framework for multiparty authoring and sequential tiered reviewing. The instrument also allows ASCP educators to bundle discrete learning activities into curricula. By portraying the relationships between general competencies, specific professional abilities and specific learning activities, educators can perform a gap analysis that identifies coverage deficiencies within a curriculum. These instruments are based on the open source Moodle learning management system and are publicly available for further development and adaptation via the Moodle community of resources.

## VIRTUAL PATIENTS IN VIRTUAL WORLDS

EMILY CONRADI, LUKE WOODHAM, SHEETAL KAVIA, TERRY POULTON

*St George's University of London, United Kingdom*

**Background:** SGUL have developed virtual patients (VPs) within the virtual world 'Second Life' for medical and paramedic students. These are delivered to groups of students for problem-based learning.

**Summary of work:** The virtual world scenarios have been developed through user-testing cycles. Early scenario ideas involving narrative-driven, option-consequence models were modified as a greater understanding of the platform developed, and scenarios have evolved into open-ended environment-driven models.

These VPs have also become a way to place other resources in context, and contain embedded websites, images, audio and video.

Example scenarios will be demonstrated during the presentation.

**Results:** Strengths and weaknesses of Second Life as a learning environment will be explored. In general students wanted more feedback on their decision-making. They reported that scenarios were engaging and a valuable way to rehearse competency, but did not want it to replace face-to-face teaching.

**Conclusion:** Creating learning materials within virtual worlds offers a unique opportunity to challenge students in ways that are immersive and relevant to their practice. As long as the strengths of such an environment are emphasised, and the space is not used to simply emulate other delivery platforms, they can be used with great effect to support and enhance student learning.

## VIRTUAL PHYSICAL EXAM

ALI HUSSAM<sup>1</sup>, SHAWN THOMAS FOLEY<sup>2</sup>

*<sup>1</sup>University of Missouri, United States; <sup>2</sup>Cerner Corporation, United States*

**DESCRIPTION:** The Virtual Physical Examination (VPE) is a solution that has been developed by Cerner Corporation in collaboration with the University of Missouri. VPE simulates more than 260 physical examinations; allows for practice evaluating real patient circumstances; compiles videos, images, audio, and interactive assets to create an immersive patient repertoire; allows educators to create new patient cases and edit existing patient using an authoring tool; and allows for collaboration as part of a online community of professionals.

The focus of this solution is to advance healthcare education of physical exam and provide research opportunities. The educational goal is to allow medical students and future health professionals to practice evaluating patient circumstances

based on the facts, concepts, rules, and procedures they have learned.

In this innovation demonstration, Dr. Ali Hussam, Director, MU Strategic Information Technology Enterprise (MU-SITE) will demonstrate the scope and capabilities of this unique virtual patient solution. Ali will discuss its implications for multiple audiences including pre-service and in-service healthcare professionals, faculty members, student, hospitals, organizations, and beyond. The focus will be on expanding the boundaries and leveraging Web 2.0 concepts to offer a web accessible, multi-disciplinary solution and approach that supports both collaborative group learning and independent individual learning.

## VPSIM – A VIRTUAL PATIENT SIMULATION WEB SERVICE

JAMES B. MCGEE, PETER M. KANT

*University of Pittsburgh School of Medicine, United States*

**DESCRIPTION:** vpSim ([vpsim.pitt.edu](http://vpsim.pitt.edu)) is a software application for authoring, playing and administering virtual patient (VP) simulations over the web. Educators and students use vpSim to independently create branching clinical scenarios with variable outcomes. This evidence-based pedagogical approach replicates a wide variety of scenarios for 1) teaching and assessing clinical reasoning skills, 2) filling gaps in clinical experience, and 3) engaging students in deliberate practice in a patient care scenario.

Educators and students designed vpSim to create linear and branching simulations using only a web browser – without technical assistance, dedicated hardware or software installation. Authoring employs a graphical interface to design a case's steps and paths and web forms for clinical data, multi-

media, didactics, and questions. vpSim includes pre-populated templates of clinical findings and diagnostics tests. Importantly, vpSim exports and imports cases based on the MedBiquitous VP specification.

The Player's streamlined design eliminates unnecessary cognitive load allowing students to focus on the clinical narrative. It is accessed either directly or integrated into an LMS with single-sign-on and automated reporting of performance and completion data.

This demonstration will review VP cases created with vpSim and introduce the audience to vpSim's authoring features. Trial accounts and licensing information are available at [vpsim.pitt.edu](http://vpsim.pitt.edu).

## USING ELECTRONIC VIRTUAL PATIENTS AND COLLABORATIVE GROUPS FOR PROBLEM BASED LEARNING

RALPH AARONS, SUSAN S. ALBRIGHT

*Tufts University, United States*

**Abstract:** TUSM has had a PBL course for decades. New LCME standards for accreditation call out PBL as an important tool in a medical curriculum. First year cases had been paper-based and second year cases have used a complex card-deck trying to simulate the clinical experience. We have now had two years of experience with paperless PBL. Collaborative groups were used for first year PBL and for second year the TUSK electronic virtual patient creator was used to create electronic versions of the card-deck. Transforming the paper cases was a simple task. The virtual patients were more difficult involving rethinking how the cases would work using the rules of the electronic virtual patient authoring tools. Facilitators, who had worked with the program, some for decades are slowly accepting this change. After the first year the virtual patient creator was reworked to make it more appropriate for PBL. The tool within TUSK, Tufts University Sciences Knowledgebase, now has more appropriate navigation and tracks the group's clinical reasoning path and associated costs. We will report on student satisfaction as compared to first year as well as an analysis of clinical paths traveled by the groups and associated costs.

### Background

Planning for introduction of a problem-based learning, PBL, component into the curriculum of the Tufts University School of Medicine, TUSM, began in the late 1970's and came to fruition with the inauguration of PBL courses for 1<sup>st</sup> and 2<sup>nd</sup> year medical students in the Fall of 1985. The format was built upon the model developed by Barrows at McMaster University and early development of the program at Tufts was fostered through direct collaboration between the two institutions over a period of years during the 1980's. The core process of PBL at Tufts employed multiple small groups (4 – 8 persons) of students assisted by a faculty tutor who served as a facilitator (an expert in the "process" of PBL, but not an expert in the "content" of clinical cases). The simulated patient cases were presented on paper to the students in short vignettes ranging from 3 to 6 pages in length. One page at a time would be encountered by the entire group with students managing all aspects of the case exploration. One student would read the case to the group while a second student would stand at a blackboard ready to write the salient elements of the case under the prescribed format of five headings: (1) What we know; (2) What we want to know; (3) Hypotheses; (4) Learning questions; (5) Statement of the problem. A third student would take notes at the table to provide the basis for resuming exploration of the case after a brief hiatus when small group of students was next convened. Small group meetings were conducted over 2 hours and met once each week. Each student would conduct independent research

pertaining to a Learning Question during the one-week interval between the group meetings. Each subsequent meeting would begin with brief presentations by the students to each other sharing the new knowledge they had discovered and discussing how that new knowledge applied to their case and helped to move forward their understanding of the issues of the case.

The content of paper cases was designed to develop in parallel with the unfolding of the medical curriculum, reflecting a gradual increase in subject matter domain and complexity as the preparation of students reflected their advancement through the curriculum. While initially limited to paper cases exclusively, the format of case presentation in PBL evolved as well and by 1990 advanced students (in their 2<sup>nd</sup> year of medical school) were given the opportunity to encounter simulated patient cases in a new format coined by Barrows "P4" (Progressive Patient Problem Pack). While the group size and organization remained the same as that used by 1<sup>st</sup> year students using exclusively paper cases, the 2<sup>nd</sup> year students encountered the P4 cases as sets of pre-printed "cards". One card would present a one-sentence "Presenting Complaint" to the students. Thereafter, all elements of the simulated patient case would be revealed by selecting one card at a time from one of five different stacks of color-coded cards: (1) History; (2) Physical Exam; (3) Tests and Procedures; (4) Consultants; (5) Management. Selection of each card required group consensus, thus students struggled to determine how to prioritize their selections and how to justify such choices when called upon to defend their position to their peers. This format was



developed as a means to begin the teaching of critical thinking and clinical reasoning. At the conclusion of each P4 case, the students were required to re-construct their “clinical reasoning pathway” by laying out the case cards in the sequence of their selection and then to discuss how they arrived at their choices and what they might have done differently to reach their conclusion with fewer steps or with less “hardship” to the simulated patient.

## Transition to Electronic Cases

The advance of academic technologies has given birth to a multitude of new tools and venues for presentation of virtual patients. Tufts University has been a vigorous environment for development of new teaching technologies. An important early application (begun in 1994) is the Tufts University Sciences Knowledgebase, TUSK, an award-winning, comprehensive, database-backed, information management system that combines features of a multi-media digital library, a learning and curriculum management system, and personal knowledge management. This system, started in the School of Medicine in partnership with the Hirsh Health Sciences Library, is now used across all Tufts' health sciences schools, as well as other medical schools in the United States, several countries in East Africa, and India. TUSK is a large application but two compelling features of TUSK, from the perspective of educators who promote the use of small group learning environments, are the capability to create “virtual” small groups where active collaboration can be conducted both synchronously (in real-time) or asynchronously (during the interval between group meetings) and the ability to create virtual patients. These features made TUSK an extremely attractive environment in which to conduct Problem-Based Learning. Thus, in Fall Semester 2008, traditional PBL “paper cases” and well as “P4 cases” were introduced into the TUSK environment and, for the first time, PBL at Tufts became “paperless”.

## Transformation of “paper cases”

Paper cases have been the traditional medium for Problem-Based Learning small groups at Tufts University School of Medicine since 1985. Facilitators have been drawn from specially trained groups of faculty or 4<sup>th</sup> year medical student volunteers. The facilitator would distribute a copy of the simulated patient case to each member at the beginning of the small group session and then the process of exploration would begin. The PBL groups meet for 2 hours once weekly and each group determines the pace of exploration independently. The duration over which each case is explored depends upon a multitude of factors such as group preferences, aptitude, efficiency, and experience. In general, the cases unfold over the course of 2 – 4 weeks, providing the one-week interval between each session as the opportunity for each student to independently research one of the Learning Questions and prepare to present what they have learned to the group at its next meeting.

The transition to electronic virtual cases on TUSK was very straightforward. Each page of a paper case was uploaded into the HTML editor of TUSK. Text could be entered by typing manually or by ‘copy-and-paste’ from an electronic document.

Graphic images, such as photos and X-rays, figures, such as electrocardiograms or microscope slides, or tables could easily be inserted at any location in the case. One of the virtues of TUSK is that one folder of PBL cases can be “reused” and linked into each PBL small group. The contents of this folder included two sub-folders: (1) a folder containing the virtual cases for the semester; and, (2) a folder containing “tools” to assist group work (instructions about using TUSK, laboratory reference values, templates for taking notes, etc.). In addition, members of each group were given privileges to create and upload material into private group folders. Documents, URLs, audio and video, and student-created presentations contributed to the exploration of the simulated case. While each student and faculty member can log into TUSK individually, a group log in was created for each group so that the course director could easily track the progress of the group. All the members of the group (the facilitator and the students) had access to the reused folder containing the instructions and the cases as well as the private group folders. Mastery of the technology was faster for the medical students and slower for the faculty. This most likely reflects the fact that the current generation of medical students has grown up with a multitude of electronic devices and computers available to them, thus learning new applications using information technologies are relatively facile for them. In contrast, some of the faculty facilitators required more assistance and time to achieve mastery. Since the students direct all facets of small group work including computer navigation, the function of the small groups appeared to proceed as smoothly as in previous years despite the change from paper cases to TUSK.

## Transformation of “P4 cases”

Moving the advanced format P4 cases into an electronic form for presentation proved more challenging. To accomplish this task, we took advantage of the unique virtual patient presentation tool developed at TUSM called the TUSK Case Simulator. The Case Simulator tool provides a user-friendly interface to design and create interactive teaching stories, such as virtual patients, to provide a content-rich, interactive educational experience. This tool allows faculty to provide information, solicit input, provide feedback and if desired, record student actions. The software was built to conform to the Medbiquitous Virtual Patient Standard.

The TUSK Case Simulator allows a case to be constructed in several steps: 1) Case Page Metadata (title of the case, access privileges, posting dates, etc.); 2) Learning Objectives; 3) Keywords (using an existing keyword in TUSK or a UMLS concept); 4) Phases (including instructions, chief complaint, history, physical exam, diagnostic studies, etc.); 5) Reference Library (links to TUSK content, full text from the medical literature, or links to external websites applicable to the case); and, 6) Permissions (the author defines the authors, editors, graders and reviewers of a case and access permissions are granted based on these permissions). In addition the tool permits the creation of default history, physical examination and diagnostic studies. These default studies will contain information regarding default normal values, default normal images (if appropriate) and default costs. These default entities are then called upon as individual virtual patients are created. The fac-

ulty need only add feedback, additional media for reference and abnormal values as needed.

There are two assessment modes (currently neither is graded): 1) Self-Assessment (anonymous results are recorded and viewable by faculty. Students can repeat the case as often as desired); 2) Reviewed Case: (results are recorded and matched with each student. Faculty can view all student input). This tool has been used for two years for PBL. After the first year some significant changes were made to specifically meet the challenges of using the tool in PBL. The original purpose of the tool had been to support linear progression through a case. This meant that students would be forced to traverse each "phase" in lock-step order. For PBL, the tool was edited to support global navigation. This meant that the students could progress through the case in whatever sequence felt natural to them without being blocked by the software. The second change was to track the groups' pathway through the case and by so doing also track expenditures. It was hoped that something might be learned about the clinical reasoning of each group by studying their pathways through the cases.

The virtual patient data revealed on P4 "cards" was entered manually into the HTML editor of the Simulator. The default set of phases was modified to conform with the 5 data sets used in the P4 method. The "welcome page" of the Simulator was used to present the case overview, usually just one line describing the patient presentation. An active button would start the case and begin by presenting instructions with each case to encourage review of the principles governing the P4 case format. All five phases are listed on left panel. Students can move forward and backward. The simulator keeps track of progress to allow students to stop and start without losing their place. Tracking of students is based on USERNAME, thus each student can proceed independently. To enable a problem-based learning small GROUP to act as one, a GROUP USERNAME was created just for PBL. In this way, students accessed their virtual patient only as a group and not as an individual. Images are used frequently to add an element of realism to each case. Thus, the chief complaint or patient presentation is always provided along with a photo of the patient. Whenever possible, media are presented to enhance the learning experience. For

example, if data from a chest X-ray is important in the case, students can choose to VIEW the digital image. In some cases an annotated image is provided but in most cases the students are confronted with the learning opportunity to explore how to interpret the chest X-ray. Students progress through the electronic virtual P4 case by the same process used with "cards", namely reaching group consensus and then selecting a case element. Where the associated COST for a particular item is available, that is included and a running total is displayed in the left margin of the Simulator. When the group believes no further data selections are required, they must select END THE CASE. This brings the group to the Case Summary page that shows everything that was selected and from that point the group may no longer re-enter the case. Instead, they review the steps they followed to reconstruct and discuss the pathway of their clinical reasoning. The P4 method is NOT a process describing how to do a history and physical; rather, it is an exercise in thinking.

### Evaluation of electronic virtual patients in PBL

Data were collected at the end of each semester of PBL by the TUSM Office of Educational Affairs for routine review and evaluation of all courses. Students complete on-line questionnaires and the data generated is compiled and reported to course directors and to the Curriculum Committee of the School of Medicine.

### Student satisfaction with electronic virtual "paper cases"

The introduction of TUSK into PBL was generally met with enthusiasm. Beginning and advanced medical students embraced the technology required for virtual group work quite easily (Figure 1). The principal virtues of TUSK that were shared

Questions addressing the usefulness of course components were presented using a 5-point Likert scale (1 = "Not useful" ..... 3 = "Modestly" ..... 5 = "Very useful").



Data from Year 1: questionnaires completed by 168 of the 177 students enrolled in the course (94.92%).  
Data from Year 2: questionnaires completed by 199 of the 201 students enrolled in the course (99.00%).

Question: "Rate the usefulness of TUSK":

Year 1 (beginning students):	N: 163 Mean: 4.27 Std Dev: 0.86 NA: 5
Year 2 (beginning students):	N: 189 Mean: 4.17 Std Dev: 1.00 NA: 10
Year 1 (advanced students):	N: 122 Mean: 3.99 Std Dev: 1.04 NA: 27
Year 2 (advanced students):	N: 167 Mean: 4.22 Std Dev: 0.79 NA: 12

Fig. 1. Student satisfaction with TUSK for Problem Based Learning

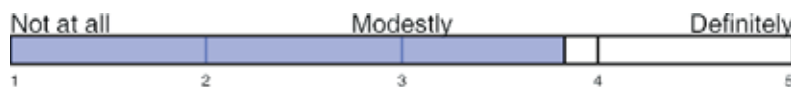
by both groups of students were the ease of projecting the text from virtual patient cases onto a screen for immediate shared access and the ease of uploading materials obtained through independent research to share with all members of the group.

A difficulty encountered by both groups related to the process of determining how best to organize uploaded materials to make them accessible in the future in a logical and user-friendly form. There was considerable variation among the small groups with respect to how systematic or disordered their uploaded materials became. No organization strategy was imposed by the faculty since it was deemed a worthy struggle for learners to collaborate and arrive at a student-generated solution.

### Student satisfaction with electronic virtual "P4 cases"

The introduction of the TUSK Case Simulator into the problem based learning environment of advanced medical students was met with guarded enthusiasm during the first year of its use, which improved quickly as students became comfortable with functionalities available in the Simulator (Figure 2). Preoccupation with mastering the technical operation of the Simulator was initially a distraction to the group and often took the focus away from group discussions. However, once Simulator operation was mastered, students found the new format more interesting, realistic, and interactive compared with the "paper

Questions addressing the use of TUSK Case Simulator were presented using a 5-point Likert scale (1 = "Not at all" ..... 3 = "Modestly" ..... 5 = "Definitely").



Data from Year 1: questionnaires completed by 149 of the 171 students enrolled in the course (87.13%).

Data from Year 2: questionnaires completed by 179 of the 208 students enrolled in the course (86.06%).

\*P4 "card" format: questionnaires completed by 310 of the 356 students enrolled in the course (87.07%).

\*[data represents students from previous 2 years who used the P4 "card" format, only].

**Question:** *"The TUSK Case Simulator [or P4 "card"] format developed your clinical reasoning skills such as identifying cues in the way the patient presents, developing hypotheses to explain the problem, ranking hypotheses, inquiry strategy, interpreting information from history, and arriving at a most likely working hypothesis":*

Year 1: N: 149 Mean: 3.80 Std Dev: 0.92

Year 2: N: 179 Mean: 3.90 Std Dev: 0.89

[P4 cards: N: 310 Mean: 3.84 Std Dev: 0.92]

**Question:** *"The TUSK Case Simulator [or P4 "card"] format provided a focus for learning in the areas of clinical and basic science":*

Year 1: N: 149 Mean: 3.76 Std Dev: 0.92

Year 2: N: 179 Mean: 3.87 Std Dev: 0.89

[P4 cards: N: 310 Mean: 3.82 Std Dev: 0.95]

**Question:** *"The TUSK Case Simulator [or P4 "card"] format of eliciting information and receiving information was effective":*

Year 1: N: 149 Mean: 3.54 Std Dev: 1.07

Year 2: N: 179 Mean: 3.72 Std Dev: 0.94

[P4 cards: N: 310 Mean: 3.53 Std Dev: 1.16]

**Question:** *"The TUSK Case Simulator [or P4 "card"] format had a positive effect on the group dynamic":*

Year 1: N: 149 Mean: 3.63 Std Dev: 1.10

Year 2: N: 179 Mean: 3.80 Std Dev: 1.01

[P4 cards: N: 310 Mean: 3.75 Std Dev: 1.14]

**Question:** *"The TUSK Case Simulator [or P4 "card"] format promoted group discussions":*

Year 1: N: 149 Mean: 3.64 Std Dev: 1.14

Year 2: N: 179 Mean: 3.95 Std Dev: 1.00

[P4 cards: N: 310 Mean: 3.86 Std Dev: 1.04]

Fig. 2. Student satisfaction with TUSK Case Simulator

case” PBL experience of their previous year. The opportunity to ‘select’ patient data elements is a key feature of the P4 case methodology that appeals to advanced students.

One area of Simulator functionality that received enthusiastic support was the inclusion of cost data for some of the tests and procedures. Students asked to see more complete cost information included in the future. At the conclusion of each P4 case, students attempt to re-construct their “clinical reasoning pathway”. In prior years this would be accomplished by laying out the P4 case “cards” in the sequence of their selection and then discussing how card choices were determined and what might be done differently to reach their conclusion with fewer steps. To accomplish the same goal with the Simulator, students wrote each of the selections into a separate log listing the sequence and rationale of each selection. This became a rather cumbersome process and frequently was forsaken in the interest of time and the desire to explore more cases. The “report” generated at the conclusion of each Simulator case listed each selected data item grouped by data category and, within each category, listed alphabetically but not in sequence selected.

One of the key improvements made to the Case Simulator for Year 2 was in direct response to student input. Programming changes were introduced that enabled capture of sequence data for each item selected. In addition, the “report” generated at the conclusion of each case was modified to permit the possibility of three different report formats: (1) data grouped by category and listed alphabetically within each category (as in Year 1); (2) data listed by the sequence of selection thereby automatically reconstructing the “clinical reasoning pathway” (thus students no longer were required to maintain a separate log); (3) data listed by cost of each selection (when a cost is associated).

## Lessons Learned

There are approximately 70 groups of PBL students meeting in small groups all over the campus. Roughly 30 groups are meeting at any one time. The medical school does not provide computers in each small group room so students were required to bring their own laptops for use. (Projectors were available in most rooms). There were times during Year 1 when each member of the group had a laptop open at the same time. This had an impact on group dynamics – as some students were moving ahead at their own pace unbeknownst to the facilitator. At the beginning of Year 2 instructions were given that no more than two computers would be permitted in use during the session: one to access the Case Simulator and one to use for a scribe to take session notes that would be shared with the group later.

Student satisfaction with the TUSK virtual patient was similar to satisfaction with the P4 cases. We need to do some controlled trials directly comparing the P4 “card” format to the Case Simulator. A limitation in the present study is that neither group had experience with the other format of learning (i.e. users of P4 “cards” never experienced the Case Simulator and vice versa). In addition both groups only had prior experience with the “paper” cases to compare to either P4 or case simulator.

Additional training for faculty facilitators may enhance the transition and acceptance of senior faculty. While some faculty are comfortable handing over the controls to students others may find it disturbing. In addition to direct comparisons between the P4 and the TUSK case simulator in a controlled trial the TUSK team plan to hold usability tests with students to understand more clearly factors that affect student satisfaction that could be changed to benefit the program.

## Acknowledgements

The authors would like to thank Samantha Fleming and Yung-Chi Sung in the Office of Educational Affairs at TUSM for providing the Course Evaluation questionnaires data and Daniel Walker, TUSK lead developer who works on the Case Simulator.

## References

1. MedBiquitous Virtual Patient Specifications and Description Document. V.0.61. January 12, 2010 (accessed February 10, 2010).
2. Kong J., Li X., Wang U., Sun W., Zhang J. (2009), Effect of Digital Problem-Based Learning Cases on Student Learning Outcomes in Ophthalmology Courses. *Arch. Ophthalmol.* 127(9): 1211-1214.
3. Jacobson S., Epstein S.K., Albright S., Ochieng J., Griffiths J., Coppersmith V., Polak J.F. (2009), Creation of virtual patients from CT images of cadavers to enhance integration of clinical and basic science student learning. *Anatomy Med. Teach.* 31(8): 749-51.
4. Lim S.J., Khan A.M., De Silva M., Lim K.S., Hu Y., Tan C.H., Tan T.W. (2009), The implementation of e-learning tools to enhance undergraduate bioinformatics teaching and learning: a case study in the National University of Singapore. *BMC Bioinformatics.* 10(Suppl. 15): S12.
5. Gwee M.C. (2009), Problem-based learning: a strategic learning system design for the education of healthcare professionals in the 21st century. *Kaohsiung J. Med. Sci.* 25(5): 231-9.
6. Poulton T., Conradi E., Kavia S., Round J., Hilton S. (2009), The replacement of ‘paper’ cases by interactive online virtual patients in problem-based learning. *Med. Teach.* 31(8): 752-8.
7. Conradi E., Kavia S., Burden D., Rice A., Woodham L., Beaumont C., Savin-Baden M., Poulton T. (2009), Virtual patients in a virtual world: Training paramedic students for practice. *Med. Teach.* 31(8): 713-20.
8. Ellaway R., Poulton T., Fors U., McGee J.B., Albright S. (2008), Building a virtual patient commons. *Med. Teach.* 30(2): 170-4.
9. Smith S.R., Cookson J., McKendree J., Harden R.M. (2007), Patient-centred learning – back to the future. *Medical Teacher.* 29(1): 33-7.
10. Schoenfeld-Tacher R., Bright J.M., McConnell S.L., Marley W.S., Kogan L.R. (2005), Web-based technology: its effects on small group „problem-based learning” interactions in a professional veterinary medical program. *J. Vet. Med. Educ.* 32(1): 86-92.

11. Taradi S.K., Taradi M., Radic K., Pokrajac N. (2005), Blending problem-based learning with Web technology positively impacts student learning outcomes in acid-base physiology. *Adv. Physiol. Educ.* 29(1): 35-9.
12. Nathoo A.N., Goldhoff P., Quattrochi J. (2005), Evaluation of an Interactive Case-based Online Network (ICON) in a problem based learning environment. *Advances in Health Sciences Education.* 10(3): 215-30.
13. Kerfoot B.P., Masser B.A., Hafner J.P. (2005), Influence of new educational technology on problem-based learning at Harvard Medical School. *Med. Educ.* 39(4): 380-7.
14. Shyu F.M., Liang Y.F., Hsu W.T., Luh J.J., Chen H.S. (2004), A problem-based e-Learning prototype system for clinical medical education. *Studies in Health Technology & Informatics.* 107(Pt 2): 983-7.
15. Ruderich F., Bauch M., Haag M., Heid J., Leven F.J., Singer R., Geiss H.K., Junger J., Tonshoff B. (2004), CAMPUS – a flexible, interactive system for web-based, problem-based learning in healthcare. *Studies in Health Technology & Informatics.* 107(Pt 2): 921-5.
16. Schitteck Janda M., Mattheos N., Nattestad A., Wagner A., Nebel D., Farbom C., Le D.H., Attstrom R. (2004), Simulation of patient encounters using a virtual patient in periodontology instruction of dental students: design, usability, and learning effect in history-taking skills. *European Journal of Dental Education.* 8(3): 111-9.
17. Lee M.Y., Albright S.A., Alkasab T., Damassa D.A., Wang P.J., Eaton E.K. (2003), Tufts Health Sciences Database: lessons, issues, and opportunities. *Acad. Med.* 78(3): 254-64.
18. Caudell T.P., Summers K.L., Holten J. 4th, Hakamata T., Mowafi M., Jacobs J., Lozanoff B.K., Lozanoff S., Wilks D., Keep M.F., Saiki S., Alverson D. (2003), Virtual patient simulator for distributed collaborative medical education. *Anatomical Record. New Anatomist.* 270(1): 23-9.
19. Freeman K.M., Thompson S.F., Allely E.B., Sobel A.L., Stansfield S.A., Pugh W.M. (2001), A virtual reality patient simulation system for teaching emergency response skills to U.S. Navy medical providers. *Prehospital & Disaster Medicine.* 16(1): 3-8.
20. Tamblyn R.M., Barrows H.S., Gliva G. (1980), An initial evaluation of learning units to facilitate problem solving and self-directed study (portable patient problem pack). *Med. Educ.* 14(6): 394-400.



## **VIRTUAL PATIENTS: SITUATED LEARNING FOR PRE-CLINICAL YEAR 1 STUDENTS**

SUNHEA CHOI, ALEXANDRA WEBB, ELIZABETH AULT, JEAN-REMY DOBOC

*University of Southampton, United Kingdom*

**DESCRIPTION:** At the University of Southampton Medical School the Virtual Patients are the key to delivering its patient-centred curriculum. In Year 1, they aim to present a realistic clinical scenario from which students can experience a patient journey and the clinical process involved. They also highlight key points in the body system studied. The patient journey is illustrated in an animated storytelling style, and interactive tasks, quizzes and learning materials are embedded in the story.

As a pilot study, a case, called Tim Brown with a motorbike accident, was designed for Nervous and Locomotor 1 course. It integrates the 4 weeks of student learning in the course, and

Tim's story tells the accident, muscle weakness, nervous injury and recovery with related basic and clinical sciences. It was implemented for the first two weeks and integrated into the course curriculum in January 2009. As part of evaluation, weekly pre and post tests for 3 weeks, questionnaires and interviews were conducted. Findings suggested that students, who had used the case between the pre and post tests, performed significantly better in the post tests than students who had not. In addition, students' comments during interviews indicated they perceived Tim Brown more than a case.

## INSTRUCTION FOR AUTHORS

1. The original and one Photostat copy of the manuscript should be mailed to: Managing Editor Zdzisław Wisniowski. Authors are strongly urged to submit a CD containing the manuscript in Word for PCs format along with the hard copies. Articles already published or those under consideration for publication in other journals or periodicals should not be submitted.
2. Manuscripts should be in English. Usage of correct language is the responsibility of the author.
3. Submission of manuscripts to us implies that the copyright of the entire material except those already copyrighted by other publications like tables, figures etc and those permission the author(s) have already obtained, belongs to the publisher.

### PRESENTATION

4. The text may be prepared from a good quality laser printer or electronic typewriter. It is to be typed (one side only) on a regular sheet of paper A4 size preferred with single line spacing. New Times Roman font of 12 point size is recommended. Authors are requested to paste figures and tables (if possible) at appropriate places in the text. If this is not possible, they may be given separately, in which case their exact locations in the text may be marked by pencil.
5. The article should begin with a short ABSTRACT followed by a short INTRODUCTION. The rest of the article may be titled and arranged as per the wishes of the author.
6. REFERENCES should continue the last section of the article. In the text, references to other papers or books should be cited using consecutive numbers in parenthesis (e.g. [1,2]) and they should be listed numerically in the last section.

Examples:

I. Pyrczak W., Sarapata K.: Instructions for authors: references. Bio-Algorithms and Med-Systems, 1, 386, 2005

II. Tadeusiewicz R., Ogiela M.R.: Medical Image Understanding Technology. Springer Verlag, Heidelberg 2004

Authors are to make sure that each reference appearing in the text appears in the list of references at the end and vice versa.

7. TITLE PAGE AND FIRST PAGE – The title page of the manuscript, the name(s) of author(s) and institution(s) where the work has been carried out should be typed out on a separate sheet of paper.
8. Section headings (ABSTRACT, INTRODUCTION etc.) are to be typed in upper case letters and placed on a separate line
1. Scientific names should be typed in italics or underlined
2. Tables should be numbered consecutively using Arabic numerals.
3. Illustrations should be limited to materials essential for the text. All figures should be numbered consecutively and should be submitted as sharp, high-quality prints. Figures that are to appear as a group should be photographed and mounted together. All figures and groups of figures should be trimmed at right angles and pasted directly on the typescript in the appropriate places. They should be of a size permitting photographic reduction by 25% together with text (not more than 15 cm across for page width and not higher than 20 cm). Legends to figures should appear directly below the respective figures.
4. In line drawings, all lines should be of uniform thickness; letters and numbers should be of professional quality and proper dimensions, approximately 1mm high when reproduced.
5. RUNNING TITLE – Please make sure to mention the running title (short title) of the article separately in the first page where the title, names of authors, their affiliations, etc. are given.
6. PREFERRED LENGTH – The length of the manuscript may be limited to 20-25 A4 size pages (20 cm width – 26 cms height) through this is not binding.
7. PERMISSION – Authors must obtain permission from other publishers if they use already published and copyrighted materials.
8. COLOUR FIGURES – Cost of printing color figures will be charged to the author at the rate of U.S. \$ 125 per plate of four color pages.
9. REPRINTS – The order for reprints should be placed at the time of submission of the article itself, so that it may be out for printing without loss of time, if found suitable for order for not less than 100 reprints is to be made.

### MANUSCRIPT SUBMISSION:

1. Electronic – the [www.bams.cm-uj.krakow.pl](http://www.bams.cm-uj.krakow.pl) address is available for all authors to submit manuscript. The instruction is available at each step of submission process.
2. The pdf or doc file with figures and tables incorporated into the manuscript body can be sent by email – address: [bams@cm-uj.krakow.pl](mailto:bams@cm-uj.krakow.pl)

