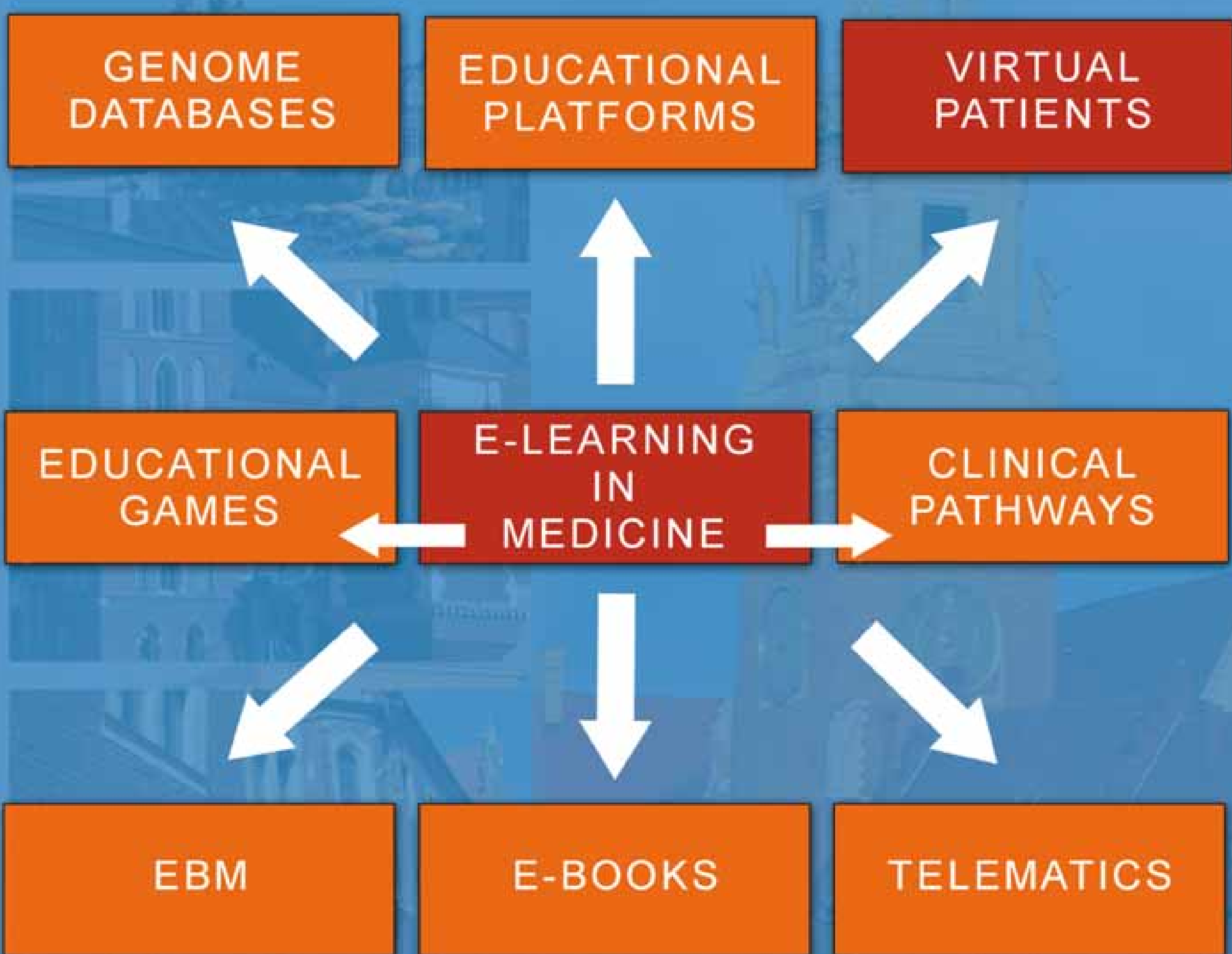
BIO-ALGORITHMS AND MED-SYSTEMS

Vol. 5, No. 9
2009

International Conference on Virtual Patients
ICVP 2009
www.icvp.eu

eViP



JOURNAL EDITED BY MEDICAL COLLEGE - JAGIELLONIAN UNIVERSITY – KRAKOW – POLAND
http://www.bams.cm-uj.krakow.pl

EDITORIAL BOARD

Polish Ministry of Science and Higher Education journal rating: 4.000

Sustaining institution: Ministry of Science and Higher Education

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

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

Contents

TEACHING & LEARNING USING VIRTUAL PATIENTS

VIRTUAL PATIENT IMPLEMENTATION & CURRICULUM DESIGN

VIRTUAL PATIENT EVALUATION

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 7

VIRTUAL PATIENTS: FROM PRAGMATIC IMPLEMENTATION TO EDUCATIONAL RESEARCH AND BACK

Martin R. Fischer[1]

[1]*University Witten-Herdecke, Germany*

contact author: Martin R. Fischer, Martin.fischer@uni-wh.de

Real patients' availability for teaching is more and more difficult at university hospitals in the light of shortened stays and more dense diagnostic and therapeutic management. Therefore, virtual patients offer a tempting educational alternative – at least for cognitive learning objectives. Virtual patients are around for more than three decades to improve medical education. Their availability has dramatically improved since they can be authored and used through the internet. What characteristics should a virtual patient's case have to foster learning? What are best practice examples for the successful implementation of virtual patients for learning and assessment? Which factors support and which impede acceptance of virtual patients by medical students? What elements are needed to create a blended-learning course with an adequate interplay of face-to-face teaching and online-learning? Which assessment formats are only working reasonably on the computer? This lecture will share experiences that shed some light on the above mentioned questions. It will also raise additional questions for educational research in the field of virtual patients.

Bio-Sketch of Dr. Martin R. Fischer

Martin R. Fischer, MD, general internist and endocrinologist, certificate in medical informatics (GMDS and GI Germany), and Master of Medical Education (MME, University of Berne, Switzerland), currently working as an assistant professor at the Medizinische Klinik Innenstadt, Munich University Hospital, Ludwig-Maximilians-University Munich (LMU).

Undergraduate education 1984-91 in Hamburg, Freiburg i.Br., Lucerne, and Hanover, NH (USA). Doctoral thesis in neuropharmacology on presynaptic autoinhibition of the serotoninergic system. 1996 member of the core group Munich Harvard Medical Education Alliance for the introduction of PBL block courses. 1999 junior Harris guest professor at Darmouth College, Hanover, NH (USA). 2000 co-founder of the spin-off enterprise INSTRUCT Inc for web-based medical education. 2002 winner of the Medidaprix for the CASUS-learning system, since 2003 member of the core group for curriculum reform (MeCuM – Med. Curriculum Munich), faculty commissioner for assessment, evaluation and e-learning. Since 2008 chair of the newly founded Institute for Teaching and Educational Research in the Health Sciences at the Private University Witten-Herdecke.

Special interests: Integration of new media technologies into undergraduate and continuing medical education, case-based learning and assessment.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 8

THE REALITIES OF THE VIRTUAL PATIENT

Rachel Ellaway[1]

[1]*Northern Ontario School of Medicine, Canada*

contact author: Rachel Ellaway, rellaway@googlemail.com

The use of virtual patients has developed out of a somewhat esoteric set of ideas and practices to become a significant part of contemporary healthcare education. Reprising nearly four decades of virtual patient development, Dr Ellaway will consider the trajectories and context for current and future work in this area. Particular issues of concern include the intersecting roles of technology, simulation, narrative and play in virtual patients' support of effective learning and assessment. Other areas of discussion will include the exploration of tensions between technocratic and human values in virtual patient applications and the layered realities they embody.

Bio-Sketch of Dr. Ellaway

Dr Ellaway is Assistant Dean and Associate Professor of Education Informatics at the Northern Ontario School of Medicine and Visiting Professor at St Georges University of London. She is also co-chair of the MedBiquitous Virtual Patient Working Group, Chair of the AFMC Informatics Resource Group and writes a regular column in Medical Teacher.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 9

A PERIOPERATIVE MEDICINE VIRTUAL PATIENT

Lester Critchley[1], Joseph Leung[1], Shekhar Kumta[1], Alex Yung[1]

[1]The Chinese University of Hong Kong, Hong Kong

contact author: Lester Critchley, hcritchley@cuhk.edu.hk

We wrote a virtual patient scenario to supplement our teaching of perioperative medicine. Our medical students need to be taught the principles of preoperative preparation and post operative care of surgery patients. They attend a 2-week anaesthesia module in groups of 7-10. Exposure to learning situations is very fragmented and difficult to organize. By creating a "detailed" virtual patient, our objective was to cover the important areas of anaesthesia and perioperative care that may be witnessed, but not taught. We began March 2007. The first electronic version was tested December 2007. Feedback from small group focused interviews helped with development. It was completed July 2008 and upload onto a Faculty server. Accessed by students was via the internet. So far 80 students have accessed the site. The scenario is based on a woman with fibroids admitted for hysterectomy. It plots her progress from pre-admission assessment clinic, though anaesthesia and recovery, to ward management of her pain. Topics as diverse as managing diabetes perioperatively, drugs used in anaesthesia, transfusing blood safely and the unconscious patient are covered. Multimedia applications (photographs, audio material and text) are used. It is made formative and interactive by embedding questions with feedback within its web pages. Our virtual patient consists of 6 sections, 162 web pages, 409 multimedia applications and 29 self scoring questions. Student feedback (questionnaire) has so far been positive. Most students logon for 3-6 hours. Most agreed that using the site provided a realist experience, improved understanding of the subject and was enjoyable.

Keywords: Perioperative, Anaesthesia, Virtual Patient, Undergraduate Medicine

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 10

ANAESTHESIA FORMATIVE ASSESSMENT CASE STUDIES

LESTER CRITCHLEY[1]

[1]*The Chinese University of Hong Kong, Hong Kong*

contact author: Lester Critchley, hcritchley@cuhk.edu.hk

Formative Assessment Case Studies (FACS) are an E-learning resource consisting of a case scenario punctuated with a series of decision making steps (multiple choice questions) and feedback for wrong answers. FACS is designed to enhance clinical decision making skills. A virtual case scenario is created that presents the student with a series of patient management steps. Approximately 10 steps are used. Choices are made regarding investigations, diagnosis, and treatment. A variety of multimedia applications that deliver clinical data are supported. FACS cases are stored together with the engine on a dedicated Faculty server. Cases are accessed via the internet. Logins require user identification and student usage is recorded. In 2006 we wrote six FACS to supplement our teaching of preoperative assessment to final year medical students on a 2-week anaesthesia clinical attachment. General issues regarding preoperative assessment and planning were covered, as well as interpretation of routine laboratory results, and the assessment and preparation of patients with diabetes, heart disease and chronic lung disease. The site has so far been accessed by over 400 students. Usage of FACS varied. Over 80% of students have logged onto FACS web-site and completion rates are between 61-70%. On average a student spends between 20-30 minutes on each FACS. Student feed back has been encouraging, and ratings from student-teacher evaluations have been on a-par with other parts of the course (>5.0 / 6.0). We are currently writing three new FACS to supplement post operative pain management teaching.

Keywords: Anaesthesia, Case studies

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 11

THE ROLE OF A LEARNING TECHNOLOGIST WHEN IMPLEMENTING VIRTUAL PATIENTS IN A HEALTH SCIENCE CURRICULUM

Ronny Sejersen[1], Nabil Zary[1]

[1]Karolinska Institutet, Sweden

contact author: Ronny Sejersen, Ronny.Sejersen@ki.se

There is an uncertainty regarding the role and responsibilities of a learning technologist. The nature of the tasks varies in different universities, from exclusively technology assistance to faculty to an active involvement in pedagogical and developmental projects. The purpose of this study was therefore to investigate the desired role of a learning technologist when implementing virtual patients in health sciences curricula. The context of the study was the ongoing implementation of virtual patients in medicine, dentistry and nursing. A two years longitudinal study was performed between 2006 and 2008, where we observed, surveyed and interviewed the different stakeholders engaged in the implementation of virtual patients in courses. Furthermore all the tasks undertaken by the learning technologists were recorded. The data was then analyzed with the aims to create a model and provide best practices for how to involve a learning technologist in the efforts of implementing virtual patients in a course. We will present a comprehensive model of the ideal tasks for a learning technologist (LT) that takes into account both the unique skills of a LT and the expectations of the different stakeholders involved in an implementation. Learning technologist have the unique position to play a bi-directional interface role between faculty that authors and use VPs, on one side, and developers that creates the VP systems on the other side.

Keywords: virtual patient implementation, authoring of virtual patients, curriculum design

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 12

TASK CENTERED CASE SIMULATIONS

ULRICH WOERMANN[1]

[1]University of Bern, Switzerland

contact author: Ulrich Woermann, ulrich.woermann@iml.unibe.ch

Virtual patients and case simulations are mainly used to teach clinical reasoning and/or case management. These are two rather complex tasks, by which novice students are often swamped. Frustration and loss of motivation can be the consequence of such negative experiences. To avoid this feeling of being overwhelmed by the many tasks to accomplish, we developed several series of task centered case simulations. Each task is embedded in a clinical scenario starting with history and physical findings and ending with a discussion and follow up. In between, students have to accomplish the task. Using a clearly structured process, they learn to indicate and read/hear urinanalyses, radiographs, EKGs, heart sounds, eye fundus and oral conditions. To support the learning process, links to corresponding tutorials or websites such as wikipedia are provided. The possibility to compare images with images of the integrated image database allows students to develop good pattern recognition. Building gradually competence in single tasks lets students have an experience of success and gives them confidence when dealing with more complex situations. Following an Open Access policy, all these learning programs are freely accessible at http://e-learning.studmed.unibe.ch/ under the names of RadioSurf (thorax and skeleton), UroSurf, CliniSurf (EKG, heart sounds, eye fundus) and DentoSurf. All these learning programs are in German except for UroSurf which has been translated to English and French.

Keywords: Urine diagnostics, radiology, EKG, fundoscopy, heart auscultation, oral examination

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 13-15

INTERPROFESSIONAL COOPERATION FOR THE CARDIOLOGICAL PATIENT BENEFITS – PLANNED COURSE USING A VIRTUAL PATIENT'S SETTING

Wojciech Szot, Emilia Kolarzyk

Hygiene and Ecology Dept., Jagiellonian University College of Medicine, Poland

Abstract: Hygiene and Ecology Department UJCM took interest in courses regarding cardiovascular and metabolic disorders, due to nature of specialist working in Department and their research.

Thanks to close collaboration between Hygiene and Ecology Department and Krakow's Cardiac Institute there is possibility to run course dealing with different types of cooperation in and among different medical professions. Since it is believed that medical students are aware of different specializations and the majority of them choose their areas of interest during the 3rd-4th year of studies, those courses were planned at the end of second semester of 4th year of medical education. To cooperate with these, students from other faculties (Nursery, Emergency Medicine, Medical Technicians etc) were invited to participate in course with using a virtual patient's setting.

During the course it is being stressed upon the need of good practice and interprofessional cooperation between specialists from different professions during the process of proper management of the patient suffering from the leading cause of sudden death which is, nowadays, cardiac failure and all diseases leading to it (heart infarction, arrhythmia, high blood pressure etc). Using the virtual patient's setting and role-playing skills of doctors who moderate this course, several problem-based cases will be presented, each leading students to their own conclusion why this cooperation and trust in others abilities is so vital in patients management.

Keywords: Interprofessional course, Cardiologic Education.

Background

According to WHO cardiovascular diseases (CVDs) are the number one cause of death and is projected to remain so. Estimated 17.5 million people died from cardiovascular disease in 2005, representing 30% of all global deaths. Of these deaths 7.6 million were due to heart attacks while 5.7 million due to stroke. The economical costs of cardiovascular diseases are great. CVDs affect many people in middle age, very often severely limiting the income and savings of affected individuals and their families. Lost earnings and out of pocket health care payments undermine the socioeconomic development of communities and nations. CVDs place a heavy burden on the economies of countries. For example, it is estimated that over the next 10 years (2006-2015), China is going to lose around $558 billion in foregone national income due to the combination of heart disease, stroke and diabetes. Lower socioeconomic groups in high income countries generally have a greater prevalence of risks factors, diseases and mortality. A similar pattern is emerging as the CVD epidemic evolves in low and middle income countries.

The effective prophylaxis, recognition and treatment of CVDs require the collaboration of many proffesion specialists. There is a growing body of evidence that interprofessional learning can significantly enhance practice and improve knowledge in CVDs.

Interprofessional education has been promoted by the World Health Organisation since 1988 and EIPEN is one of the associates in a new WHO framework for interprofessional education and collaborative practice. Hygiene and Ecology Department is a member of European InterProfessional Educational Network (EIPEN). Thank to close ties and contacts with partners from many European Union countries we've learnt that close collaboration of general practitioners, professional medicine doctors, doctors of other specializations, engineers, medical analytics and highly specialized workers in environmental protection sector is essential.

According to CAIPE (The UK Centre for the Advancement of Interprofessional Education) definition of interprofessional learning goes as follow: Interprofessional Education is when two or more professions learn with, from and about each other to improve collaboration and the quality of care.

In the area of prevention of CVDs, close collaboration between Jagiellonian University College of Medicine and Krakow's Cardiac Institute was initiated.

Krakow's Cardiac Institute acts as a major centre in southern Poland to manage patients with all kinds of chronic and acute cardiovascular disease. At John Paul II Hospital medical professionals are committed to helping patients live a longer and healthier life. The comprehensive medical services include the most advanced diagnostics and intervention treatments available in cardiothoracic medicine. Starting with diagnostic and acquiring the most comprehensive medical history from each patient, followed by the most advanced procedures available for treatment in the modern medicine. In the event of an emergency all patients receive immediate appropriate medical treatment at a facility staffed by leading professionals with state-of-the-art interventional equipment.

Still it was observed by both hospital managers, authorities and scientists responsible for the quality of service, that sometimes problems occur from the lack or at least slowdown of communication on different levels of health care, including General Practioners – Emergency Medicine Specialists – Cardiologist.

Aims and Methods

To improve that several measures were undertaken, including planning a course for students and for medical doctors, using the virtual patient model and role-playing skills of moderators, to show the participants benefits of good communication and cooperation among professionals. Thanks to ties between Department of Hygiene and Ecology and Krakow's Cardiac Institute and, possibility for several courses dealing with different types of cooperation in and among different medical professions was enabled. Since it is believed that medical students are aware of different specializations and the majority of them choose their areas of interest during the 3rd-4th year of studies, those courses were planned at the end of second semester of 4th year of medical education. To cooperate with these, students from other faculties (Nursery, Emergency Medicine, Medical Technicians etc) were invited to participate.

Hygiene and Ecology Department took interest in courses regarding cardiovascular and metabolic disorders, due to nature of specialist working in Department and their research. We started to incorporate changes into our educational programme, with greater emphasis on interprofessional colaboration. Teaching the students how to derive from multi-factor etiology of diseases the ecological factors responsible for the diseases, confirmimg this way the relationship between the disease and environmental factors exposure. Students from different medical faculties participate in our courses. When possible we try to merge students from different professions to show them that the diffrences, the strong points of different specializations should be aimed for one goal – the benefit of the patient. As an example students of Medical Analytic Division are being taught about proper choice of laboratory tests and biological material (blood, urine, hair) for finding and determining the biomarkers of exposure. After graduation, they should be able to collaborate with medical doctors to help them in proper selection of the biomarkers of effects.

Medical students study biomarkers of effects and susceptibility. Emergency Medicine students are being taught how to quickly diagnose possible cause of environmental disorders, how and where get help from health professionals, and to be able to choose where the particular patient should be taken. Dietician and Nutrition students learn how to help doctors with patients management in various acute and chronic disorders. To achieve these goals we work closely with other departments of Jagiellonian University in a network of interprofessional education.

The greatest benefits of interprofesional education (IPE) include, but are not limited to, the following:

- Critical boundary exchanges – no field 'belongs' to only one profession, but each profession has particular skills that should be focused on.
- Recognition of importance of teamwork and communication for better patient's managment
- Critical exchanges on methodology used by professions
- Increase knowledge and understanding of other professions leading to closer ties
- Critical exchanges with patients and their families.
- Interprofessional education needs to relate to intercultural skills: creation of non-defensive, non-discriminatory identities
- Remove stereotypes in viewing each other, which should help in breaking "the ice" and improvement of cooperation.

This course was prepared by specialists from different professions, including specialists in Primary Care, Emergency Medicine, Cardiologists, Invasive Cardiologists, Diagnostic Specialists (Nuclear Medicine, Ultrasound and Radiology Specialists), Nursery and Dieticians. It consists of seminars and workshops (with case studies and problem solving learning). During the course it is being stressed upon the need of good practice and interprofessional cooperation between specialists from different professions during the process of proper management of the patient suffering from the leading cause of sudden death which is, nowadays, cardiac failure and all diseases leading to it (heart infarction, arrhythmia, high blood pressure etc). Several problem-based cases are presented during the course, each leading students to their own conclusion why this cooperation and trust in others abilities is so vital in patients management.

Moderators, using the virtual patient's model, role-playing skill, and vast library of results of studies performed at John Paul II Hospital, prepare several "patients" the group of participants may interact with. Each group consist of students/ medical professionals from different specialties, with at least one nurse, one GP, one emergency medicine, one paramedic included. Depending on this specialty division, each participant is given different materials regarding patient's history. During the course participants interact with one another, while moderators act both as patients as well suply of results of the studies that participants propose to perform. The chain of events leading patients from the beginning (symptoms of disease) through all procedures (diagnostic and management) to endpoints defined as implementation of advanced procedures such as cardiac surgery/percutaneous interventions is being performed through the course. Using the differential diagnosis, which is the systematic method physicians use to identify the disease causing a patient's symptoms, participants plan diagnostic procedures and interact with virtual patient, as they could do in real life situation. The GP and a nurse begins by observing the patient's symptoms, examining the patient, and taking the patient's personal, family and social history. Then they list the most likely causes, which is followed by consulting other paricipants to propose the performance of tests to eliminate possibilities until the diagnosis is reached and all participants become satisfied that the single most likely cause has been identified.

During all phases of presentation of the above mentioned chain of events it was stressed that cooperation and participation of different medical and in some cases non-medical personnel is essential for patient's well-being. Workshops planned for this included problem-solving case studies that are introduced to students of different professions, with at least two specialists managing course of action and observing progress of each scenario, presenting results to the test/procedures proposed by students. Participants are able to propose majority of the most sophisticated studies modern medicine has to offer, inluding top Computer Tomography, Nuclear Medicine Studies or Magnetic Resonance. In case of more advanced diagnostic procedures moderators help participants to describe and analyze the annomalies, as well as help them to reach conclusion about virtual patient's status. At the end of course students will be given the assessment as well as possibility to present feedback regarding course topics to the Specialists Team that prepared course.

Through this course we hope to achieve better preparedness of students from different Medical Faculties and Technical Academies for the chalanges of modern world. Preparedness of undergraduate and post-graduate courses for doctors of different specializations, paramedics, pharmacy, dieticians and nurses. Awareness about need for establishing a basis of interprofessional collaboration in health care services. Interprofessional cooperation in management of patient suffering from cardiovascular system disorders and other diseases. This should also become a drive toward scientific research and prophylactic program focused on necessity of interprofessional collaboration concerning prevention of various civilization disorders, which become a plague of modern world.

Among challenges and problems we've encountered while planning and putting to practice the above mentioned course, we must mention taking over of mentality and thinking about inter-professional collaboration in health and social care. It seems many health professionals understands that the challenge of present day, is a good collaboration among professions, and the exchange of experiences on national and international level. Another encountered problem include a distrust, often a very deep one, among different medical professions, which quite frequently leads to competition instead of collaboration. It is unfortunately still unclear for many, that professional educators, professionals and professional bodies are in agreement that IPE in postgraduate education is necessary and important in the healthcare arena.

The course will be run in May 2009. Till that time we want to evaluate feedback from students, and compare it with feedback given by professionals running the course. After analyzing this we plan to see if and what changes are needed and do our best to implement them.

References

1. Hammick M., Freeth D., Koppel I., Reeves S. & Barr H.: A Best Evidence Systematic Review of Interprofessional Education, BEME Guide No 9 (e-publication: http://www.bemecollaboration.org/beme/pages/reviews/hammick.html).
2. Liaskos J., Frigas A., Antypas K., Zikos D., Diomidous M., Mantas J.: Promoting interprofessional education in health sector within the European Interprofessional Education Network, Int J Med Inform., 19, 2008.
3. Lê Q., Spencer J., Whelan J.: Development of a tool to evaluate health science students' experiences of an interprofessional education (IPE) programme, Ann Acad Med Singapore, 37(12): 1027-33, 2008.
4. Munsch C.: What cardiology trainees should know about coronary artery surgery and coronary artery surgeons: ischaemic heart disease, Heart, 94(2): 230-6, 2008.
5. McKeon L.M., Oswaks J.D., Cunningham P.D.: Safeguarding patients: complexity science, high reliability organizations, and implications for team training in healthcare, Clin Nurse Spec, Nov-Dec, 20(6): 298-304, 2006.
6. Ross F., Southgate L.: Learning together in medical and nursing training: aspirations and activity, Med Educ, Sep, 34(9): 739-43, 2000.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 17-21

INTEGRATION OF VIRTUAL PATIENTS INTO EXISTING CURRICULA OF BH PEDIATRIC DEPARTMENTS RESULTS OF TWO EVALUATION STUDIES

Dejan Bokonjic[1], Bozo Petrov[2], Srdjan Masic[1], Sören Huwendiek[3], Srdjan Lozo[1]

[1]Medical Faculty Foca, Bosnia and Herzegovina,
[2]Medical Faculty Mostar, Bosnia and Herzegovina,
[3]Medical Faculty Heidelberg, Germany.

Abstract: Introduction: Virtual patients (VPs) are interactive computer programmes that simulate real-life clinical scenarios. We have identified pediatric departments at BH Medical faculties Foca and Mostar as suitable for introducing virtual patients due to the lack of training in patient management and clinical reasoning.
Methodology: We have introduced three virtual patients of the CAMPUS system (www.campusvirtualpatients.com). Our tutors were trained by the staff of the Medical Faculty of Heidelberg University. We organized introduction sessions and then divided our students into small groups. Two studies were done using questionnaires, which measured students' satisfaction, learning outcomes, design of virtual patients and the perception of different integration scenarios.
Results: In the study, students estimated virtual patients as a good tool for studying and fostering clinical reasoning. Average mark of each part of the programme measured by questionnaire and total mark of the whole programme was almost the same (Kruskal-Wallis=7,892; P=0,096). Students assessed the virtual patients as very stimulating for learning of pediatrics and emphasized that the experience they gained will help them in the continuation of their education. Students estimated the design and integration of virtual patients into the curriculum as fostering learning.
Conclusion: We evaluated the use of VPs at two BH faculties. Results indicate that VPs were well integrated and will help our students to improve their clinical reasoning.

Keywords: virtual patient, CAMPUS system, clinical training and reasoning

Introduction

The Medical faculties in Bosnia Herzegovina (BH) are in process of reform of their curricula. They made joint efforts by using funds of different EU projects, mainly tempus card projects and mentoring by the Medical Faculty University of Heidelberg, to develop a common frame for a BH medical curriculum. The main focus of interest was and is the introduction of new teaching methodologies. Among them, virtual patients, as innovative e-learning instruments, play an important role. Virtual patients (VPs) are interactive computer programmes that simulate real-life clinical scenarios. (Ellaway et al 2006). Virtual patients allow students to get standardised experiences with clinical problems. Students can be introduced also to uncommon diseases regardless of patient availability. Virtual patient programs are interactive learning environments in which students can learn relevant skills (e.g. clinical decision making) without risk for real patients. Furthermore, the training can be repeated with these e-learning modules as often as needed and students are provided with feedback to support improvement of their skills. VP can be presented in different ways, e.g a problem based or a narrative approach. In the problem based approach (Bearman, Cesnik and Liddell 2001, Garde et al. 2005) students are choosing what is the next step in the process of the clinical case work up. They have to gather information from history questions, physical examinations, laboratory and technical tests and make appropriate decisions accordingly. One example of a virtual patient system of the problem based approach using controlled vocabularies is the CAMPUS virtual patient system, which has been used in our studies. This system provides a user-friendly interface and the necessary tools to generate virtual patients (authoring system) and play virtual patients (player system) (Garde et al 2005).

In this study we describe how CAMPUS virtual patients were introduced at the two BH Medical faculties Foca and Mostar and how these were perceived by the medical students.

Methods:

A group of teachers from the BH Medical faculties Foca and Mostar were send to the Medical Faculty Heidelberg to be trained for using the CAMPUS virtual patient system. After one training there, and two further training sessions in BH a teacher core group for the introduction of virtual patients in BH Medical faculties were established. Together with the experts from the Centre for virtual patients in Heidelberg the CAMPUS system was translated, adopted to the needs and distributed to all Medical faculties in BH. Two studies were performed, one at the Medical faculty Mostar and one at Foca.

Study 1: The first study consisted of students in their sixth year of study from the Medical Faculty of Mostar, attending the pediatric course. Out of 38 students, 24 students decided to participate in this study. Students worked with three Campus cases. Two nephrology cases were (child with brown urine and child with edema) and one was from pulmology (child with cough and dyspnea). Two virtual patients were developed by Heidelberg team (child with brown urine and child with edema) and one was developed by our team (child with cough and dyspnea). The virtual patients developed by Heidelberg team were translated and adjusted for use in BH, while the third case was developed on our language and was imported to Bosnian version of the CAMPUS. All students were divided into small groups, 2-3 students per computer. Sessions lasted for 1.5 hours and were lead by BH tutors. After working through three CAMPUS virtual patients, students were asked to fill in a questionnaire, comparing virtual patients (as new method of teaching) with the classical methods of teaching students were used to. The classical methods consisted of bed side teaching and theoretical teachings. This questionnaire was especially designed for this purpose. It compared both the classical and new approach, students' motivation after the classical and new exercises, cognitive presence, overload during both approaches, and development of different skills and utility of the exercises.

Study 2: The second group of students was from the Medical Faculty Foca. Those students were from the fifth year of study and were involved in pediatric course. 29 students were involved in this study. All students were divided into small groups, 2-3 per computer and work on each case for 1,5 hours. The virtual patients were the same VPs used by the students in Mostar. The students were asked to fill in two different questionnaires: one questionnaire concerning the design of virtual patients and one concerning the curricular integration of virtual patients (preliminary versions of the instruments described by Huwendiek et al. and De Leng et al. in this issue). Factors, which were evaluated, included questions concerning the learning tool, authenticity of the assignement, and professional approach. In processing of data we used Kolmogorov-Smirnov. This test was used to check if a sample comes from a population with a specific distribution. For calculating average value, we used median and interquartile range in case of asymmetric distribution and arithmetic mean and standard deviation in case of symmetric distribution of variables. For comparison of two asymmetrical distributed variables we used Mann-Whitney U test and for comparison of more than two variables we used Kruskal-Wallis test. Student T Test was used for comparison of symmetrical distributed variables and Leven test was applied to investigate the equality of variance.

Results:

Study 1: After working with the virtual patients students' motivation for learning was much higher than after classical exercises and as a consequence students were more motivated for further studying of pediatrics (Student t-test, P<0,05). Students appraised the virtual patients as a much better tool for development of analytical skills than classical methods, while classical methods were evaluated as better for development of communicating skills (Student t-test, P<0,05). Students involved in the study compared classical methods and virtual patients. Values in the figure 1 are the mean ± SD of student answers on different questions. Estimation of the programme was done using scale 1-5, where 1 was the poor and 5 was the excellent grade. Student T Test was used for comparison of symmetrical distributed variables.

Overall, students rated their knowledge, which they aquired during their work with virtual patients, as more important for their continual education than the classical methods. (Student t-test, P<0,05) (Figure 1).

Study 2: In this study the virtual patients were evaluated as a tool for improving student's learning and clinical reasoning. This program was graded with 3,91±0,75 points, on scale out of 5. (Figure 2).

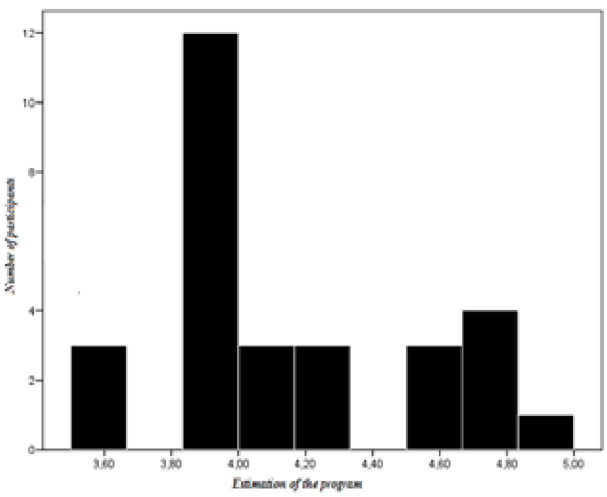


Figure 2. Learning and clinical reasoning experiences with virtual patients

Results in figure 3 are presented as average values of separate parts of the questionnaire. Estimation of the virtual patients was done using scale 1-5, where 1 was the poor and 5 was the excellent.

It was shown that the virtual patients achieved good marks in almost all categories of the questionnaire. In category authenticity of patient encounter and the consultation, from student answers can be realized that most students felt like they had to make the same decisions during working with CAMPUS, a doctor would make in real life (4,03±0,823). On the other hand, most students did not feel like really caring for the patient during solving the case by using CAMPUS system (3,62±0,942). In the category coaching during consultations, most of students were indifferent answering on the question, which compared level of difficulty of the case and their level of training (3,52±1,022). Concerning learning basic diagnostic

Figure 1. Comparison of classical methods and virtual patients

Variables	M±SD methods of learning		t-test	P
	Classical methods	Campus		
Motivation for work during practical exercises	3,83±1,01	4,33±0,71	2,006	0,048
Number of hours necessary for preparation and realization of exercises	2,85±0,96	3,23±0,70	1,465	0,151
Exercises are helping in developing of analytical skills	3,75±,1,32	4,37±0,77	2,035	0,048
Exercises help in developing of communicating skills	4,58±0,77	2,79±1,47	5,270	<0,001
Exercises help in developing of skills necessary for preparation of scientific article	2,08±1,31	2,37±1,21	0,800	0,428
Exercises help in developing of skills necessary for preparation of working assignements	3,41±1,34	3,70±1,08	0,826	0,413
Practical exercises stimulating further learning of pediatrics.	3,50±1,58	4,12±1,09	2,018	0,049
IT (when I used them) helped me in learning pediatrics	3,41±1,22	3,66±1,40	0,661	0,512
Support from teaching staff for using this methodology	4,43±1,16	4,65±0,57	0,805	0,425
Motivation of assistants during teaching process	4,62±1,01	4,75±0,73	0,489	0,627
Involvement of teaching staff in providing of information, which is necessary for teaching and learning process	4,16±1,01	4,25±1,11	0,272	0,787
Time necessary for understanding of learning material and aims of teaching.	2,62±1,24	3,21±0,90	1,874	0,068
Dynamics of practical training	3,16±1,34	3,83±0,76	2,118	0,041
Estimation of evaluation methods during practical exercises	3,30±1,18	3,78±0,90	1,540	0,131
Knowledge aquired during practical exercises on pediatrics will be important for continual education.	3,95±1,54	4,52±0,83	2,325	0,026

approaches in pediatrics by using CAMPUS system, medical students were very satisfied (4,24±0,635). Students rated the overall case-work up of virtual patients with „excellent“, what is slightly better than the average grade of other categories (Kruskal-Wallis test=11,875; P=0,018) (Figure 3).

The way virtual patients were integrated into the medical curriculum was evaluated by using a questionnaire, which covered different fields important for such integration. It was shown that there was no statistical difference between the rating of the different categories and overall judgement (Kruskal-Wallis) (7,892; P=0,096) (Figure 4).

Students rated the integration of virtual patients into the curriculum from different aspects. Results are shown as average values. Ratings of the different aspects of CAMPUS integration into curriculum was done using a scale 1-5, where 1 was poor and 5 was excellent.

There was no statistical difference in the evaluation of different aspects of the curricular integration and the overall judgement of the curricular integration among male and female students involved in the study (Figure 5).

Students rated the integration of virtual patients into the curriculum from different aspects according to gender of participants. Results are shown as average value of different aspects of the VP integration into the curriculum. Rating of the curricular integration was done using scale 1-5, where 1 was poor and 5 was excellent.There was no statistical difference between male and female students.

Discussion:

Our studies showed that BH students welcome virtual patients and that they enjoy working with computer based stimulations. They found out that working with VPs was stimulating and motivating for them. They discovered many advantages of this system comparing with classical methodologies like involvement in clinical decission making process, in establishing differential diagnosis, dismissing working diagnosis and learning different diagnostic-therapeutic algorythms. Before introducing new teaching approaches, students were involved only in bed side teaching during practical classes. Depending on the number of patients at particular departments, skills and motivation of the teaching staff, students learned less or more.

Most of the students from both faculties, who were involved in our study, emphasized that the VPs were very useful for them for continuation of education and also for learning basic diagnostic and therapeutic approaches in pediatrics (4,24±0,635). All students found the work with CAMPUS pleasurable and judged it as important, that they could repeat some skills as many times as they wish without fear that they can

Figure 3. Influence of virtual patients on students learning and clinical reasoning skills

Variables	Estimation of the program (scale 1-5)*			
	Median	Interquartile range	Minimum	Maximum
Authenticity of patient encounter and the consultation	4,00	1,00	2,00	5,00
Professional approach in the consultation	4,00	1,00	3,50	5,00
Coaching during consultation	4,00	0,67	3,33	5,00
Learning effects during consultations	4,00	0,50	3,00	5,00
Overall judgment of case workup	5,00	1,00	3,00	5,00

* Kruskal-Wallis test.

Figure 4. General estimation of integration of CAMPUS program into curriculum

Variables	Estimation of the program (scale 1-5)			
	Median	Interquartile range	Minimum	Maximum
Teaching presence	4,2	1,20	3,00	4,90
Cognitive presence	4,25	1,00	3,00	5,00
Social presence	4,00	1,00	3,00	5,00
Learning effect	4,00	1,00	3,00	5,00
Overall judgment of the course	5,00	1,00	3,00	5,00

* Kruskal-Wallis test.

Figure 5. Estimation of integration of CAMPUS program into curriculum according to gender of participants

Variables	C±Q gender		Mann-Whitney U	P
	Male	Female		
Teaching presence	4,20±1,60	4,05±1,18	74,000	0,472
Cognitive presence	4,00±1,75	4,62±1,00	64,500	0,234
Social presence	4,00±2,00	4,50±1,00	60,000	0,167
Learning effect	4,00±1,75	4,50±1,50	55,000	0,105
Overall judgment of the course	4,0±2,0	5,0±1,0	54,000	0,095

* C (median); Q (interquartile range).

make mistakes. Most students felt like they had to make the same decisions a doctor would make in real life (4,03±0,823). Students were impressed with the possibilities to make decisions themselves even if it happens in a virtual environment. Most students did care less for this patient (3, 62±0,942). This might be due to the fact that our students are used to real patient encounters and are not as much emotionally involved during solving cases in a virtual environment.

Both groups of pediatric students during pilot study solved three cases, two from nefrology and one from pulmology by using CAMPUS system. Before working on these cases they were theoreticaly prepared through ex catedra teaching. They did not have a chance to go into practical bed side teaching at the pulmology department, so that is why most of the students were indifferent answering the questions. It was the case in appropriate level of difficulty for their level of training (3,52±1,022).

During our study a major complaint of our students was the problem with using foreign language in solving cases presented in CAMPUS system (two cases from nephrology were mostly in English and one from pulmology was in Bosnian). Even if the most of students involved in the study were speaking English, they were not used to think and discuss in English, so they asked for a translated version of the CAMPUS software. Now there is a translated CAMPUS version available and will be introduced into regular teaching in pediatric departments from next semester. So, apart from English version of

CAMPUS (Heid et al., 2004), also a version in Bosnian languages will help in dissemination of the CAMPUS system in the region of Western Balkan.

We anticipate that the introduction of virtual patients at our faculties will help our students in improving clinical reasoning and practical skills by following patients from admittance to discharge and give them opportunity for extensive repetitive practice with proper feedback. Controlled studies higher up the Kirkpatrick's levels are needed to test whether this holds true. Our group helped in forming core groups for introducing virtual patients to all Medical faculties in BH and they are planning to introduce this system at different departments in the nearest future.

Acknowledgement:

Prof Hans-Guenther Sonntag, contractor of EU Tempus project INTEL M, who financed all activities connected with introducing of new curriculum and teaching methodologies at BH Medical faculties.

Mr Frank Hess and Mathias Bauch, who helped us in adoption and translation of the CAMPUS system to our language.

References:

1. Bearman M., Cesnik B., and Liddell M., Random comparison of "virtual patient" models in the context of teaching clinical communication skills, Med Educ. Vol. 35, No 9, 824-832, 2001.
2. Ellaway R., Candler C., Green P. and Smother V., An Architectural Model for Medbiquitous Virtual patients, Medbiquitous, Baltimore, MD, 2006.
3. Garde S., Bauh M., Haag M., Heid J., Huwendiek S., Ruderich F., Singer R., Leven F. J. CAMPUS – computer-based training in medicine as part of a problem-oriented educational strategy, Studies in LEID 2(1), 2005.
4. Heid J., Leng B. D., Huwendiek S., Bauch M., Tönshoff B., and Leven F. J., Campus: A platform for development of multilingual computer-based medical teaching cases, Leiden, The Netherlands, Slice of Life, 2004.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 22

TEACHERS' EXPECTATIONS AND CONCERNS ABOUT INTRODUCING VIRTUAL PATIENTS IN A CLINICAL COURSE

Samuel Edelbring[1], Nabil Zary[1]

[1]*Karolinska Institutet, Sweden*

contact author: Samuel Edelbring, samuel.edelbring@ki.se

Virtual Patients (VPs) are believed to contribute to student learning by affording an active approach to patient cases for learning and by connecting factual knowledge to context in a flexible way. But what possibilities do teachers see with VPs and what concerns do they have about introducing VPs in their course?

Context: In the planning of a course in basic and clinical science for 4th term medical students VPs were decided on to be used as a means for students to work with patient cases. The course offers basic knowledge about how to reach a preliminary diagnosis by patient interviews and different investigations and knowledge about functional systems in imbalance.

Method: During the planning phase of the course an investigation among course directors and teachers (n=12) were performed regarding their expectations and concerns about introducing VPs in the course. A questionnaire was distributed with three open ended questions: 1) In what way do you believe the VP activity will contribute to student learning in your course?, 2) What general expectations do you have on the VP activity? and 3) Do you have any concerns (worries) about the VP use? 10 questionnaires were returned (83%) and data were analysed qualitatively.

Result: Expectations and concerns of intended VP use can be elicited by open ended written questions. The investigation revealed the teachers' expectations regarding learning process and outcome as well as some important issues related to curricular integration of VPs.

Keywords: teachers' expectations, VP integration

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 23

VIRTUAL PATIENTS AS AN INNOVATIVE LEARNING ACTIVITY IN DISTANCE NURSING EDUCATION

Carina Georg[1], Nabil Zary[1]

[1]*Karolinska Institutet, Sweden*

contact author: Carina Georg, carina.georg@ki.se

Background: The interest and demand for distance nursing education have increased lately. There is therefore a need to explore instructional approaches that better fitted a distance based curriculum. Simple patient cases have been used but the use of virtual patients remains to be studied. The purpose of this study was to investigate the acceptance and value of virtual patients (VPs), in a distance nursing education setting, as a mean to support the students in improving their clinical reasoning.

Method: Four VPs were created by the course director and then introduced, as a mandatory requirement, in a distance course in emergency medicine (5 weeks). The students (n=25) filled in a questionnaire at the end of the course with regard to the authenticity of the patient encounter, their professional approach while interacting with the VPs and their perceived value of such type of learning activity.

Result: The students (77%) reported that they adopted a professional approach by actively engaging in gathering information and revising their working hypothesis during the process of interacting with the VPs. The majority of the students (80%) also felt that the encounters mimicked a real life situation. A recurring comment from the students was the importance of an adequate feedback to foster a deeper reflection.

Conclusions: VPs could help nursing students improve their clinical reasoning in a distance education setting. Creating VPs with adequate feedback might foster a deeper reflection. The quality of the feedback is probably more important than on campus courses where the teacher can provide alternative forms of support.

Keywords: virtual patient, nursing education, distance education

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 24

VIRTUAL PATIENT PLAYERS AND AUTHORING TOOLS – DIFFERENT PLAYERS, DIFFERENT CHARACTERISTICS.

Anna Hammarsten[1], Samuel Edelbring[1], Uno GH Fors[1], Nabil Zary[1]

[1]*Karolinska Institutet, Sweden*

contact author: Anna Hammarsten, anna.hammarsten@ki.se

Several virtual patient players and authoring tools have been developed by the virtual patient lab (VP-Lab) at Karolinska Institutet. Three kinds of software will be demonstrated: Web-SP, NUDOV and MICS. They are all Virtual Patient players but differ in characteristics and educational purpose. Web-SP is a web-based platform for virtual patients, with a built-in authoring tool allowing any teacher to develop cases without the support of technical staff. NUDOV is a VP software developed with the goal to afford interaction with authentic patient cases throughout the visualised clinical process. The purpose of MICS was to create common e-learning software where students from different health science programmes work jointly with the same virtual patient although from their respective perspectives. The design allows the student to follow up and manage the patient at different encounters, consecutively over time, alongside with different professions. The primary aim of this demonstration is to engage the participants in a discussion around how different design factors affect targeted learning needs when creating and implementing virtual patients in curricula.

Keywords: patient system, health science education, authoring tool, curriculum integration

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 25

DIFFERENT LEARNING AND ASSESSMENT SCENARIOS USING THE CAMPUS VIRTUAL PATIENT SYSTEM

Jörn Heid[1], Benjamin Hanebeck[1], Frank Hess[1], Simone Huber[1], Martin Haag[1], Sören Huwendiek[1]

University Hospital of Heidelberg, Germany

contact author: Jörn Heid, heid@hs-heilbronn.de

The success of a learning environment depends among others on the correct alignment to the special needs of the students. For that the assumption assessment drives learning and the curricular integration in several areas led to the development of several players for different learning and assessment scenarios at Heidelberg – relying on the same backend with an authoring system and database. The simulative variant, called Classic-Player, is used for self-study in order to feel and act like a real doctor. For a more flexible way of Virtual Patient representation the so called Card-Player can be used with the same case. It offers a faster patient work up because of a reduced amount of possibilities on each card. For formative assessments the usage of the players is recorded and the results can be used to judge the success of the students for different courses. For graded exams with a higher demand for security a special summative exam player has been developed. It is network and server failure tolerant and justiciable. For Virtual Patients it supports the key feature approach after Page and Bordage, multimedia files and several question types including long menu, multiple choice and hotspot questions. The newly developed eViP-Player is capable of showing any eViP (an European project for repurposing Virtual Patients) conformant case. With these four different players the CAMPUS system is capable of delivering content optimal suitable for different learning and assessment goals, making the system uniquely valuable for curricular integration of Virtual Patients in many areas.

Keywords: e-Learning, Assessment, eViP, Virtual Patients

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 26

IMPLEMENTATION OF VIRTUAL PATIENTS IN A DENTAL SCHOOL – A PROPOSED MODEL TO MOVE BEYOND THE EARLY ADOPTERS

Gunilla Johnson[1], Nabil Zary[1]

[1]Karolinska Institutet, Sweden

contact author: Gunilla Johnson, Gunilla.Johnson@ki.se

Background: Virtual patients (VPs) were introduced at the dental school at Karolinska Institutet (KI) in 2002. The initial adoption of the VPs was in the field of comprehensive dentistry. In 2007 a prospective longitudinal study was initiated to experiment different models for increasing the adoption and use of VPs based on Rogers's diffusion of innovations theory. The aim of this sub-study was to investigate if two dissemination activities could be employed by early adopters to drive the adoption process.

Method: A team composed of an early adopter of VPs at the dental school and a learning technologist was formed. The entire faculty (n=76) at the dental school was recruited to the first intervention – an introduction seminar about VPs and a short hands-on exercise. Interested teachers were then asked to sign up for the second intervention – a thorough individualized training session. Finally after 5 months data was collected about courses that implemented VPs as a regular learning activity. Questionnaires were filled-in by the participants after each intervention.

Result: The team composed of a subject matter expert and a learning technologist had the required competencies for the interventions planned. Of the recruited faculty, 20% (n=15) showed an active interest for learning more about how to author and use VPs. Four teachers (5%) implemented VPs in their courses after a few months. The proposed model with a team, composed a subject matter expert and a learning technologist, and a two interventions managed to diffuse the innovation to a subset of the early majority.

Keywords: virtual patient, implementation, dentistry education, adoption

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 27

INTEGRATION OF THEORETICAL KNOWLEDGE AND CLINICAL PRACTICE USING VIRTUAL PATIENTS

Daphne Vassiliou[1], Katarina Arnrup[1], Asa Derolf[2], Samuel Edelbring[3], Marie Evans[4], Eli Westerlund[5], Jonas Spaak[5], Peter Henriksson[5], Stephanie Mindus[2], Magnus Sköld[2], Christer Sylvén[4], Ronny Sejersen[3], Uno GH Fors[3], Nabil Zary[3], Eva Sjöblom[1], Olle Broström[1]

[1]Karolinska Institutet, Department of Clinical Science and Education, Södersjukhuset, Sweden
[2]Karolinska Institutet, Department of Medicine, Karolinska University Hospital Solna, Sweden
[3]Karolinska Institutet, Sweden
[4]Karolinska Institutet, Department of Medicine, Karolinska University Hospital, Huddinge , Sweden
[5]Karolinska Institutet, Department of Clinical Sciences, Danderyd Hospital, Sweden

contact author: Daphne Vassiliou, daphne_vass@yahoo.com

Supervising students during the transition from preclinical courses to clinical practice presents with a challenge for medical teachers: applying knowledge acquired during theoretical training in the context of a patient case. The need for integrating theory and practice has been evident to the authors, who have been teaching medical students just starting their clinical residency in the course “Clinical Diagnostics”. The Web-based Virtual Patient Simulation environment (Web-SP) has previously been tried as an educational tool for medical teaching both locally and internationally. Using our experience, we used Web-SP to create virtual patients (VPs) that highlighted the importance of implementing preclinical knowledge in the various steps of obtaining a diagnosis. After completion of a complete medical history and a thorough examination the student can choose, in an efficient manner, from a great variety of tests and procedures the VPs offer. The students can order and evaluate procedures in radiology, physiology and neurophysiology, clinical chemistry, bacteriology and pathology. The VPs were introduced during the last part of the Clinical Diagnostics course. Access to the VPs was given so that the students had a limited amount of days to look through VPs – either alone or with peer students. The VPs were then presented by the teachers during a two-hour seminar, with focus on the diagnostic procedure. Results from student evaluations will be presented. With the amount of scientific knowledge expanding exponentially, there is a great need for efficient teaching tools. Our experience of the virtual patients indicates that it might be used to enable students to use previously acquired preclinical knowledge and implement it in a clinical context.

Keywords: Virtual Patient, Integrated Patient Cases, Curriculum Design, Implementation

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 29-34

NEEDS ANALYSIS FOR VIRTUAL PATIENTS: A REPORT FROM THE EVIP PROJECT

David A. Davies[1], Chara Balasubramaniam[2], Sören Huwendiek[3], Bas de Leng[4]

[1]The University of Warwick, UK,
[2]St George's, University of London, UK,
[3]University of Heidelberg, Germany,
[4]Maastricht University, The Netherlands

Abstract: The eViP Programme has conducted a survey on the current use of virtual patients across the EU and the wider global community. A total of 216 respondents have given feedback on the current and potential future use of virtual patients, including different educational settings and scenarios within which virtual patients have been used. Data has been gathered on different business models for access to a repository of virtual patients. The broad demographic profile of respondents has been gathered to help analyse these data in context. This report will be of use to those considering a virtual patient approach in their curricula, as well as providing a snap-shot of the current good practice in this area. It is planned to release an updated version of this survey in 2010 towards the end of the eViP Programme so that changes in opinion and implementation of a VP approach can be reviewed.

Keywords: virtual patients, e-learning, needs analysis, survey

Introduction

eViP[1] is a 3-year Programme co-funded by the European Union (EU) to create a bank of repurposed and enriched multicultural virtual patient cases from across Europe. A key aim of the eViP project is understanding the current use of virtual patients (VPs) in institutions across the EU, as well as how ready these institutions might be to adopt a repository of VPs produced by eViP. As a first step towards this aim the team created an online survey to gather data on current use and potential future use of VPs across the EU and globally.

Method

An online survey was constructed in SurveyMonkey[2], a commercial survey and data analysis service. A paper version of the survey was also created for manual distribution and completion at the Association of Medical Education in Europe (AMEE) 2008 conference in Prague[3]. The team did not want to bias results of our survey by only offering it one medium.

The online survey was publicised to encourage participation from across the EU and globally. Publication channels included the MedBiquitous virtual patient working group[4] mailing list, the MedEdPortal list[5], the UK Higher Education Academy Subject Centre for Medicine, Dentistry & Veterinary Medicine mailing list[6] and through various other local networks across partner countries.

The survey was divided into 5 sections:

1. An introduction describing the purpose of the survey and defining virtual patients
2. Questions relating to the current use of virtual patients, including educational settings, etc
3. Questions relating to the potential future use of VPs including perceived barriers, curriculum areas best suited to VPs, etc
4. Questions relating to the use of a collection of VPs including some outline business and licensing models
5. Personal information including country, host institution and well as respondent demographics and contact details

Results

A total of 216 survey responses were collected both online and on paper, with 170 (79%) of respondents answering every question. The SurveyMonkey system allows for manual import of response from other sources including data collected offline. Data from the paper-based responses were added to the online data, so that all responses could be analyzed together.

A PDF copy of the complete survey results including graphical analysis is available on the eVIP project web site[1]

Analysis and commentary on individual questions

Questions relating to the current use of VPs

1. *Are virtual patients used somewhere in your curriculum? (212 responses, 4 respondents skipped this question)*

Interestingly, responses were equally split between respondents who are currently using VPs and those who are not. Therefore, this question sets the context for the rest of the survey as half of all respondents answered questions in relation to their own current use of VPs. Since half had little or no experience of using VPs, their responses were based upon their perceptions of the benefit or otherwise of a virtual patient approach. Future analysis will compare the responses of these two groups.

2. *Do you currently use virtual patients in your own practice (teaching, learning and/or assessment)? (144 responses, 72 skipped this question)*

A total of 55% of respondents currently use VPs in their own teaching but the surprisingly large number of respondents skipping this question suggests that perhaps many assumed that this question was asking the same information in question 1. The purpose of this question was to determine the balance between institutional use of VPs and personal use by the respondent. A refined version of this survey would make this distinction clearer.

3. *If yes, please briefly describe the educational scenarios in which you use virtual patients (95 responses, 121 skipped this question)*

The dominant educational scenarios were independent learning (58.9%) and problem-based learning (45.3%). Both of these scenarios require the student to work alone or with a small number of peers.

Free-text responses listing other educational scenarios included:

- Assessment (3 responses)
- Integration with basic science teaching (2 responses)
- Distance learning or other online activity (2 responses)
- Other activities (2 responses)

4. *At what stage/level your students usually use virtual patients? (106 responses, 110 skipped this question)*

Clinical (67%) or pre-clinical (48.1%) undergraduate level activities accounted for the majority of responses with residency (26.4%) and CPD (12.3%) being less represented. A future survey might uncover the reason for this split between undergraduate and postgraduate/CPD use.

5. *Are students expected to use VPs (115 responses, 101 skipped this question)*

For independent study (66.1%) was the dominant response, confirming question 3 as a planned activity rather than as a student-led activity. The remaining responses were approximately equally spread over other timings including preparing for classes, during a class, as a follow up to classes or in assessment.

6. *Where do the virtual patients you use come from? (115 responses, 101 skipped this question)*

VPs currently in use by respondents overwhelmingly came from their own institution (67%).

The remainder of respondents either shared their VPs with other institutions as part of a collaboration (33%) or purchased them commercially (23.5%). The least popular way of getting VPs was finding them on the Internet (20.9%) which is a significant riposte to those who say all e-learning materials can be easily found on the Internet. For higher-level e-learning content such as VPs this does not appear to be the case, at least for the respondents to this survey. This underlines the importance of content collaborations such as eViP.

7. *Does your virtual patient system include any question types? (88 responses, 128 skipped this question)*

Multiple-choice questions (MCQs) are the dominant for of self-assessment within VPs (79.5%) with open questions (50%) the next most popular. Extended matching (25%) and long-menu questions (18.2%) were considerably less well used. Free-text responses to this question also listed hot-spot questions as being used (2 responses). These findings are important evidence for the technical interoperability standard for VPs. MCQs as part of the question and test interoperability specification are currently being incorporated into the eViP technical application profile.

8. *Have you used virtual patients in summative student assessment? (62 responses, 154 skipped this question)*

A surprising number of respondents have used VPs in some aspects of assessment including preparation (51.6%), in Objective Structured Clinical Examinations – OSCEs (46.8%) or in preparation for exams (51.6%) although these represented only 62 out of 216 respondents in total. However, it does show that VPs have a valuable part to play in assessment.

9. *Have you conducted any evaluation of virtual patients with students? (115 responses, 101 skipped this question)*

The majority of respondents have not evaluated their VPs (58.3%). However, of those who have (41.7%) a number have been published in the peer reviewed literature (6 responses) and these references will be consulted in eViP as part of WP5 (Assessment and Evaluation).

10. *Do you use a computer-based system to manage your virtual patients?* (113 responses, 103 skipped this question) and

11. *Is your virtual patient system a commercial system, open source, or has your institution developed it?* (100 responses, 116 skipped this question)

A little over half of respondents use a computer-based system to manage their VPs (59.3%) with 53% using a system developed by their own institution (53%). Of the systems listed as being used, the following were the most popular:

- Home-grown (7 responses)
- Laerdal MicroSim and related software (5 responses)
- CASUS (4 responses)
- Moodle (3 responses)

These are interesting results as the most common systems in use are home grown or non-commercial. A number of systems quoted as being used e.g Moodle are not VP systems *per se* so it will be interesting to find out more about how these are used to manage VPs.

12. *Do you know if your virtual patient system supports import/export of virtual patients? (91 responses, 125 skipped this question)*

This is a vital question for the eViP project because it gives a clue as to the state of technical preparedness for standards-based content packaged VPs. If VP systems cannot import standards-based content packages then eViP content will be largely inaccessible to these systems. Of the 91 responses, 19.8% stated their systems can import new VPs while 16.5% stated their systems could export. A total of 63.7% of respondents did not know. It will be essential during year 2 of eViP that more awareness of the technical standard for VP import/export reaches the wider developer community.

Questions relating to the potential future use of VPs

13. *Is there a need for virtual patients in your curriculum as a whole? 179 responses, 37 skipped this question) and 14. Do you have a need for virtual patients in your teaching or assessment? (169 responses, 47 skipped this question)*

An overwhelming 88.3% of respondents supported the need for VPs in their curricula and especially their own teaching (89.3%). Justification for this included:

- "an important way of standardization"
- "modern way to enrich curriculum"
- "More students with less training time"
- "There aren't many 'real' patients available for every student"
- "VPs are needed to ensure uniform exposure to patients across teaching sites and throughout the year"

However, some are still unconvinced of the need for VPs (11.7%). Their comments include:

- "Patient actors suffice and I believe are more spontaneous"
- "I don't consider it promotes learning"
- "It's not realistic enough"

15. *What kind of educational scenarios do you think best fit the use of virtual patients? (126 responses, 90 skipped this question)*

See Fig. 1.

16. *If time was not a barrier, what would be the main barrier to more widespread use of virtual patients in your institution?* (132 responses, 84 skipped this question)

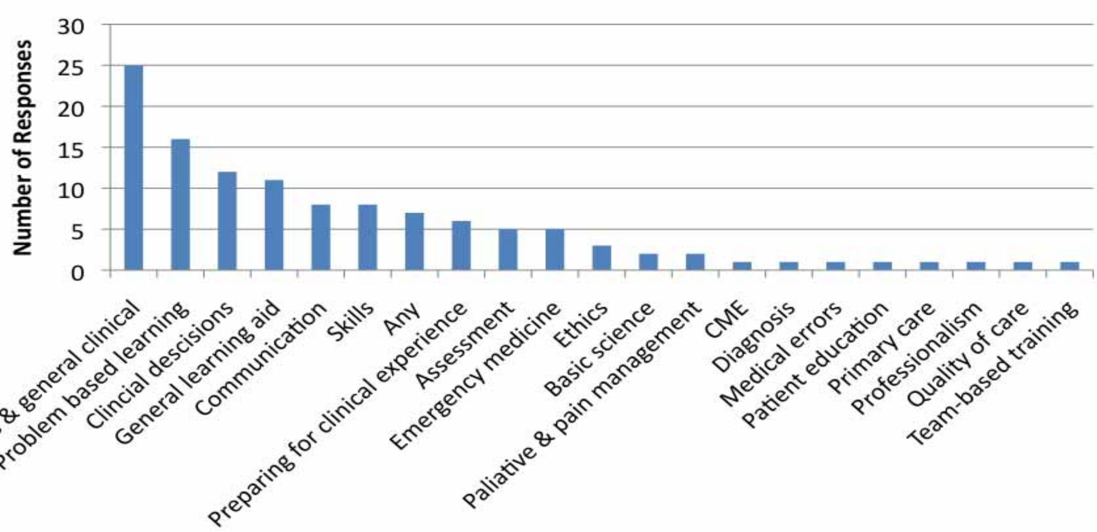


Fig 1. Summary of the reported educational scenarios best suited to a VP approach

Table 1. Summary of the top 10 perceived barriers to the adoption of a VP approach

Barrier	Responses
Cost	56
Acceptance by teachers or clinicians	29
Authenticity	9
Collecting quality content	9
Technical literacy of teachers	7
Needs computer lab	5
No barrier	4
Training	3
Effectiveness	2
Time in the curriculum	2

17. What areas of the curriculum do you think are especially relevant for virtual patients? (124 responses, 92 skipped this question)

See Fig. 2.

18. In what discipline areas do you think virtual patients can be a useful learning tool? (170 responses, 46 skipped this question)

Medical education was the dominant response (96.5%). However nursing (75.9%) interdisciplinary (65.3%), dental (60.6%), and other health-related education (54.7%) were also chosen by more than half of respondents. Basic science teaching was thought to be the least appropriate discipline area for VPs (38.8%).

19. How many virtual patients would ideally be required to cover a complete medical curriculum? (167 responses, 49 skipped this question)

Relatively few respondents wanted to commit to a specific number of VPs required to cover a curriculum, instead 43.1% thought *"It depends upon the educational strategies in curriculum"* and a further 36.5% thought *"Impossible to say, students need access to an unlimited variety of patient cases, real or virtual"*.

Questions relating to a virtual patient collection

20. Please rate the following statements [about a VP collection] (167 responses, 49 skipped this question).

On a 5-point Likert scale from Strongly Disagree to strongly agree the majority of respondents chose to Agree with these statements:

- I believe access to virtual patients and related e-learning content should be free as a result of centralized educational funding (39.8%)
- I would expect my institution to pay for me to access a repository of virtual patients (50.9%)
- I would support my institution reallocating teaching resource funding to implement virtual patients (46.6%)
- Commercial sponsorship is acceptable for virtual patients (37%)
- I would be willing to contribute virtual patients to a repository (46.3%)

While the majority chose to disagree with the following statement: I would be willing to pay personally to access a repository of virtual patients (33.7%).

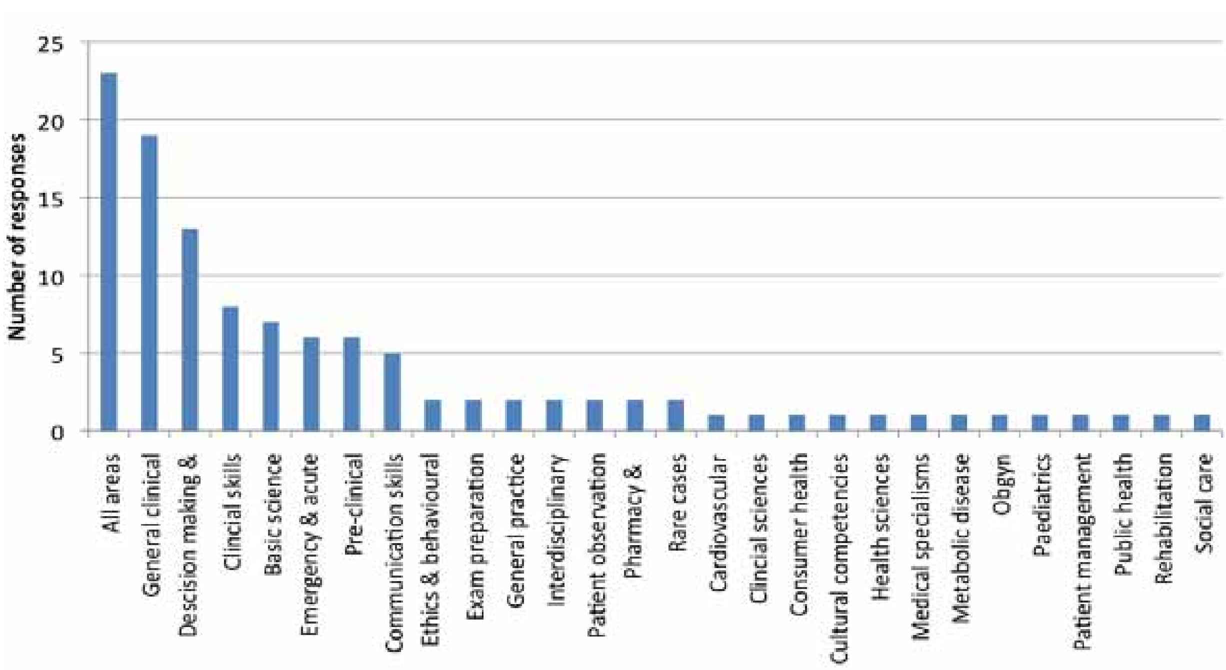


Fig 2. A summary of the reported curriculum areas best suited to a VP approach

21. On what basis do you think that you or your institution would be prepared to pay for virtual patients? (155 responses, 61 skipped this question)

A total of 44.5% of respondents thought that VPs should be free, 33.5% favoured a variable fee based upon the number of students, and 21.9% were prepared to pay a fixed fee per VP. A free-text question asked respondents to quote a figure that they would be prepared to pay per VP (in Euros).

Table 2. Summary of the amount (in Euros) respondents were prepared to pay for a single VP

Fee in €	Responses
<10	1
10-100	9
100-250	3
1,000-5,000	3
5,000-20,000	1
>20,000	1

22. Would you or your institution be willing to use virtual patients developed by others, for example from eViP? (154 responses, 62 skipped this question)

Reassuringly 93.5% of respondents would be prepared to use VPs developed by others. This is a marked shift from the "not invented here" syndrome that has plagued reusable e-learning content for many years.

23. Were you previously aware of eViP? (164 responses, 52 skipped this question)

After only one year, 33.5% of respondents had already heard of eViP. Awareness will have been further raised by the survey itself, and the dissemination events at the AMEE conference.

24. Are you aware of the work by MedBiquitous in the area of virtual patients? (163 responses, 53 skipped this question)

Similarly, although 27% of respondents had heard or MedBiquitous, a further 27% had not heard of their VP work and a further 41.1% had not heard of MedBiquitous at all. So awareness needs to be raised about this group and its efforts to develop a virtual patient technical standard.

Questions about the respondent

25. The country where you work (166 responses, 52 skipped this question)

The list below shows the countries that were represented by one survey respondent. For a complete list of countries that were represented, please refer to the full report on the eVIP web site[1].

Table 3. Top 10 responding countries

Country	Responses
USA	69
UK	14
Poland	11
Canada	10
Germany	7
Netherlands	6
Australia	4
Czech Republic	3
Thailand	3
Turkey	3

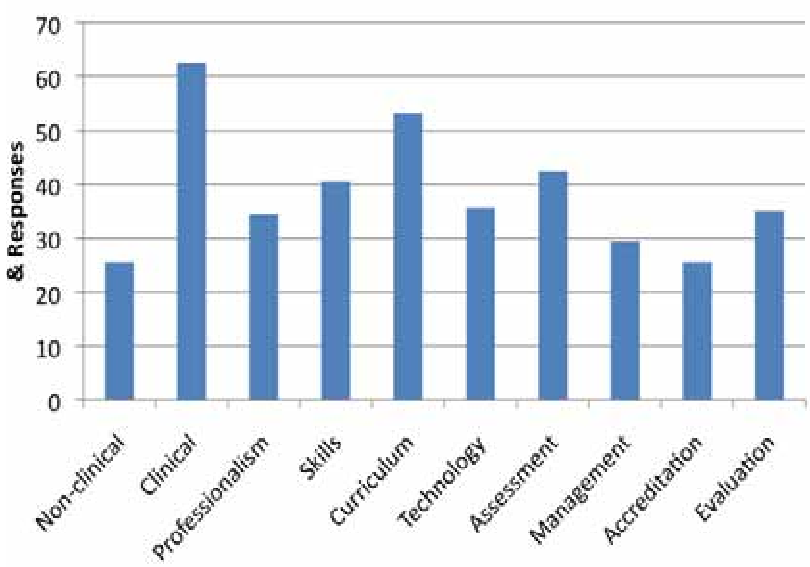


Fig 3. The reported role of those responding to the survey

26. Your institution (154 responses, 62 skipped this question)

A full list of institutions can be found in the full report on the eViP web site[1].

27. Your role (155 responses, 61 skipped this question)

A full list of institutions can be found in the full report on the eViP web site[1].

28. Your area of focus (160 responses, 56 skipped this question)

See Fig. 3.

29. The level at which you work (160 responses, 56 skipped this question)

Table 4. The reported level at which respondents work

Level	Respondents
Undergraduate	61.9%
Postgraduate	56.9%
CME/CPD	39.4%
Inter-professional	23.8%

30. Your age (167 responses, 49 skipped this question)

See Fig. 4.

31. Your sex (158 responses, 58 skipped this question)

45.6% female, 54.4% male.

Questions 32 and 33 asked for name and email address. Those responding to this question will receive a copy of the survey report and will be invited to join an eViP mailing list.

Discussion

This survey has successfully reached an international audience, and has provided invaluable background information on the current use of virtual patients and virtual patient systems. It has also gathered opinion on the potential future use of VPs. Information gathered in this survey will be of use to other groups considering a virtual patient approach in their curricula, as well as for those reviewing the current good practice in this area.

These data are particularly helpful to the eViP Programme team, who can use the feedback to better focus developmental activity in the remaining years of the project. Feedback on the approaches to funding a sustainable repository of virtual patients will help set the scene for further market research. Results of technical questions will be fed into the MedBiquitous virtual patient working so that the emerging technical standard for virtual patient interoperability can benefit as a result. Awareness of the currently VP systems in use is essential for a technical interoperability standard. A further detailed analysis of this survey's data is required to correlate responses by geographic region, by discipline area (medical, nursing, dental, etc) and by level of working (undergraduate, postgraduate, etc). Finally, a modified and updated version of this survey will be released towards the end of the eViP Programme in 2010 to track changes in usage and opinion about VPs.

References

[1] http://www.virtualpatients.eu
[2] http://www.surveymonkey.com
[3] http:///www.amee.org
[4] http://www.medbiq.org/working_groups/virtual_patient/index.html
[5] http://www.aamc.org/mededportal
[6] http://www.medev.ac.uk

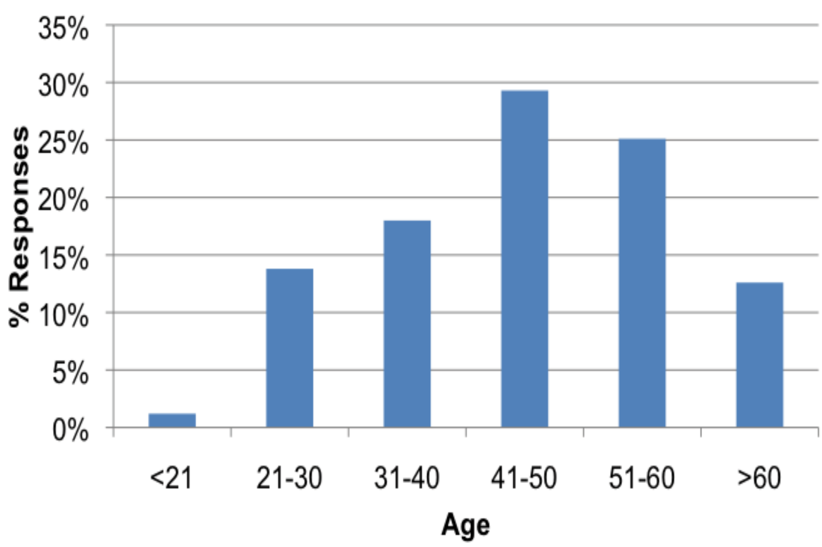


Fig 4. The age profile of survey respondents

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 35-44

EVALUATION OF CURRICULAR INTEGRATION OF VIRTUAL PATIENTS: DEVELOPMENT OF A STUDENT QUESTIONNAIRE AND A REVIEWER CHECKLIST WITHIN THE ELECTRONIC VIRTUAL PATIENT (EVIP) PROJECT

Sören Huwendiek[1,2], Helen Rani Haider[2], Burkhard Tönshoff[1],
Bas de Leng[3]

[1]University Children's Hospital Heidelberg
[2]Centre for Virtual Patients University Hospital Heidelberg
[3]Maastricht University, Dept. of Educational Development and Research

Abstract:
Introduction: The use of virtual patients in medical education is increasing rapidly. The curricular integration of the e-learning modules is essential for their success. To date, we are not aware of any published standardized instruments to evaluate the curricular integration of virtual patients.
Methods: In a literature review, we searched for valuable frameworks for designing a student questionnaire and a teacher checklist concerning the curricular integration of virtual patients. The resulting instruments were reviewed by the electronic Virtual Patient project (eVIP) partners and accordingly refined. The resulting instruments were tested on the target groups and further refined. The resulting student questionnaire was translated into the 6 partner languages, again tested and refined.
Results: Student questionnaires in six languages and a reviewer checklist concerning the curricular integration of virtual patients were developed based on a framework informed by the literature. The final student instruments consist of 20 questions, clustered in the following 5 main categories: teaching presence, cognitive presence, social presence, learning effect, and overall judgement. The final reviewer checklist consists of 12 questions characterizing the virtual patient scenario and 24 items around the same 5 main categories.
Conclusion: We developed multi-lingual student questionnaires and a teacher checklist, in order to analyze and compare virtual patient curricular integration scenarios around the globe.

Keywords: Virtual patients, curricular integration, blended learning, CAMPUS, evaluation, questionnaire

Introduction

Virtual patients (VPs) are increasingly used in medical education [1]. A crucial factor to the educational success is that e-learning modules, such as VPs are integrated with other curricular components [2, 3]. The knowledge about how to integrate computer technology into medical school instruction is far less evolved than the knowledge about how to design computer-based instruction itself [4]. There is a well documented need for further research concerning the curricular integration of e-learning [2, 4]. Already in 1994, Friedmann formulated the demand for research that would explicitly compare different modes of integration of e-learning [4].

A standardized evaluation instrument which focuses explicitly on the curricular integration of virtual patients offers the opportunity to compare different integration modes and elucidate strategies of effective curricular integration. While there are several reports about the curricular integration of computer-based learning materials [5, 6, 7, 8], none of the articles uses a framework to evaluate the aspect of curricular integration.

VPs are especially well suited to foster clinical reasoning [9]. Thus, the aim of this project was to develop a student questionnaire and a reviewer checklist which evaluate and characterize the curricular integration of virtual patients in an educational scenario, with the primary aim of fostering clinical reasoning.

This study is anchored in the electronic Virtual Patient project (eViP, www.virtualpatients.eu), which is co-funded by the European Union [10]. Eight European universities corporate in this project, creating a shared online bank of enriched virtual patients, adapted for multicultural and multilingual use, thereby improving quality and efficiency of medical and healthcare education across the EU [11]. The development of evaluation instruments for learning scenarios using virtual patients is one of the goals of the eViP work package "Assessment and Evaluation". The aim is to develop instruments that evaluate the manner in which prospective users (students, teachers and curriculum designers) perceive the curricular integration of VPs in different educational settings. The results of these evaluations will support teachers and curriculum designers in implementing VPs in their curriculum.

The rapid development and success of virtual patients and the increasing number of curriculum designers aiming for successful integration of virtual patients as an e-learning element in their courses, reflect the need for valid instruments to evaluate and help refine the curricular integration of virtual patients. Therefore, we developed evaluation instruments to assess the curricular integration of virtual patients based on a framework informed by the literature and reviewed by the eVIP partners.

Methods

Literature review

A literature review was conducted, covering the literature databases MEDLINE and ERIC, internet searches (Google scholar), and literature of the authors. Search terms included: Blended Learning, Flexible Learning, Constructive Alignment, Curricular Integration, E-Learning and Virtual Patients. Within this literature review, no standardized valid instrument for the evaluation of VP curricular integration or even e-learning in general could be found.

The following literature informed a theoretical framework for the creation of our evaluation instruments. The Community of Inquiry Model [12] served as a general framework for the questionnaire, enhanced by the Blended Learning framework of Khan [13] and the criteria categorizing didactic scenarios by Heyer [14]. Furthermore, principles concerning the curricular integration of virtual patients, drawn from a focus group study among students at the University of Heidelberg, were incorporated in the questionnaire [15].

According to the Community of Inquiry Model by Garrison et al. [12] learning is highly dependent on the teacher's role and his facilitation of the learner's active learning. Furthermore learning is influenced by the interaction, e.g. collaboration with other learners, and the ability of learners to project themselves socially and affectively into a community of inquiry. In the Community of Inquiry Model, deep and meaningful learning takes place in a community of inquiry composed by instructors and learners, as key-participants in the educational process. The model assumes that learning occurs through the interaction of three core components: cognitive presence, social presence, and teaching presence [12]. Cognitive presence is defined as the extent to which participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication. Social presence represents the ability of learners to project themselves socially and emotionally within a community of inquiry. Teaching presence includes the design and management of learning sequences, providing subject matter expertise, and facilitating active learning [12]. The questions concerning "teaching presence" were informed by a blended learning framework created by Khan [16]. Singh refers to it as the "Octagonal Framework" for blended learning. This framework clusters factors which are important for designing, developing and creating meaningful distributed learning environments into eight dimensions: pedagogical, technological, interface design, evaluation, management, resource support, ethical and institutional [13]. Heyers article [14], dealing with the categorization of different blended learning scenarios through labelling criteria which describe them, further enhanced the questionnaire. The following eight labelling criteria were incorporated in the questionnaire: social form, organization, level of virtuality, media, content, learning objectives, location, teaching method.

In addition, the questionnaire should analyze the curricular integration of virtual patients with the primary aim to fostering clinical reasoning. In order to assure the evaluation of such, literature concerning educational strategies to promote clinical diagnostic reasoning has been reviewed [17], [18], [19], and the questions, especially concerning teacher-student interaction, were refined accordingly.

Process of refinement by VP experts

In the first step of the refinement process, the draft of the questionnaire and the reviewer checklist were made available for review by eVIP partners, via the eVIP Wiki. The first changes were made, and the instruments were tested with the target groups and further refined. The refined instruments were put up for discussion again and all partners conducted a final review. The finalised instruments were made available to all partners via the Wiki and translated to the partner's local languages. The local language student questionnaires were tested with students and possibly refined again. These questionnaires were then retranslated into English to ensure that all instruments had identical meaning. The final instruments, translated in all partner languages, will be available on the eViP website.

Results

This project resulted in a newly created student questionnaire and reviewer checklist, both designed for the evaluation of the curricular integration of virtual patients. The final English instruments can be found in the appendix A and B.

Questionnaire for evaluation of the curricular integration of virtual patients from the students' perspective

The questionnaire consists of 20 questions, clustered in 5 main categories:

(A) Teaching presence (B) Cognitive presence (C) Social presence (D) Learning effect (E) Overall judgement. Additionally, three open ended questions (F) attempt to discover new factors which influence successful curricular integration of virtual patients. Responses are measured on a 5-Point-Likert-Scale: (1) strongly disagree (2) disagree (3) neutral (4) agree (5) strongly agree. In addition, students can also choose the answer (6) not applicable. After each question students are asked to indicate briefly the reasons for their answer (optional). In order to make this questionnaire employable for all different kinds of educational scenarios using virtual patients, we used the term "corresponding teaching event" to describe teaching and learning activities which go along with virtual patients. Each partner can give his own definition of "corresponding teaching events" according to their educational scenario (for example virtual patients used during problem-based learning, or small-group-discussions after working with virtual patients). In this manner the questionnaire is adjustable to all partners across Europe.

Reviewer checklist for the characterization of the curricular integration of virtual patients

The reviewer checklist delivers a detailed characterization of the curricular integration of virtual patients; it consists of a comprehensive list of possible factors influencing virtual patient curricular integration. In addition, it focuses on those factors which are thought to foster clinical reasoning. The checklist gives a general definition of 'VP-Session' (virtual patient-session) and 'Corresponding Teaching Event'. It consists of 12 items describing the educational scenario:

1. Describing the VP-Session and corresponding teaching event scenario: VP-session without/before/after a corresponding teaching event, virtual patient-work as summative assessment, other use of virtual patients
2. Co-ordination of content: production of artefacts in VP-sessions for corresponding teaching events and vice versa, time allocation
3. Type of VP-session: individual/pair studies, small group, seminar, other
4. Type of corresponding teaching event: lecture, seminar, small group, bedside, other
5. Communication:
   - during VP-sessions: student-student, instructor-student: face to face, computer mediated communication synchronous/ asynchronous, other
   - during corresponding teaching event: student-student, instructor-student: face to face, computer mediated communication synchronous/asynchronous, other
6. Education of staff: training offered for a) corresponding teaching event – teachers b) computer mediated communication – teachers c) VP-sessions – teachers
7. Accessibility/Flexibility: Access according to location and time
8. Summative assessment of VP content: MCQ, Short Menu Questions, Long Menu Questions, OSCE, other
9. Summative assessment of VP content by VPs: type of VP assessment questions: MCQ, Short Menu Questions, Long Menu Questions, other
10. Intended target group
11. Main learning objective
12. Description of scenario in own words

Furthermore, the checklist contains 24 items clustered into the same 5 subsets used in the student questionnaire: (A) Teaching presence (B) Cognitive presence (C) Social presence (D) Learning effect (E) Overall judgement. Free-text questions (F) are included to reveal – until now – unknown factors which foster or inhibit clinical reasoning. The issues addressed under the 5 subsets are the same as in the student questionnaire, unless the questions are more detailed.

Discussion

We developed a student questionnaire and reviewer checklist for evaluating the curricular integration of virtual patients. The student questionnaire consists of 20 questions, clustered in the following 5 main categories: teaching presence, cognitive presence, social presence, learning effect and overall judgement. The final reviewer checklist consists of 12 questions characterizing the scenario and 24 detailed items about the same 5 main categories.

To date, we believe that this is the first published report on standardised instruments for evaluating the curricular integration of virtual patients. The checklist is intended to help an independent reviewer capture the affordances of a course dealing with virtual patients. Combined with the student questionnaire, this checklist enables the reviewer to verify if the constituents (the combination of virtual patients with other teaching sessions) are assembled to best foster clinical reasoning skills. In addition the instruments inform how to improve virtual patient curricular integration for the intended purpose of fostering clinical reasoning. The combined use of student questionnaires and checklists will allow comparison of different virtual patient scenarios worldwide, and help to find further factors of successful curricular integration of virtual patients. Discovered factors can then be the subject of studies higher on the Kirkpatrick levels.

We tried to make the overall student questionnaire and teacher checklist applicable for as many prospective scenarios as possible. However, in some scenarios only a subset of questions and items might be applicable. Furthermore, we incorporated aspects which are currently not standard practice. Even though this might result in low ratings in these areas, their inclusion is important, so as to not miss relevant aspects. Within the eVIP project, these evaluation instruments will be employed in different educational scenarios across Europe and will undergo further validation.

Conclusion

For the successful curricular integration of virtual patients, we developed a student questionnaire in 6 languages and a teacher checklist; tools which allow comparison and scientific analysis of different curricular integration scenarios with standardised instruments. We hope the instruments will be helpful to medical educators, and widely implemented around the globe.

Acknowledgement

We would like to express our sincere gratitude to all partner leads and members of the eVIP project for supporting us in the development of these instruments.

Literature:

1. Huang G., Reynolds R., Candler C.: Virtual patient simulation at US and Canadian medical schools, Academic Medicine, 82: 446-451, 2007.

2. Cook D. A.: The research we still are not doing: an agenda for the study of computer-based learning, Academic Medicine, 80: 541-548, 2005.
3. Hege I., Kopp V., Adler M. et al.: Experiences with different integration strategies of case-based e-learning, Medical Teacher, 29 (8): 791-7, 2007.
4. Friedmann C.: The research we should be doing, Academic Medicine, 69: 455-7, 1994.
5. Karsten G., Illert M.: Curriculare Integration des e-Learning in das Medizinstudium: Erfahrungen im vorklinischen Unterricht mit einer Lehr-/ Lernplattform, in Pöppl S. et al.: Rechnergestützte Lehr – und Lernsysteme in der Medizin, Proceedings zum 8. Workshop der GMDS AG, Computergestützte Lehr – und Lernsysteme in der Medizin, Universität zu Lübeck, 25-26 März 2004, Shaker Verlag, Aachen 2004.
6. Siegert M. et al.: Integration computer-basierter Lehrmaterialien in das Curriculum der Radiologie, in Pöppl S. et al.: Rechnergestützte Lehr – und Lernsysteme in der Medizin, Proceedings zum 8. Workshop der GMDS AG, Computergestützte Lehr – und Lernsysteme in der Medizin, Universität zu Lübeck, 25-26 März 2004, Shaker Verlag, Aachen 2004.
7. Dugas M., Demetz F., Christ F.: Online-Kurs Notfallmedizin: Kurrikulare Integration von Computer-based Training, Anaesthesist, 49: 881-886, 2000.
8. Leong S. L., Baldwin C. D., Adelman A. M.: Integrating Web-based Computer Cases into a Required Clerkship: Development and Evaluation, Academic Medicine, 78: 295-301, 2003.
9. Cook D.: Lecture on Simulation in medical education, Proceedings of the Conference of the association for medical education in Europe, 14-18 September 2008, Genua, Italy 2008.
10. Poulton T., Fors U., Fischer M., Davies D., de Leng B., Huwendiek S., Muntean V., Roterman I., Balasubramaniam C.: The European electronic Virtual Patient programme – the story so far, AMEE Conference 2008 Abstract, 2008.
11. www.virtualpatients.eu
12. Rourke L., Anderson T., Garrison D. R., Archer W.: Assessing Social Presence In Asynchronous Text-based Computer Conferencing, Journal of Distance Education, ISSN: 0830-0445, 2001.
13. Singh H.: Building Effective Blended Learning Programs, Educational Technology, 43:6, 51-54, 2003.
14. Heyer S.: Didaktische Szenarien und deren Verhältnis zu Lernmaterialien, Forschungsberichte des Fachbereichs Elektrotechnik & Informationstechnik, ISSN: 0945-0130, Fernuniversität Hagen, 2006 (www.fernunihagen.de/etit/fachbereich/forschung/index.html).
15. Huwendiek S. et al.: Curricular integration principles of virtual patients: a focus group study among students, 2008, Manuscript in preparation.
16. Khan B. H.: A Framework for Open, Flexible and Distributed Learning, Proceedings of the Technological Education and National Development Conference “Crossroads of the New Millenium”, 2nd, 8-10 April, 2000, Abu Dhabi, United Arab Emirates, 2000.
17. Bowen J. L.: Educational Strategies to Promote Clinical Diagnostic Reasoning, N Engl J Med, 355: 2217-25, 2006.
18. Ark T. K., Brooks L. R., Eva K. W.: The benefits of flexibility: the pedagogical value of instructions to adopt multifaceted diagnostic reasoning strategies, Medical Education, 41:3, 281-287, 2007.
19. Gruppen L. D., Frohna A. Z.: Clinical Reasoning, in: Norman, Geoffrey R.: International handbook of research in medical education, Kluwer Academic Publishers, Dordrecht 2002.

Appendix A:

Student questionnaire concerning the integration of virtual patients

Dear Students,

We want to know how well virtual patients are integrated and aligned with corresponding teaching events such as lectures, small group work, online discussions etc. related to virtual patient topics.

Please respond using the following 5-point scale: 1) strongly disagree, 2) disagree, 3) neutral, 4) agree and 5) strongly agree, 6) not applicable). Please indicate briefly the reason(s) for your response for each question (optional).

Characteristics of respondents:

Your age (in years):
Your gender:
(male/female)

A Teaching presence

Categories: Organization (Information, time allocation and sequencing, co-ordination of content, assessment, accessibility/flexibility) and facilitation

Information:

1. I felt well informed about how the virtual patients were integrated into this course.

Time allocation and sequencing:

2. The chronological order of the virtual patient work and the corresponding teaching events was well thought out.
3. The time spent on the virtual patients was well balanced with the time spent on the corresponding teaching events.

Co-ordination of content:

4. The content of virtual patients and the corresponding teaching events complemented each other well.
5. The corresponding teaching events gave me an insightful learning experience, which I would not have had from the virtual patients alone.

Assessment:

6. I think that learning with the virtual patients is important in order to do well in the final exam for this course.

Accessibility/flexibility:

7. I had easy access to the virtual patients at my convenience.

Facilitation:

8. The teachers helped me to assess my learning during the corresponding teaching events
9. The teachers facilitated the further development of my clinical reasoning skills during the corresponding teaching events.
10. The teachers were well prepared for the corresponding teaching events (incl. familiarity with the virtual patients).

B Cognitive presence

11. I was actively involved in critically weighing pros and cons for explanations given by other students during the corresponding teaching events.
12. I was actively involved in applying my newly gained insights in clinical reasoning, during the corresponding teaching events
13. I was actively involved in refining my clinical reasoning skills during the corresponding teaching events.
14. The quality of discussion during the corresponding teaching events was good.

C Social presence

15. I felt secure enough to openly discuss even my shortcomings (e.g. my mistakes while working with virtual patients) during the corresponding teaching events.
16. I felt a positive climate for learning during the corresponding teaching events.
17. I felt like part of a 'community' during the corresponding teaching events.

D Learning effect

18. The combination of virtual patients and corresponding teaching events enhanced my clinical reasoning skills.
19. The combination of virtual patients and corresponding teaching events made me feel better prepared to care for a real life patient with this complaint.

E Overall judgement of the course

20. Overall, the combination of virtual patients and corresponding teaching events was a worthwhile learning experience.

F Open-ended questions

21. Special weaknesses of the overall virtual patient integration into this course:
22. Special strengths of the overall virtual patient integration into this course:
23. Please describe how an ideal integration of VPs would look like in this context, from your point of view:
24. Any additional comments:

Thank you very much!

Appendix B:

Reviewer Checklist
Curriculum Integration of Virtual Patients

Name of reviewer:

Institution:

Date:

Definition of VP-session:
Teaching session in which students work through virtual patients (VPs).
(Could be self-study, seminars, small group sessions...)

Definition of Corresponding Teaching Event (CTE):
Teaching event which corresponds to a VP session, without directly working with a VP case.
(Could be a lecture, seminar, group study, bedside – teaching, high fidelity simulation…)

Course Design

1. VP Session & Corresponding Teaching Event Scenarios:

A	VP session without a corresponding teaching event Total number of VPs available: Comments:
B	VP session after a corresponding teaching event Number of VPs used in each session: Comments:
C	VP session before a teaching event Number of VPs used in each session: Comments:
D	VP work as summative assessment Total number of VPs used: Type of assessment: Comments:
E	Other use of VPs: – Total number of VP's used: – Comments:
2. Co-ordination of Content	Did the corresponding teaching event inspire the creation of artefacts for the VP session? If so, what kind of artefact? e.g. Notes: Charts/graphs:
	Did the VP session inspire the creation of artefacts for the corresponding teaching event? If so, what kind of artefact: e.g Notes: Charts/graphs:
	Time allocation: What _____ % was spent in VP sessions? What _____ % was spent in a CTEs?

3. Type of VP Session

	Individual Study	Pair Study	Small Group	Seminar	Other
A					
B					
C					
D					
E					

4. Type of Corresponding Teaching Event

	Lecture	Seminar	Small Group	Bedside	Other
A					
B					
C					
D					
E					

5. Communication:
During the VP session:

Instructor – student:

	CMC Synchronous	CMC Asynchronous	Face to Face	None
A				
B				
C				
D				
E				

CMC = Computer Mediated Communication

Student – student:

	CMC Synchronous	CMC Asynchronous	Face to Face	None
A				
B				
C				
D				
E				

During the corresponding teaching event:

Instructor – student:

	Face to Face	CMC Synchronous	CMC Asynchronous	Other
A				
B				
C				
D				
E				

Student – student:

	Face to Face	CMC Synchronous	CMC Asynchronous	Other
A				
B				
C				
D				
E				

6. Education of staff	Was training offered for CTE Teachers: Yes / No What kind? – Workshop – Written material – Other: Content of training?
	Was training offered for CMC Teachers: Yes / No What kind? – Workshop – Written material – Other: Content of training?
	Was training offered for VP-Session Teachers: Yes / No What kind? – Workshop – Written material – Other: Content of training?
7. Accessibility/ Flexibility	Student access to VPs: Location: From any computer on campus? Only from certain computers? From remote computers? Time: 24 hour access Access during specified hours Access only during VP session
8. Summative assessment of VP content:	What kind of assessment: MCQ: Short Menu questions: Long menu questions: OSCE: Other:
9. Summative assessment of VP content by VPs	What kind of VP assessment questions: MCQ: Short Menu: Long menu: Other: Please describe how VPs are used for assessment:
10. Intended target group:	Medical student in the ____th year Resident's training: Continuing medical education: Other:
11. Main learning objective (e.g. clinical reasoning, communication):	
12. Description of scenario(s) in own words (if needed):	

VP-Curricular – Integration-Checklist

Please respond using the following 5-point scale:
1) strongly disagree, 2) disagree, 3) neutral, 4) agree and 5) strongly agree, 6) not applicable/do not know.
Please use the comment field whenever you feel unsure concerning the question's meaning or for additional feedback.

Example:
The content of the VP is relevant for the exam.
Do not agree at all – --- – totally agree, not applicable
1 2 3 4 5 6
Comment:

A. Teaching presence
(Categories include: Information, Time allocation and sequencing, assessment, accessibility/flexibility, facilitation)

Information
13. Students receive sufficient information about the way VPs are integrated into the course. How are the students informed? [free text]
14. Students are informed about which VP sessions correspond to which teaching events.
15. Students are informed about the possibility of discussing with other students and teachers via an online discussion forum, online chat, or email.

Time allocation and sequencing
16. Students had fixed blocks of time in their schedule for the VP sessions.

Co-ordination of content (Applicability of these questions depends on questions 3 and 4.)
17. When CTE is after VP session:
The CTE is effective for refining students' clinical reasoning of topics addressed in the VP session. Why? [free text].
18. When CTE is after VP session:
Students are asked to make an artefact during the VP session which can be used or discussed in the following CTE.
19. When CTE is before VP session:
Students are asked to make an artefact (e.g. taking notes) during the CTE which they can use during the VP session.
20. When VP session alone:
The VP session is effective in refining students' clinical reasoning skills regarding topics addressed in the VP.
Why? [free text]
21. The content and structure of VPs and "corresponding teaching events" were co-ordinated and implemented in a way to create the most meaningful use of time.
Explain why if you agree:

Assessment
Virtual patient learning objectives, instruction and assessment are well aligned, in terms of content and methods.
(Concept of constructive alignment, Biggs 1996).

Facilitation
23. Teachers are taught how to provide elaborated feedback on students' clinical reasoning skills during face to face sessions. If Yes: How?
24. Teachers are taught how to provide elaborated feedback on students' clinical reasoning skills online.
25. Teachers are taught to encourage students to create a short summary of the patient's problem using medical terms.
26. Teachers are taught to encourage students to interpret the data presented critically.
27. Teachers are taught to encourage useful reading habits (e.g. students should read comparatively about at least two diagnostic hypotheses of a VP).
28. Teachers are taught to use special questioning strategies (e.g. open-ended questions) to reveal the developmental level of the student concerning clinical reasoning skills.

B. Cognitive presence
29. Teachers are taught to ask students explicitly about which findings support or refute each diagnosis in the differential diagnosis during the corresponding teaching events or VP sessions.
30. Teachers are taught to ask students to discuss clinical reasoning concerning the VPs with other students and/or a teacher during the during CTE or VP sessions.
31. Teachers are taught to ask students explicitly, to discuss clinical reasoning concerning the VPs with other students and/or a teacher during CTE or VP sessions.
32. The mix of VP-sessions and corresponding teaching events is well suited to stimulate discussions on clinical reasoning.

C. Social presence

3. Teachers are taught how to create a good climate for learning.
(e.g. eye contact, relaxed body posture, using gestures, smiling, humour, addressing students by name, praising students work, Rourke et al. 2001)

D. Learning effect (Category included: Learning success)
34. Overall, the combination of VP sessions and corresponding teaching events is very well suited to foster clinical reasoning in the target group.
35. Overall, the combination of VP sessions and corresponding teaching events is very well suited to prepare a student of the target group to care for a real life patient with this complaint.

E. Overall judgement
36. Overall, the combination of VPs sessions and corresponding teaching events is very well suited to enhance learning in the target group.

F. Open-ended questions
37. Special weakness of the of the overall VP integration:
38. Special strengths of the of the overall VP integration:
39. Other comments:

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 45

EVALUATION INSTRUMENTS TO SUPPORT EDUCATORS IN MAKING DELIBERATE CHOICES WHEN THEY USE VIRTUAL PATIENTS TO TEACH CLINICAL REASONING

Bas de Leng[1], Jeroen Donkers[1], Cecilia Brasch[2], Sören Huwendiek[3], Andrzej A. Kononowicz[4]

[1]Maastricht University, The Netherlands
[2]Heidelberg University, Germany
[3]University Children's Hospital Heidelberg , Germany
[4]Faculty of Medicine, Jagiellonian University, Poland

contact author: Bas de Leng, b.deleng@educ.unimaas.nl

Virtual patients can be seen as computerized problem-solving cases in which the user can 'virtually' explore and intervene with the health problems of a patient. The literature on computerized problem-solving programs and multimedia games tells us that features like structure, prompts for reflection, and feedback have great influence on the learning effect of these tools (Davis & Linn, 2000; Fund, 2007; Moreno & Mayer, 2005). These features make it possible to place complex authentic tasks within a learner's 'zone of proximal development' (Hmelo-Silver, Duncan, & Chinn, 2007).

In order to use virtual patients effectively in medical education, the aforementioned pedagogical knowledge has to be translated into the designs of our virtual patients. Extensive translational research at the practitioner level could add substantially to the limited knowledge we have about the affordances and limitations of virtual patients for teaching clinical reasoning. With this goal in mind we developed, within the European e-ViP project, two evaluation instruments to support design-based research concerning virtual patients: (1) a comprehensive checklist enabling reviewers (e.g. teachers, authors) to characterize the design of a virtual patient in detail, and (2) a concise student questionnaire assessing their experiences with virtual patients for learning clinical reasoning.

The checklist (in English) and the student questionnaire (in English, German, Swedish, Polish, Romanian, and Dutch) are implemented as web-based forms that are fed into a secured database. The forms are each linked to a unique virtual patient from the eViP virtual patient repository. Both student responses and teacher\author reviews are reported back per virtual patient to authorized users.

Davis, E., & Linn, M. (2000). Scaffolding students' knowledge integration: Prompts for reflection in KIE. International journal of science education, 22(8), 819-837.

Fund, Z. (2007). The effects of scaffolded computerized science problem-solving on achievement outcomes: a comparative study of support programs. Journal of Computer Assisted Learning, 23(5), 410-424.

Hmelo-Silver, C., Duncan, R., & Chinn, C. (2007). Scaffolding and achievement in problem-based and inquiry learning: a response to Kirschner, Sweller, and Clark (2006). Educational Psychologist, 42(2), 99-107.

Moreno, R., & Mayer, R. E. (2005). Role of guidance, reflection, and interactivity in an agent-based multimedia game. Journal of Educational Psychology, 97(1), 117-128.

Keywords: VP design, evaluation, good practice

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 46

EVALUATION OF A DENTAL SIMULATOR

Marjoke Vervoorn[1], Dirk Bakker[1]

[1]Academic Centre for Dentistry in Amsterdam, The Netherlands

contact author: Dirk Bakker, secretariaatprekliniek@acta.nl

For a virtual patient that can be trade by a dental student, the patient must have the following opportunities: haptic feedback, 3-d imaging, realistic feedback of transformation of forces into recognizable visualization of processes, 3-d imaging of tools passing through 3-d images. Up till now no system is built for dental education that integrates all these opportunities into a realistic learning environment. In the current preclinical training, practicing is restricted to non-realistic procedures on phantom heads with plastic teeth. Now a simulator has been developed to replace these traditional lab conditions. Such a simulator offers the opportunity to let students from the beginning develop the required competencies learning in an almost realistic environment. Such a simulator would only be accepted as a (preclinical) training tool if the level of realism of the system is close to the clinical reality. Therefore a pilot study has been carried out on the perception of teachers and general practitioners about the level of realism of the simulator.

Keywords: evaluation dental simulator preclinical traning

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 47-50

APPLICATION IN VP SYSTEMS INDIVIDUALIZATION OF DISTANCE LEARNING PROCESS USING STUDENT'S PSYCHOLOGICAL PROFILES OBTAINED BY MEANS OF ARTIFICIAL INTELLIGENCE METHODS

Ryszard Tadeusiewicz

AGH University of Science and Technology, Krakow, Poland

Abstract: One of most important advantages in the learning process using VP application is possibility of full individualization of learning path for every particular student. A typical distance learning system has many multimedial utilities, as well as valuable additional elements as self-control tools for student, integration with modern distance learning platform (e.g. *Blackboard*) – but often lacks elements necessary for proper individualization of learning process. It means that despite of interactive possibilities of a computer system, every student must perform the learning process in a uniform way (perhaps faster or slower). In the VP based learning systems a learning process is in fact a kind of exploration. Student not only learn the knowledge – he discover it by himself. Of course this discovery process is controlled and supervised, but the most essential advantage of the VP use are related directly to this virtual research performed by the students instead of simple learning. It is also evident, that such methods of knowledge collecting must be adapted for individual properties and preferences of a particular student. It should be performed automatically by the computer supervising VP based knowledge discovery process. It requires an identification of the student's psychological properties during the learning process. It is not an easy, however, a feasible approach. The author proposes a novel methodology of simultaneous teaching and identification process based on a student's behavior during the learning. The computer system can evaluate selected parameters characterizing student's individual psychology. The extracted psychological parameters are subsequently used, as a feedback, for the selection of optimal teaching methods for given VP.

Keywords: distance learning, artificial intelligence, virtual patients, students psychological parameters

Introduction

Distance learning and teaching methods, especially VP based, are very useful tool for the effectiveness of medical education process and the economic vitality. It explains why almost every university around the world tries to include the VP technology to the distance learning facilities as an important element in whole medical education process. However, from the point of view of the learning psychology and teaching methodology, one of the most valuable aspects of VP based distance learning is individualization of the learning process. In the VP based learning systems a learning process is always in fact a kind of exploration. Student not only learn the knowledge – he discover it by himself using VP as a tool and as a exploration area. Of course this discovery process has to be controlled and supervised, because necessity of assure proper direction of learning and complete all planed learning goals. It means, that the goal of this simulated discovery process must be pointed very precisely, but the way to this goal can be different for every particular student.

Taking into account that the most essential advantage of the VP use are related directly to this virtual research performed by the students instead of simple learning we must strive toward combining full (almost) freedom of research activity of the student with very precisely determined final goals. It is also evident, that such methods of knowledge collecting must be adapted for individual properties and preferences of a particular student. It should be performed automatically by the computer supervising VP based knowledge discovery process. It requires an identification of the student's psychological properties during the learning process. It is not an easy, however, a feasible approach. The author proposes a novel methodology of simultaneous teaching and identification process based on a student's behavior during the learning. The computer system can evaluate selected parameters characterizing student's individual psychology. The extracted psychological parameters are subsequently used, as a feedback, for the selection of optimal teaching methods for given VP.

Interaction during the learning process

Computer is an interactive tool so the teaching program can adapt the methods of communication with a student and the teaching material presentation on the basis of feedback obtained from the student during the learning process. However, in most practical applications of distance learning process this advantage is not utilized at all, or only on a marginal scale, because of difficulties in acquisition of necessary data from the student. We can easy obtain the information about the student's knowledge. However, the data about the student's psychological portrait, the type of his or her personal preferences in teaching methods (e.g. deductive or inductive), perceptional abilities, and may other important features, are usually not recorded although they are the key factors for really successful learning process.

The paper deals with a problem of ensuring high quality of learning in the Virtual Learning Environment. One of the crucial factors is how the knowledge is delivered by the system to the student. The designers of a contemporary LMS try to implement some individualized solutions based on tracking one's learning path or offering different starting levels depending on the students' prior knowledge in the field being taught, but the way of presenting the material usually remains the same. On the other hand, psychological theory of learning indicates that everyone has his/her individual learning style which influences the way new skills and knowledge are acquired. It means that during the distance learning, we need the data about the psychological portrait of every particular student, because only on the base of such data, we can assure optimal adaptation of the teaching process (performed automatically!) to the individual abilities of every student.

In this paper, we propose a new method of discovery of the student personality parameters encountered during a normal learning process. We construct the adaptive model of the student psychological and perceptional abilities on the base of analysis of student behavior by applying artificial intelligence techniques. The developed method is based on the artificial intelligence and treats problem of identification of students psychology as a pattern recognition problem. Using pattern recognition methods, genetic algorithms, fuzzy logic methods and neural networks, we attempt to recognize and/or classify the learning parameters allowing us to establish a student's psychology model. In fact, there are not many detailed models with a substantial number of parameters, because finding and tuning of such model can turn to be too complicated and too cumbersome for the systems under consideration. Hence a rough categorization of students personalities usually suffices. According to such categorization, every particular student can be classified as belonging to one of the selected didactical models.

Usually, a couple of different teaching methods are defined. Learning objects containing small pieces of information stored in various forms (text, graphics, video clips) create the repository called a base of knowledge. A heuristic chooses the appropriate objects corresponding with teaching method most suitable for one's individual learning preferences and generates a course material. By applying different way of teaching to every didactic model of a student's personality, we obtain better results in distance learning by the higher level of teaching individualization.

We present an outline of such heuristic construction as well as proposed teaching methods. Its usability will be analyzed by the results of a questionnaire posted online to students at Universities in Poland where a central coordination of the distant education takes place and allows for such type of studies.

Individualization as the Key Feature of Good Teaching and Learning Process

Every e-learning application has a goal of providing powerful, useful and user-friendly tools to all students, which can be used by the students as the method for obtaining, collecting and memorizing all necessary knowledge. This goal is nearly to achieved. In fact, computer-based teaching materials become better and better and the e-learning process usually is both pleasant (because of interesting multimedial elements) and effective for students. Nevertheless, nothing is perfect and every good tool can be still enhanced and it is also applicable to e-teaching and e-learning. However, it seems that the most important and most expected improvement of contemporary e-learning tools can be achieved by the means of better individualization of learning process.

Individualization is a very important issue in every education process. Even for teaching and learning performed in traditional form, e.g., by direct contact between "Master" and "Apprentice", individualization is what differs a genius teacher from mediocre one. A good teacher can present knowledge in different form and can penetrate minds of students using different way which depend on individual preferences and individual formation of every particular student.

Using distance learning tools theoretically speaking, it is also possible to achieve individualization of learning process, because computer is an interactive device and we can design an e-learning system with a psychological feedback. We can also design the proper way of best teaching in any particular case if we can recognize a student's psychological profile for every particular case working online. Depending on information obtained from the student's identification module, we can apply different methods of teaching the same knowledge. For example, we can select deductive method of presentation of selected information instead of inductive one – or vice versa. We can also extract suggestion about optimal segmentation of the material by the analysis of student behavior. For some students, it will be better to present teaching material divided into small parts. For others, it is necessary to show a bigger segment because of better tracing of internal dependences between facts and information inside more comprehensive parts of material.

The use of multimedia in computer-based teaching materials should be controlled by psychological feedback. Every human being is different and one student needs many colorful, animated and graphically advanced presentation for achieving good result of learning, while other student can be tired and disgusted by superfluous multimedia ornaments, which can be found as noises.

We can show many other forms of expected individualization of automatic learning and teaching process, but the presented examples are probably sufficient for formulation following conclusion:

Automatic individualization of the teaching and learning process in e-learning systems is highly desired feature, however, it is difficult to develop an automatic system which can support the individualized teaching process according to the assumptions discussed above.

Two Types of Problem for Solving

There are two kinds of difficulties on the way toward intelligent adaptive e-learning systems. One kind of troubles is associated with the individualized presentation of teaching materials. When we decide to use individualized method of teaching, it means huge complication of the learning control module, because for every student must be designed and realized another individual path throw the presented knowledge. Also files containing teaching texts, plots, graphs, and examples must be multiplied and prepared (at least for the same problems) in many different forms – sometimes in biggest parts, and sometimes in smallest pieces, sometime with multimedial decorations, and sometime without – and so on.

However, difficulties with multiple presentation of same teaching items are still smaller in comparison with troubles with the system input. For the individualized learning process, it is necessary to feed the system with the information about didactic abilities and psychological preferences of every particular student.

Knowledge about students psychological profile must be automatically extracted from the observation of student natural behavior during learning process, because rarely anybody accept special psychological test treated as prerequisite element, which would need to be completed before starting of the learning process. Typical student is impatient and busy, therefore he/she wants to begin learning immediately after switching on the teaching program and does not want to accept any psychological testing even if it can speed up his/her learning process.

It means that we must:

- use intelligent methods for observation of a student's behavior during the natural learning process,
- derive additional information from the students answers during self test,
- observe faster and slower reactions of the student in different situations;

and on the base of all such information, we must try establish a hypothetical psychological portrait of a student for using the derived features as a control parameters for optimization of teaching process. All methods can be useful in this case and they are described in the next section.

Students Psychological Profile Building During the Learning Process

The psychological profile of a student is necessary for individualization of the teaching and learning process according to individual abilities and individual preferences (including a non aware cases).

The psychological profile must be automatically generated on the basis of passive observations of the natural student's behavior during learning process. Some student reactions can be intentionally provoked by showing part of teaching material in special form (e.g., a big an more complex part of knowledge is presented very fast without pausing followed by testing the students' understanding of the merit sense of the presented material). Some information may deducted from indirect circumstances (e.g., we can observe the student behavior during answering the tests taking into account not only frequencies of proper and wrong answers, but also fact of the faster or slower reaction of the student).

There are methods of obtaining the data from students behavior, because almost every student's activity can give us additional information abut his/her individual personality. However, every particular observation and every separate conclusion in still insufficient for solving general problem discussed in this paper. The problem is: "how to increase quality of learning process of this particular student?"

Fortunately, we have a good collection of mathematical and computer based methods, ready for answering similar questions. These methods are called artificial intelligence techniques and are really powerful tool for solving classification problems and for building adaptive models even for incomplete and imprecise data.

Artificial Intelligence as a Tool for Reconstruction of Students Psychological Profiles

In the situation described in previous section, we need to classify and recognize some objects (in our case: student's psychological profiles) on the base of collections (vectors) of measured parameters, observed features and other extracted data. It is a typical task for the branch of Artificial Intelligence (AI) known as *patter recognition*.

Classification of students having similar preferences and treated by the system by means of similar way of teaching can be also solved by yet another AI method, known as cluster analysis. When we try to predict behavior of student and select (for stressing the social risk of such venture we call it "guess"), which method of teaching will be most successful for achieving desired results of learning and we can use, for example, a Neural Network model for it. Such a model can be useful also for preparing the individual student's psychological profiles on the base of sequence of observations only, because a known property of Neural Networks is power of model forming even if data, on which we try to build our model, are not complete and/or accurate.

Elements and components of psychological profile of students are not described precisely and usually are not in an quantitative form. Fortunately amongst available AI methods, there is Fuzzy Logic, which can be used for describing imprecise and qualitative dependences, similar to the natural language descriptions but fully compatible with computer methods and calculations models.

Last but not least, we can take into account possibilities of getting help from the artificial evolution and genetic algorithms (GA). In forming student psychological profiles, GA-based approach can be very useful as a method of optimization of the matching process since for every psychological feature encountered during observation of student natural behavior during free learning, we must find proper method of teaching process, which can promote better learning and can help in obtaining better correspondence between real students demands and tools offered by e-learning software.

Conclusion

In the paper, we stress dependencies, which need to be established between methods offered by e-learning systems and psychological demands of particular students, who may be very different. Good adaptation of teaching methods to the psychological portrait of every particular student is a key issue in a desired individualization of learning process for e-learning.

Easier (although not trivial one) part of the problem is associated with the method of proper adaptation of the teaching method to the personal preferences of every particular student. It requires a lot of work, because we can build many streams of knowledge transmission, many paths of individual studying, and many alternative forms of explanation of the same facts and the same information. However, with a bit of imagination how to achieve necessary teaching condition and knowledge of our goals, we can design a really good tool for adaptive teaching.

A more complicated problem is with the input for the proposed closed loop of feedback control of the e-learning process. This problem is more complex and more research need to take place in this particular area before it is possible to implement. This paper proposes that shaping the psychological portrait of the student, who actually learn by means of a developed system, can be done by observations of natural activities of the student. It can be used to make a model of the student psychological features of particular students using Artificial Intelligence methods.

The presented idea is explored by the author and group of his co-workers on the base of observation and optimization of e-learning and e-teaching processes at some Polish Universities now.

References

1. Chrząszcz A., Gaś P., Kusiak J., Tadeusiewicz R., "Learners-Teachers on-line Mutual Support", New Challenges and Partnerships in an Enlarged European Union – Proceedings of the EDEN Annual Conference, Budapest 2004, pp. 522-527.
2. Kushtina E., Zaikine O., Rozewski P., Tadeusiewicz R., "Conceptual Model of Theoretical Knowledge Representation for Distance Learning", Beyond the Network – Innovative IT-Services, EUNIS 2003, Universiteit van Amsterdam 2003, pp. 239-243.
3. Kusiak J., Tadeusiewicz R., "Virtual versus Classical Learning and Teaching. Conflict or Mutual Strengthening?", New Horizon in Web-based Learning, World Scientific, London-Singapore-Beijing 2004, pp.171-179.
4. Tadeusiewicz R., "Spreading of Roles and Functions Between Man and Computer in Virtual Learning and Teaching Systems", Wissenschaft und Kunst für Europa, Publikationen der Societas Humboldtina Polonorum, Band 10, 2005, pp. 79-104.
5. Tadeusiewicz R., "Virtual Teaching on the Basis of Experiments in Computer-Assisted Instruction at the University of Mining and Metallurgy of Cracow". Higher Education in Europe, UNESCO CEPES, Vol. XXVI, nr 4, 2002, pp. 553-566.
6. Tadeusiewicz R., "Technical Education and the Demands of the Information Community – The opening paper for the 23rd Polish Engineers Congress", Foundry Survey, nr 2, 2002, pp. 45-50.
7. Zaikine O., Kushtina E., Rozewski P., Malachowski B., Tadeusiewicz R., Kusiak J., "Polish experience in the didactical materials creation: the student involved in the learning/teaching process", IT Innovation in Changing World, Proceedings of the 10th International Conference of European University Information Systems, University of Ljubljana 2004, pp. 428-43.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 51-55

IMPLEMENTATION OF THE MEDBIQUITOUS STANDARD INTO THE LEARNING SYSTEM CASUS

INGA HEGE[1], ANDRZEJ A. KONONOWICZ[2], MICHAEL PFÄHLER[1], MARTIN ADLER[3], MARTIN R. FISCHER[4]

[1]Medical Didactic Unit, University of Muenchen, Ziemssenstr. 1, 80336 Muenchen, Germany
[2]Jagiellonian University, Department of Bioinformatics and Telemedicine ul. Kopernika 7e, 31-034 Krakow, Poland
[3] Instruct AG, Lindwurmstr. 25-27, 80337 Muenchen, Germany
[4] Private University Witten-Herdecke, Alfred-Herrhausen-Str. 50, 58448 Witten, Germany

Abstract: E-Learning applications such as electronic virtual patients (VPs) are an indispensable component of modern medical curricula. The eViP project is a 3-year programme co-funded by the European Union to create a bank of repurposed and enriched multicultural virtual patient cases from across Europe.
One of the deliverables of this project is to implement the MedBiquitous Virtual Patient (MVP) standard within the four included VP systems in order to support the exchange process. The linear learning system Casus® is part of eViP and has implemented an export and import functionality for MVP conformant VPs. The challenges we faced during implementation were the inclusion of assessment items – a crucial part of Casus cases – and the import of branched VPs without loss of information.
The experiences and results of exchanging VPs based on the MVP specification will provide valuable information for future projects in this area.

Keywords: MedBiquitous standard, eVIP, CASUS, Virtual Patient

1. Background

E-Learning applications such as electronic virtual patients (VPs) are an indispensable component of modern medical curricula. It has been shown that people learn more efficiently and faster by using such applications under certain conditions and demonstrate better knowledge retention.[1,2] It can be time-consuming, expensive and complicated to produce sophisticated VPs.[3] An important step might be to try to enhance the exchange of VPs among medical faculties and the VP systems integrated there. The question arises, if exchanging is a more efficient way to produce VPs than creating them from „scratch". The results of a EU wide project in sharing electronic cases in occupational medicine (NetWoRM – Net based Training in Work-Related Medicine)[4] offers promising results concerning this repurposing VPs within one learning system. The electronic virtual patients project (eViP) reported here goes one step forward with the repurposing of VPs across different learning systems.

EViP (electronic virtual patients) project[5]

The eViP (electronic virtual patients) project is a 3-year programme co-funded by the European Union to create repurposed and enriched multicultural virtual patient cases from across Europe. The programme officially started in September 2007 and is due to finish in September 2010. More than 300 VPs have been collected and will be exchanged, enriched, adapted and integrated into the curricula of the participating faculties by the end of the project.

One of the programme aims is to support sharing of Virtual Patients by enabling each system within eViP to export and import their Virtual Patients in a common technical standard developed in collaboration with MedBiquitous.[6]

Within eViP four different VP systems (Campus, Casus, OpenLabyrinth and Web-SP), are collaborating to support the exchange of VPs among their systems technically. The systems are different concerning educational approach, educational scenarios and structure model.

The VP structure models can be classified as follows:

- Linear VP systems, like Casus, guide the learner through a case. This model enables the learner to access all information provided by the case author in a structured way.
- Semi-linear VPs, like Web-SP and Campus, provide the student with the possibility to arbitrarily select interview questions, laboratory tests, physical and technical examinations from an extensive list of predefined concepts and options. A case may be comprised of many linearly ordered free-choice states regarding different stages of the patient treatment process. Cases in a semi-linear model are usually created by modifications of comprehensive templates of standard answers and results.
- Branched VPs, like OpenLabyrinth, offer the learner to make choices at key scenario points. The learner can take whichever path he wants to complete a VP.

MedBiquitous Virtual Patient (MVP) specification

Standards are an important aspect of e-learning and offer the opportunity for collaboration.[7] The MedBiquitous Consortium established a virtual patient working group in 2005 which developed the XML-based MedBiquitous Virtual Patient (MVP) data specification. This specification enables the exchange and reuse of VPs across different systems.

The following are the main components of the MVP architecture (figure 1):[8,9]

The **VirtualPatientData (VPD)** provides the personal and clinical data that is relevant to the clinical scenario being simulated. The VPD contains data elements and some kind of structure that corresponds to the medical history, physical and technical examination and therapy.

The **DataAvailabilityModel (DAM)** specifies the aggregation of the VPD and MR elements for exposure through the AM. VPD and MR elements can be reused in this context in multiple DAM nodes controlling the way that data aggregations such as patient histories or test results are displayed.

The **ActivityModel (AM)** encodes what the learner can do and how he may interact with the virtual patient. By creating available paths through the content using interconnected nodes and controlling how the user can follow them using a simple rule system, a great variety of virtual patient activities are possible. The AM provides the contexts in which they are exposed to the learner.

Media Resources (MR): Media resources like images, animations, videos and audio files associated with the virtual patient are referenced either in the DAM or in the VPD elements. IMS Content Packaging is used to structure media resources within the MVP specification and provide unique identifiers for each media resource.

The metadata of a VP are implemented using the Learning Object Metadata (LOM) standard, which was published in 2002 by the Institute of Electrical and Electronics Engineers (IEEE).[10] Within the eViP project a subset of metadata fields from the LOM has been selected to characterise the exchanged virtual patient packages. An eViP profile of the IEEE LOM is being discussed to address special requirements of virtual patient authors.

Description of Casus

Casus® is a software package for authoring and delivering case-based learning based on the pedagogical concept of hypothetical-deductive diagnosing developed by the AG Medizinische Lernprogramme at the LMU since 1993[11] and distributed by the Instruct AG since 2001. Casus has been well

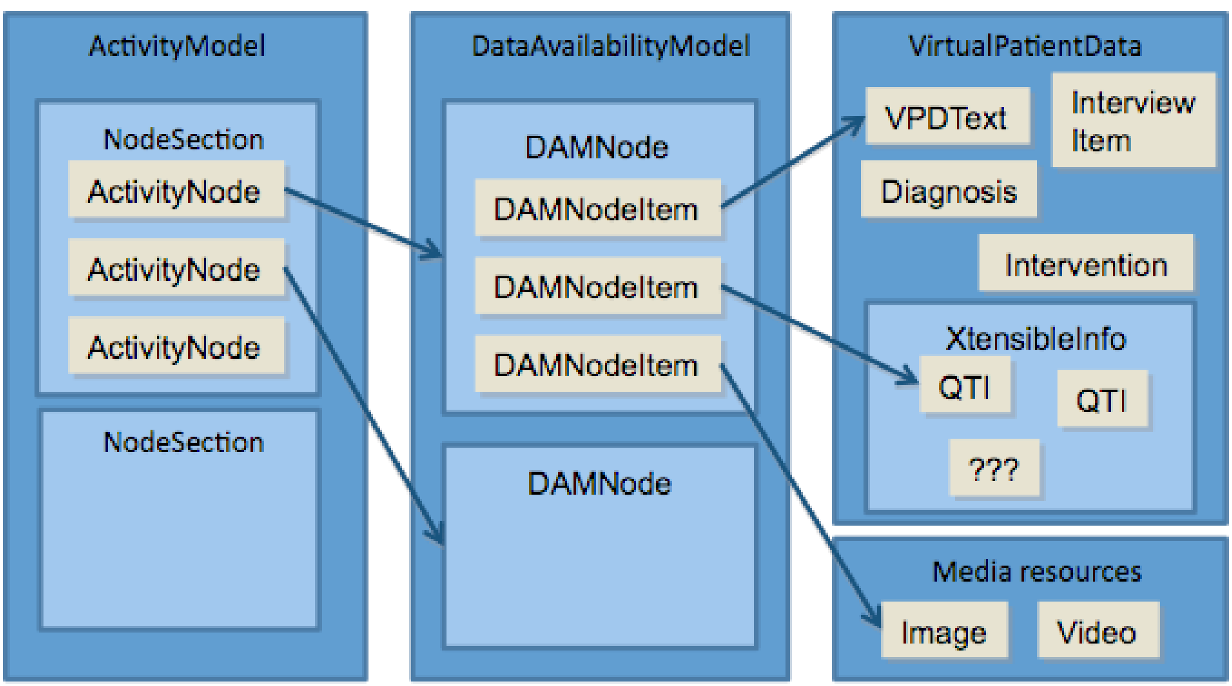


Figure 1: (Simplified) Model of the MVP specification

integrated into the curricula for undergraduate students at different faculties in paediatrics, physical therapy, epidemiology, internal medicine, neurology, radiology, general medicine, surgery, occupational and environmental medicine and medical psychology.[12,13]

Moreover cases designed with Casus are applied for continuing medical education (CME) scenarios.

A Casus VP or case usually presents the story of a real patient history organized in didactic units with findings and management. This linear approach reflects established clinical practice. About 5 (short case) to 25 (long case) screen cards form a learning case. Each card represents a variable combination of text elements with hyperlinks, multimedia material, expert comments for additional information and, most importantly, interactive elements such as eight different question types with immediate evaluation of student responses and a detailed answer comment. The question types include multiple choice (MC), freetext, sorting, mapping, a differential diagnostic reasoning tool and long menu. If enabled by the course instructor, students can contact the case author via asynchronous communication and discuss questions and problems they encountered while working through the cases. At the end of each case an online questionnaire pops up to enable students to evaluate the case.

Technically Casus is server-side implemented with Java and all data are stored in an Oracle database. The database layer is realized with Hibernate. On the client-side HTML templates are used.

2. Methods

For enabling Casus to import and export cases conformant to the MVP specification, all elements of the specification are implemented as Java classes. For the creation and import of the xml files Castor[14] has been used. Castor is an Open Source data binding framework for Java. It provides Java-to-XML binding, Java-to-SQL persistence, and more.

When converting a Casus case into a MedBiquitous conformant model the case is loaded from the database, the „CASUS model“ is converted into the „MedBiquitous model“ which then is marshalled to create the appropriate xml files.

The conversion of the Casus into the MedBiquitous model is implemented as follows:

ActivityModel:

The ActivityModel of Casus is straightforward. The chapters and subchapters are implemented as the NodeSections with the cards and answer comments as ActivityNodes. The activity sequence is linear and allows the learner to go either from one card to the next or, if there is an assessment item on this card, from one card to an answer comment and then to the next card.

DataAvailabilityModel (DAM):

The ActivityNodes representing a card as well as the answer comments are grouped by nodes in the DAM. The answer

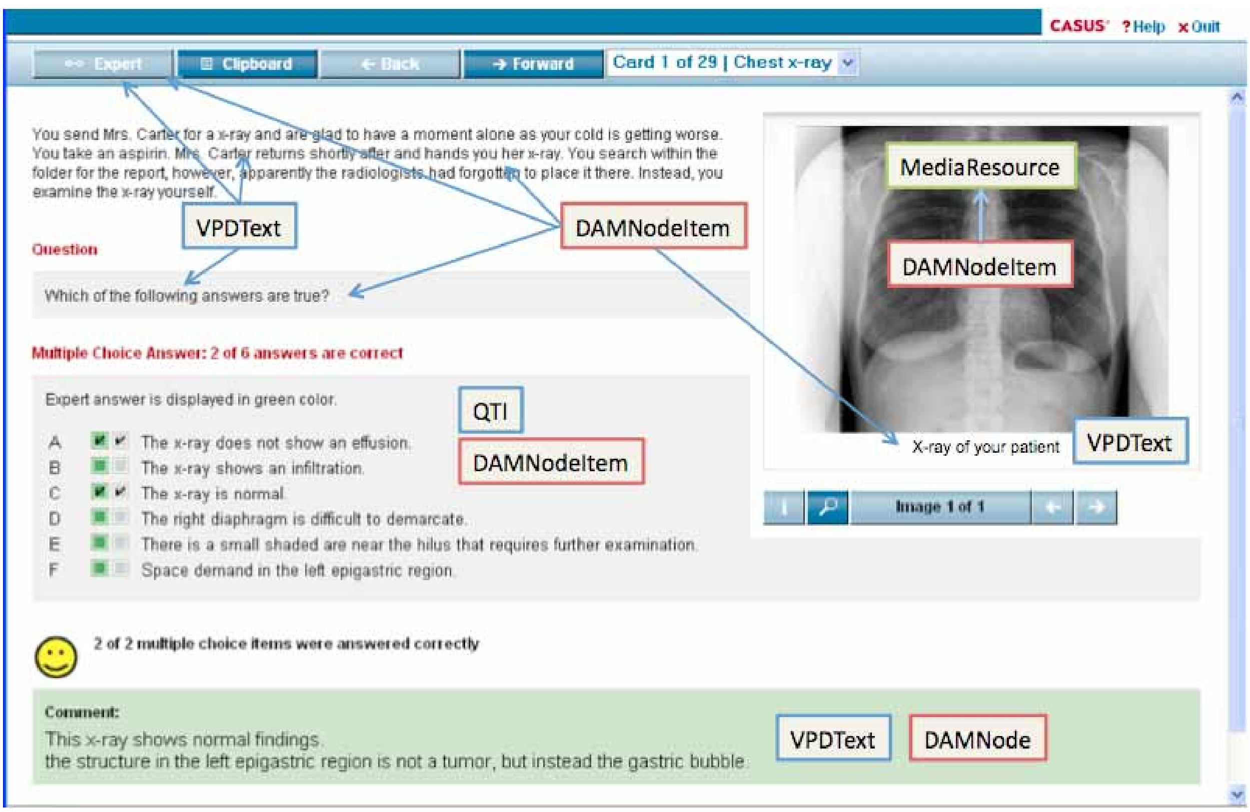


Figure 2: Mapping of a Casus card (= DAMNode) to VPD and DAM components

comment nodes are displayed on trigger only – after the user has submitted his answers.

All elements of a card (info text, question, expert comment, internal hyperlinks, multimedia items, assessment items) are implemented as items of this card node referencing to the media resource or entry in the VirtualPatientData (VPD).

VirtualPatientData (VPD)

The MVP specification allows a detailed classification of the elements in the VPD. For example there are fields for diagnosis, physical examination and medication. But there is also the possibility to add general text elements (VPDText item). The support of context information for text elements, for example whether a text refers to examination or therapy, is not very strong in Casus. Even though such information can be entered by authors for each subchapter, in most VPs this is not a reliable source, so we decided not to divide the text elements on this base. Instead we use the general text element provided by the MVP specification. That means that all text elements of a card including the answer comment are implemented as VPDText items.

For the eight different assessment item types including, for example, multiple choice (MC), freetext, sorting, mapping or long menu the IMS Question & Test Interoperability (QTI) specification is used. This specification was developed by the IMS Global Learning Consortium and enables exchanging questions, answers or complete tests.[15]

The following figure (figure 2) displays the mapping of Casus case elements to the MVP components.

3. Discussion

A major issue is the import of branched VPs into a linear VP structure. Experiences from a manual import of a branched into a linear VP show that it is crucial to support technically the determination of the critical pathway.

To do this several options can be implemented:

- Import the critical pathway (if marked by the original VP system)
- Import the shortest or longest pathway
- Import all nodes and make the correct pathway visible

For option 1 and 2 there will be a loss of information due to the fact that not all nodes are imported. The decision whether nodes of side pathways also contain valuable information for the learner cannot be made by a system automatically, but has to be done by the author after or during the import.

Option 2 does not ensure that all nodes of the correct pathway are included, since the correct one does not necessarily have to be the shortest or longest pathway.

Therefore we decided to import all branches and implement the activity model as directed graph with an optional weighting of edges.

This allows us to import all information and display the pathways for the author so he can decide about keeping or skipping information.

As a first step we display at the end of each card a note containing all possible next cards or if there are no further cards, we mark it as an end node.

The approach developed to import branched VPs can also be applied for semi-linear VPs, so there is no need to implement any additional features.

A second challenge we faced during the implementation period is the integration of questions/answers to the VP package. Because these questions often include important information concerning the progress through the case and are an essential interactive component of a Casus VP, they need to be included in the VP package.

The MVP specification offers the possibility to implement questions with answers as QTI items in the VirtualPatientData. We faced the problems of how to map question types not explicitly implemented in QTI, such as the differential diagnostic network tool from Casus, in such a way that other systems can interpret the QTI item in a meaningful way.

Moreover, QTI was originally designed for an easy conversion of assessment items into HTML via XSL transformation. Hence some of the QTI features are difficult to transform into an object-oriented data model (e.g. POJO) because structural information and HTML blocks are combined.

For example a textEntryInteraction which is used in Casus to model the freetext and cloze question type is required to appear within an enclosing XHTML element (<p>).

4. Future work

Until now the repurposing of the eViP VPs has been done manually (Copy&Paste) without any technical assistance. For the coming two years the repurposing of VPs based on the technical import and export functionality of all partner systems within the eViP project will be continued. A detailed evaluation of this process will determine how effective the technical component is and how this process might be enhanced and improved.

There will be a need to adapt and enhance the currently available interoperability specifications especially for the exchange of assessment items and we will work to reach a consensus on how to deal with the metadata and more complex question types.

The implementation of standards helps to exchange and share VPs among systems.

An important issue which could be supported also by technology standards, is the updating of VPs, a frequently not considered task which is also time-consuming. When sharing VPs among different systems it will become increasingly important to develop a mechanism to exchange and track the updates of a VP as well. For example this could be implemented like a versioning system to track changes from all systems and allow each partner to include updates from other VP copies.

The experiences and results of exchanging VPs based on the MVP specification will provide valuable information for future projects in this area.

5. Acknowledgements

The authors would like to thank the eViP group and the MedBiquitous Virtual Patient working group for their fruitful collaboration and support.

Moreover would like to acknowledge the support of Prof. H. Lyon for revising the paper linguistically.

6. Notes

1 Ruiz J. G., Mintzer M. J. & Leipzig R. M.: The impact of E-learning in medical education, Acad Med., 81(3): 207-12, 2006.
2 Greenhalgh T.: Computer assisted learning in undergraduate medical education, BMJ, 322, 40-44, 2001.
3 Ellaway R., Poulton T., Fors U., McGee J., Albright S.: Building a virtual patient commons, Med. Teach., 30: 170-174, 2008.
4 Kolb S., Reichert J., Hege I., Praml G., Bellido M. C., Martinez-Jaretta B., Fischer M., Nowak D., Radon K., NetWoRM group: European dissemination of a web – and case-based learning system for occupational medicine: NetWoRM Europe. Int Arch Occup Environ. Health, 80(6): 553-7, 2007.
5 http://www.virtualpatients.eu [accessed 12/12/2008]
6 http://www.medbiquitous.org [accessed 12/12/2008]
7 Smothers V., Greene P., Ellaway R., Detmer D.: Sharing innovation: the case for technology standards in health professions education, Med. Teach., 30: 150-154, 2008.
8 http://www.medbiquitous.org [accessed 12/12/2008]
9 Triola M., Campion N., McGee J., Albright S., Greene P., Smothers V., Ellaway R.: An XML-based standard for virtual patients: Exchanging case-based simulations in medical education, AMIA Symposium Proc., 2007: 741-745, 2007.
10 Hodgins W., Duval E., et al.: Draft Standard for Learning Object Metadata, Learning Technology Standards Committee, IEEE, 15 July 2002.
11 Fischer M. R.: CASUS – An Authoring and Learning Tool Supporting Diagnostic Reasoning, in: Use of Computers in Medical Education (Part II), Ch. Daetwyler (Ed.), Zeitschrift für Hochschuldidaktik 1/2000: 87-98, 2000.
12 Fall L., Berman N. B., Smith S., White C. B., Woodhead J. C. & Olson A. L.: Multi-institutional Development and Utilization of a Computer-Assisted Learning Program for the Pediatrics Clerkship: The CLIPP Project, Acad. Med., 80(9), 847-855, 2001.
13 Simonsohn A. B. & Fischer M. R.: Evaluation of a case-based computerized learning program (CASUS) for medical students during their clinical years, DMW, 129(11): 552-6, 2004.
14 http://www.castor.org [accessed 12/12/2008]
15 http://www.imsglobal.org/question/ [accessed 12/12/ 2008]

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 57-63

MARYLAND VIRTUAL PATIENT: A KNOWLEDGE-BASED, LANGUAGE-ENABLED SIMULATION AND TRAINING SYSTEM

Marjorie McShane[1], Sergei Nirenburg[1], Bruce Jarrell[2], Stephen Beale[1], George Fantry[2]

[1]Univeristy of Maryland Baltimore Country, USA
[2]Univeristy of Maryland School of Medicine, USA

Abstract. Maryland Virtual Patient (MVP) is system aimed at training medical personnel in certain aspects of clinical medicine. The user plays the role of attending physician and is tasked with diagnosing and treating virtual patients (VPs), with or without the help of a virtual tutor. Each VP is composed of both a realistically functioning physiological side and a reasoning – and language-enabled cognitive side. The former permits the VP to undergo the physiological states and changes associated with diseases, their treatments, and even unexpected external stimuli, such as clinically counterindicated interventions. The latter permits the VP to consciously experience and reason about its disease state, make decisions about its lifestyle and medical care, and discuss all of these with its attending physician (the user). This paper provides a brief overview of core aspects of MVP.

Keywords: virtual patient, medical simulation, automatic tutoring, knowledge-based systems

1. Overview

Maryland Virtual Patient (MVP) is a knowledge-based, language-enabled simulation and training system whose goal is to provide medical personnel with the opportunity to develop clinical decision-making skills by managing many highly differentiated virtual patients suffering from various diseases and combinations of diseases. The system seeks to offer a breadth of experience not attainable in a live clinical setting over a corresponding period of time.

MVP is modeled as a network of human and artificial agents, as shown in Figure 1.

The human agent, who is typically a medical practitioner or trainee seeking to improve his or her cognitive decision making skills, plays the role of the attending physician. High-level artificial agents include the virtual patient (VP), other medical personnel like lab technicians and specialist consultants, and an automatic tutor. Lower-level artificial agents include both domain-related processes, such as diseases, and control-oriented processes, such as event schedulers.

Users of MVP can interview a VP; order lab tests; receive the results of lab tests from technician agents; receive interpretations of lab tests from consulting physician agents; posit hypotheses, clinical diagnoses and definitive diagnoses; prescribe treatments, like medication and surgery; follow-up after those treatments to judge their efficacy; follow a patient's condition over an extended period of time, with the trainee having control over the speed of simulation (i.e., the clock); receive mentoring from the automatic tutor, if desired; and repeat the management of a given VP using different management strategies to compare their outcomes. The user can launch any intervention available in the system at any time during the simulation, be it clinically justified or not. In the latter case, if the user inadvertently worsens the VP's condition or initiates a new disease process, he must recover from the error in the continuing simulation.

The core artificial agent, the VP, is a knowledge-based model and simulation of a person suffering from one or more diseases. The VP is a "double agent" in that it models and simulates both the physiological and the cognitive functionality of a human (Nirenburg et al. 2008a). Physiologically, it undergoes both normal and pathological processes and responds realistically both to expected and to unexpected (e.g., by user error) internal and external stimuli. Cognitively, it experiences symptoms, has lifestyle preferences (a model of character traits), has dynamic memory and learning capabilities, has the ability to reason in a context-sensitive way, and can communicate with the human user about its personal history, symptoms and preferences for treatment. User-VP communication is carried out in unrestricted English.

Currently, MVP covers 7 diseases of the esophagus. We chose to initially model esophageal diseases because the esophagus is a relatively uncomplicated organ and because one of the symptoms of esophageal disease, chest pain, can

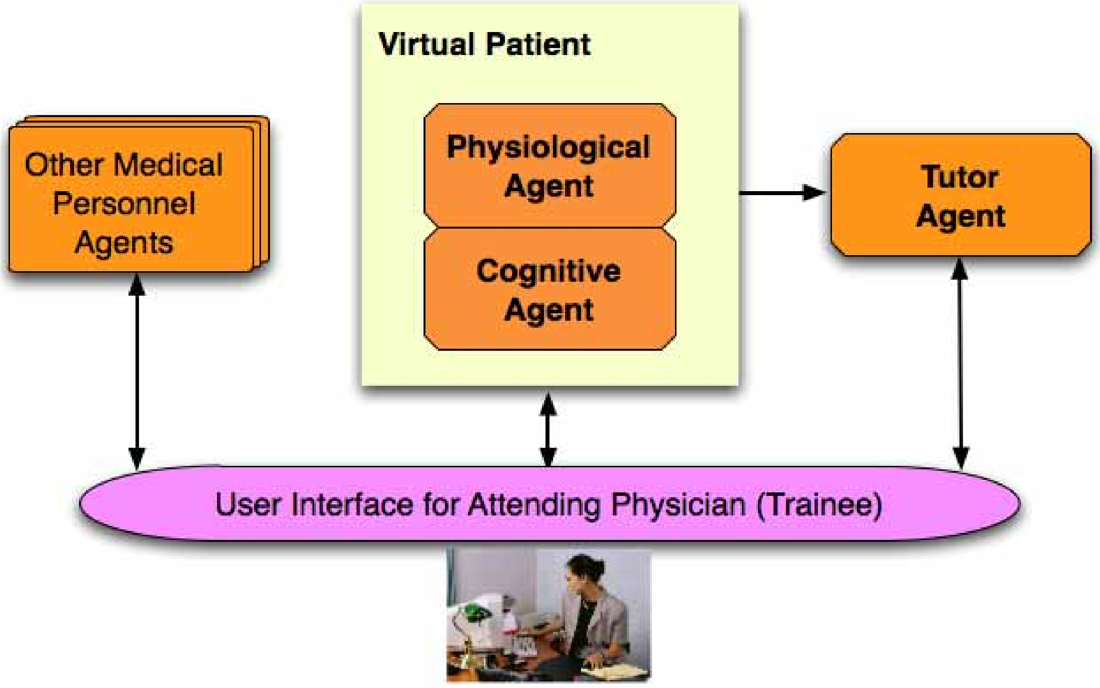


Figure 1. The network of human and artificial agents in MVP.

cause significant diagnostic dilemmas with cardiac disease. All modeling in MVP is done to the grain-size needed to support a realistic simulation. No attempt is made at achieving full coverage of all known medical processes since that endless and amorphous task would stand in the way of practical progress.

A question that frequently arises is, *How can one create unbiased models of aspects of clinical medicine considering that different physicians have different knowledge, experience and opinions?* The answer is that one cannot: a given simulation cannot simultaneously reflect more than one understanding of how things work, and a given tutor cannot simultaneously provide conflicting advice, at least if it intends to help rather than confound the trainee. However, a given *system can* house different models and different tutors, meaning that MVP could include variants 1-*n* of a given disease that reflect the mental models and tutoring advice of *n* different experts.

In the sections below we briefly describe a number of core aspects of MVP, pointing to references that describe them in more detail: the ontological substrate, physiological modeling, modeling best clinical practices, modeling the cognitive agent, and creating a society of VPs. We finish with some concluding thoughts.

2 The Ontological Substrate

The MVP simulation is grounded in an ontologically-defined model of human anatomy and physiology. The ontology, which was initially developed for, and is still used in, the OntoSem language processing environment, is a world model populated by concepts written in a language-independent metalanguage of description (Nirenburg and Raskin 2004). It currently contains around 8,600 concepts – equivalent in overall size to about 135,000 RDF triples – approximately 90% of which are general-purpose. The medical domain has been developed particularly well to support the needs of MVP.

Each object and event concept in the ontology is described by an average of 16 properties, some locally defined and others inherited. Key to the MVP simulation are ontologically recorded complex chains of events that are essentially scripts in the sense of Schank and Abelson (1977). Scripts describe how things typically happen in the world, with all of the relevant temporal and content-related variations on the theme. Examples of high level scripts relevant for MVP include the progression of a disease, the impact of treatments on disease progression, the first visit to a doctor, follow-up visits, and so on. Each high-level scripts breaks down into components scripts, which in turn can have component scripts, eventually ending with singleton events.

3 Physiological Modeling

The VP at the center of MVP is comprised of both normal and abnormal anatomical structures, and can experience both normal and pathological processes. For diseases of the esophagus, the core normal physiological process is swallowing, with its hundreds of component events – nerves firing, sphincters opening and closing, peristaltic muscle contractions moving like waves down the esophagus… Disease processes then affect specific aspects of these anatomical structures and processes.

When modeling a disease in MVP, knowledge engineers help physicians to distill their extensive and tightly coupled physiological and clinical knowledge into the most relevant subset, express it in concrete terms, and hypothesize about unknown and currently unknowable things, like the nature of disease progression at the pre-clinical (pre-symptomatic) stage. The models thus created are dissimilar to anything physicians themselves have ever encountered and anything that is available in the medical literature. It turns out that even outside of any simulation, the models themselves are useful to trainees as a complementary learning resource, as shown by informal training sessions conducted at the University of Maryland School of Medicine.

One of the challenging aspects of medical modeling is that far from all biomechanisms are understood by the medical community. This necessitates a split strategy for modeling: modeling some processes in terms of biomechanistic causal chains, and others using what we refer to as knowledge "bridges", which derive from practical clinical knowledge, situational knowledge, observations and probabilistic methods.

We model using biomechanistic causal chains when the relevant biomechanisms are known and are relevant for our simulation. Let us take a *highly simplified*, *informally rendered* example of a causal chain related to gastroesophageal reflux disease (GERD) (Jarrell et al. 2007):

If a person's lower esophageal sphincter (the sphincter between the esophagus and the stomach) is hypotensive (too loose), acidic liquid from the stomach leaks up into the lower esophagus.

If liquid with a low pH is in contact with the esophagus for too long, the tissue that lines the esophagus can become inflamed.

If excessively low pH in the lower esophagus continues for long enough, the inflamed tissue can begin to erode.

If the erosive process continues for long enough, an ulcer can develop.

If the tissue lining the lower esophagus is inflamed, eroded or ulcerated, and if that tissue is exposed to an acidic substance, the person can experience heartburn.

If damage to the esophageal lining continues for too long, the person can develop esophageal cancer.

If the pH of the liquid in the stomach is raised (as by medication), the refluxing of liquid into the lower esophagus typically has no harmful effects and healing of the tissue occurs: an ulcer heals to an erosion, which heals to the inflammatory stage of the disease, and the inflammation ultimately goes away, leaving normal tissue. Cancer is not reversed by pH-raising medication.

Note that our rules say that things *can* happen because the esophageal lining of different patients reacts differently to acid exposure, with some reactions being far more common than others, of course.

Modeling using biomechanisms is preferable when possible not only because of its verisimilitude but also because it permits the VP to respond realistically even in the face of unexpected interventions (McShane et al. 2007a). For example, say a VP has the esophageal disease Zenker's diverticulum, which involves the upper esophagus and has nothing to do with the lower esophageal sphincter. And say the user mistakenly orders the surgical procedure Heller myotomy, which cuts the lower esophageal sphincter. This will automatically give the patient GERD, meaning that the user will not only have failed to effectively treat the Zenker's diverticulum, he will also have given the patient a secondary disease that must be managed for the rest of the patient's life. There is nothing in the model of Zenker's diverticulum that explicitly says what will happen if a patient suffering from the disease has its lower esophageal sphincter cut; there need not be – Heller myotomy is ontologically described as rendering the experiencer's lower esophageal sphincter extremely hypotensive, and an extremely hypotensive lower esophageal sphincter is ontologically described as giving rise to GERD in humans.

When biomechanisms are not known, or when they are not relevant for our simulation (typically being of a grain-size that will not play a role in the system), we bridge the gaps in the various ways mentioned above. For example, it is currently unknown why untreated GERD progresses to different levels of severity in different patients: some GERD patients never progress past the inflammation stage of the disease, others progress to only to erosion, still others progress to ulcer, and some develop cancer. Until some genetic or other determining factor is discovered, each VP in the system – no matter what its disease – is explicitly provided with a "GERD path" – just as it is provided with a height, weight, race and so on. The GERD path indicates which path the disease will follow if the VP should ever get GERD (McShane et al. 2007b).

Another example of a knowledge bridge is the use of temporal rather than causal chains to model diseases for which causal chains are unknown. One such disease is achalasia, a disease in which the lower esophageal sphincter, over time, becomes hypertensive (too tight), thus rendering swallowing increasingly difficult. This disease is modeled as being composed of 5 conceptual stages that reflect important clinical landmarks. Changes of relevant physiological and symptom-related property values through those conceptual stages, using functions that interpolate values for each moment in time, define the disease path. The changes in values for some properties over time is fixed across patients, while the values for others are variable within a specified range. This means that each disease model is sufficiently constrained so that all VPs suffering from the disease show appropriate manifestations of it (the disease is recognizable), but it is sufficiently flexible to permit different VP instances to present with differing clinical manifestations.

4 Modeling Best Clinical Practices

In addition to disease models, MVP includes models of best clinical practices that permit the automatic tutor to evaluate user moves and provide guidance throughout the management of a patient. These patient management scripts not only cover when it is appropriate to order a given test, procedure or medication – information that can be found in various published manuals – they also include crucial knowledge about the *process* of diagnosing and managing a patient, such as when it is more appropriate to make a generalized hypothesis ("this patient appears to have a motility disorder") than a specific hypothesis ("this patient appears to have the disease achalasia").

There are many capabilities that could be desirable of a virtual tutor, a representative inventory being described in CIRCSIM (Evens and Michael 2006). Developing a maximally robust tutor is not one of the near-term goals of our work, as we are not pursuing predominantly pedagogical issues such as whether or not an automatic tutor should provide hints and if so, when and how. Our plan of tutor development consists of the following three stages.

The Stage I Tutor, which is already implemented, knows the "preconditions for best practice" for hypothesizing each disease, definitively diagnosing each disease, and ordering each test and procedure. This means that each time the user carries out a related move, the tutor can agree with it or not. Tutor responses can be of various types, depending on user settings. The tutor can dynamically show all fulfilled and unfulfilled preconditions for the move, show only unfulfilled preconditions, or simply respond that the move is not valid with no further information. Whether the tutor is enabled or disabled, all of the responses it made or would have made during the session are stored for post-session review. To take one example, if the tutor is enabled and the user decides to order a Heller myotomy but has not yet posited the diagnosis of achalasia, the tutor will block the move and – given the first tutor setting above – will say that the precondition for a Heller myotomy is a definitive diagnosis of achalasia. If the user then immediately attempts to posit a definitive diagnosis of achalasia but has not yet gathered all of the necessary test results to confirm that diagnosis, the tutor will respond, e.g., that although preconditions X and Y have been fulfilled, precondition Z has not… and so on, until the user carries out a sequence of moves, each of which is justified by the user's current state of knowledge about the VP.

The Stage II Tutor, which is under development, must be able to respond to the user's question "What should I do next?" This requires considerably more domain knowledge recorded as diagnosis and treatment scripts because the tutor must be able to select a single one of possibly many valid (according to Stage I knowledge) moves, and it must be able to explain that choice to the user.

The Stage III Tutor will permit the user to ask open-ended questions. Our long-term plans involve enabling the tutor not only to reason over the knowledge in our local knowledge bases but also to detect when outside knowledge is needed. In the latter case, the tutor must be able to find the relevant information on the Web or in some other available digital resource and return it as a targeted English response, not a pointer to some number of potentially relevant articles. This capability is actually not as far beyond the current state of the art as it might sound because of the strong language processing capabilities already available in the system (e.g., Nirenburg and Raskin 2004; Beale et al. 2004; McShane et al. 2008a,b).

5 Modeling the Cognitive Agent

The cognitive side of the VP currently models several aspects of cognitive processing:

- **interoception**, which is the perception of physiological phenomena, such as symptoms, and the interpretation and remembering of such phenomena
- **decision making**, including deciding when to go see a physician, both initially and during treatment; deciding whether to seek help in making decisions related to treatment by asking the user knowledge-seeking questions about a recommended test or intervention; and deciding whether to agree to a recommended test or intervention
- **natural language processing**, including language perception and understanding; this involves interpreting both the direct meaning of physician-user communication in natural language and its intent, deciding on what, specifically, to communicate to the user, and actually generating natural language utterances
- **learning**, which involves receiving from the user new knowledge about the world and the words and phrases used to describe it, and adding them to the ontology and lexicon, respectively (Nirenburg and Oates 2008; Nirenburg et al. 2008b)

We will briefly touch upon each of the above points with the goal of describing *what* the VP can do rather than *how* it does it. A sufficient discussion of the latter would require far more space.

Interoception. Interoception is the perception of physiological phenomena. It is a VP feature that has both physiological and cognitive aspects. The source of interoception is physiological phenomena, like symptoms of a disease, hunger and sleepiness. Here we focus on symptoms of a disease because our disease models to date have not required the tracking other kinds of interoception.

The VP experiences current symptoms of its disease and has memories of past symptoms so that useful comparisons can be made. For example, it might reason (of course, not using natural language), *Symptom X has gotten much worse, I had better go see my doctor sooner than our next scheduled appointment.*

Memories are stored using an ontologically grounded metalanguage that is identical to the one used to represent the meaning of language input. Of course, when memories about interoception are stored, there need be no translation into and from a natural language: the entire process occurs at the level of the metalanguage.

The experiencing of symptoms is individualized for each VP instance through the use of character traits and physiological features. Our current inventory of character traits includes trust (in the doctor's advice), suggestibility (how readily the VP agrees to the doctor's recommendations) and courage (how willing the VP is to undergo tests or procedures even if they are risky or have significant side effects). Our current inventory of physiological traits includes physiological resistance (e.g., how well the VP tolerates treatments), pain threshold (how much pain the VP can stand) and the ability to tolerate symptoms (how intense or frequent symptoms have to be before the VP seeks medical attention). This inventory will be significantly expanded in the future. When a given VP is created, values for these features are selected and affect the VP's reactions in the face of its disease(s). Of course, values for the physiological aspects of the disease(s) and the VP's response to interventions, should they be applied at various times, are selected for each individual VP during the process of patient authoring (cf. Section 6).

Decision-Making. The decision-making behavior of specific instances of virtual patients is parameterized using a model of personality traits and physical and mental states. It is informed by (a) the content of the VP's short-term memory, which is modeled as knowledge invoked specifically for making the decision at hand, and (b) the content of the VP's long-term memory, which is its recollection of its past states of health, past communications and decisions, and general world knowledge.

A VP's decision-making is affected by the severity and duration of its symptoms, its knowledge of tests and procedures, the character traits trust, suggestibility and courage, and the physiological traits physiological resistance, pain threshold and the ability to tolerate symptoms.

VP reasoning is carried out through modeling the VP's goals and plans, thus broadly conforming to the belief-desire-intention (BDI) approach to developing intelligent agents (e.g., Bratman 1999).

When the VP starts to experience symptoms it can either do nothing, go the doctor, go to the emergency room or self-treat. To decide when to see a doctor for the first time, the VP compares its symptom severity with its ability to tolerate symptoms. Later in its treatment the VP also considers the date of its next scheduled appointment, whether or not its symptoms have spiked, what the doctor told it to expect, and so on.

When the doctor recommends a test or procedure, the VP must compare its knowledge of the test/procedure with its character traits, like courage and suggestibility. For example, if it knows nothing about the test/procedure and has little trust in the doctor, it will ask questions about the properties that interest it, like the expected pain and side effects; by contrast, if it has complete trust in the doctor and a high value for suggestibility, it will ask no knowledge-seeking questions and, instead, will agree to anything the doctor suggests.

When the patient has received all the information it wants about a test/procedure, it will decide whether or not to agree to it. It can also suggest other options that it happens to know about (based on its personal ontology), and the doctor can accept or reject such suggestions.

Language Processing. Our approach to treating language communication is unlike most other approaches in that all language-oriented reasoning is carried out on the basis of formal interpretations of the meaning of linguistic expressions. Our automatically generated, semantically-oriented text meaning representations (TMRs) are written using the same ontological knowledge substrate and the same ontologically grounded metalanguage as are used to represent physiological processes, interoception and agent goals and plans. In short, all knowledge and reasoning in our environment employ the same metalanguage, so whether a VP experiences new symptoms (through interoception) or learns information about its disease from the user (through language processing), the new information is be stored the same way in the VP's memory.

There are several advantages to orienting an agent's language processing around TMRs rather than text strings. First, TMRs are unambiguous, since linguistic ambiguity is resolved as the TMRs are being generated. Second, TMRs reduce to a single representation many types of linguistic paraphrase, be it lexical (*esophagus ~ food pipe)*, syntactic (*I will administer it to you ~ It will be administered to you by me*) or semantic (*Does the food get stuck when you swallow? ~ Do you have difficulty swallowing?*) (McShane et al 2008 a,b). Third, TMRs facilitate the detection of which aspects of meaning are central and which are of secondary importance. As regards paraphrase processing, in addition to having to resolve linguistic paraphrase, the VP must be able to resolve two other kinds of paraphrase: a) the reformulation of the representation of physiological events (e.g., symptoms) in "lay" ontological terms that can be understood and remembered by its cognitive agent and b) the representation of the meaning of verbal messages in terms compatible with how related content is stored in the cognitive agent's memory. Remember, the VP is typically not a medical professional, meaning that it must have a different ontology and a different lexicon than a physician would.

Learning. We just noted in passing that the VP's ontology and lexicon do not match those of a physician. Indeed, the physician's ontology will contain a vast subtree of medical information including objects, events and the properties that link them as well as script-based knowledge, which permits the physician to understand the progression of a disease, how to treat it under various circumstances, etc. The physician will have a correspondingly large technical and non-technical vocabulary (lexicon) that is linked to the respective ontological concepts and is used to analyze and generate language in the medical domain. The patient's knowledge base, by contrast, will typically include an impoverished medical subtree in the ontology and a relatively small number of medical terms in the lexicon – unless, of course, the VP happens to be a physician or even a specialist in the given domain.

In conducting an interview with a VP, the user must be able to express himself in different ways, using paraphrases selected according to the degree of medical knowledge the VP possesses. During appointments the physician will naturally teach the VP about various aspects of its condition: its name, the names of related drugs and procedures, the properties of drugs and procedures that the VP asks about or the user chooses to provide, the medical terms for words that formerly had to be paraphrased for the VP, and so on. For example, when the user tells the VP the name of its disease, that disease is added to the VP's ontological subtree of diseases and a new lexicon entry is created that maps to this ontological concept; and when the VP learns information about a test or procedure, it remembers it and no longer asks those questions about it – unless, of course, the VP forgets, in which case the user will need to offer a reminder.

6 Creating a Society of Virtual Patient Instances

A cornerstone for creating a realistic virtual patient training system is providing for wide variation among instances of VPs with a given disease. Our models of each disease include all relevant paths of progression, or "tracks", and each track provides many choice points that can differentiate individual, named cases. A graphical representation of this basic scheme is shown in Figure 2.

The overall model for the disease GERD is represented by the cross shape to the left. The clinically important prototypes that derive from it are shown in the middle with each prototype being represented by a different coloring: the "inflammation only" track has a black upper projection whereas the "inflammation to erosion" track has a progressively shaded lower projection. The named instances of virtual patients are shown to the right, each showing the main feature of its disease (the cross shape) and its track (the coloring of the upper or lower projection) as well as its own personal features, represented by the additional small colored shapes.

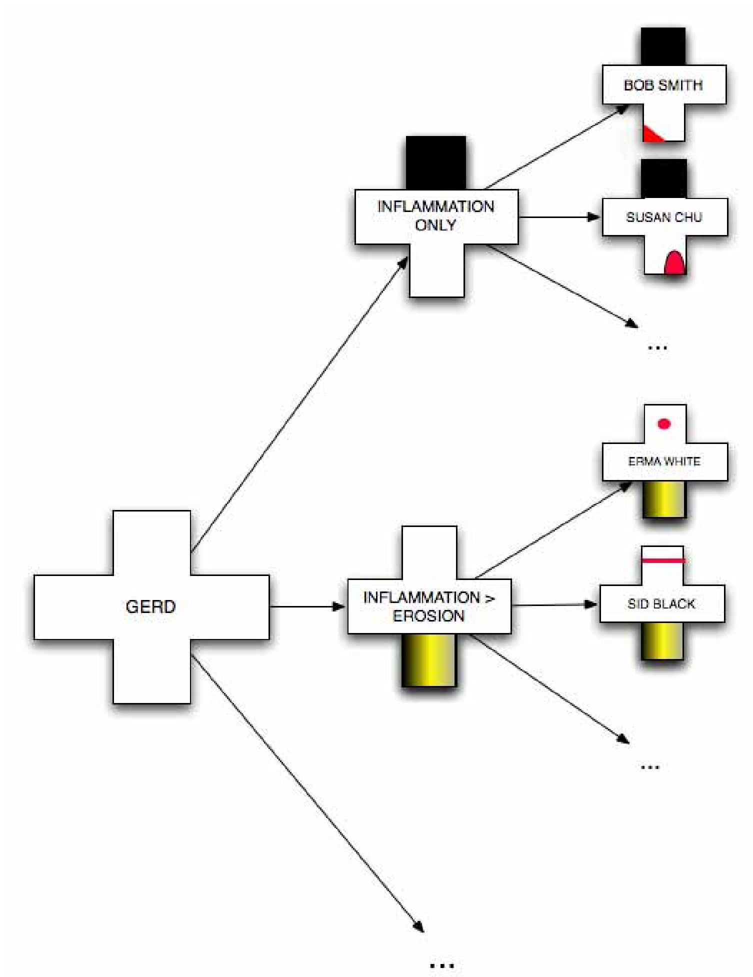


Figure 2. A graphical representation of a basic disease model, its tracks, and actual VP instances that represent those tracks.

A large population of VPs suffering from a given disease can quickly be assembled by teachers, disease specialists and even students and developers by filling out what we call a patient creation template, which is essentially a multiple-choice questionnaire. Each template shows the features central to the model and the various ways they can be initialized and change over time. For example, for GERD the relevant features include lower esophageal sphincter pressure, the state of the lining of the lower esophagus (inflamed, eroded, etc.), the frequency and duration of heartburn, the efficacy of various medications, and so on. The template permits the patient author to select parameter values within the permitted range and according to the permitted combinations. As soon as the values (or defaults) for all relevant properties are chosen and the patient data is saved, the patient is available for use. For details on creating a population of VPs and the ways in which the patient creation template reveals the conceptual model of the disease, see Jarrell et al. (2008).

7 Concluding Thoughts

As mentioned earlier, MVP is an implemented system at the prototype stage of development that currently covers 7 esophageal diseases. All of the functionalities discussed above are incorporated to varying degrees. We are currently working on making the language interaction more robust and will soon move to completing our in-progress model of heart disease.

MVP is a classical AI (artificial intelligence) system in that it strives to model human perception, reasoning and action capabilities and does so on the basis of encoded knowledge. It differs from much of classical AI practice in that it includes people as components in its architecture. If MVP were an expert system in the classical sense, *the system* would have been tasked to diagnose and treat patients rather than the other way around. Indeed, many systems in the medical domain, from Mycin (Buchanan and Shortliffe 1984) on up, had this as their main goal. Another difference from classical AI is the centrality of the descriptive component of the system: the VP's world is certainly not toy (i.e., it does not cover only an extremely small domain). Our emphasis is on acquiring knowledge that is sufficiently deep to support the complex reasoning, simulation and language processing required by the application. This is in contrast to many recent and current approaches – notably, in natural language processing – that stress broad coverage of data in contrast to the utilization of a depth of acquired knowledge.

We believe that the statements often heard nowadays about the demise of AI are ill conceived. The AI enterprise did not fail. In fact, it has not yet been brought to the test. This is because the enterprise is much more complex than it was perceived to be even by many AI practitioners themselves. Despite the recent emphasis in the field on statistics-oriented methods, they should not be viewed as having superceded classical AI. In fact, these methods have contributed to the core task of knowledge acquisition that is a prerequisite to the success of the program of AI. Progress in learning, knowledge visualization and other ergonomic factors, the ease of access to vast collections of data on the Web and other developments make the original AI goals incrementally more attainable. Our work on the MVP corroborates this state of affairs. We believe that the development of a comprehensive MVP is feasible both scientifically and logistically.

References

1. Beale, S., Lavoie, B., McShane, M., Nirenburg, S., Korelsky, T.: Question answering using Ontological Semantics, Proceedings of the ACL-2004 Workshop on Text Meaning and Interpretation, Barcelona, 2004.
2. Bratman, M.: Faces of Intention, Cambridge University Press, 1999.
3. Buchanan, B., Shortliffe, E.: Rule-Based Expert Systems: The Mycin Experiments of the Stanford Heuristic Programming Project, Addison-Wesley, 1984.
4. Evens, M., Michael, J.: One-on-One Tutoring by Humans and Computers, New Jersey and London, Lawrence Erlbaum and Associates, 2006.
5. Jarrell, B., Nirenburg, S., McShane, M., Fantry, G., Beale, S., Mallott, D., Raczek, J.: An interactive, cognitive simulation of gastroesophageal reflux disease, Stud Health Technol Inform, 194-199, IOS Press, 2007.
6. Jarrell, B., Nirenburg, S., McShane, M., Fantry, G., Beale, S.: Revealing the conceptual substrate of biomedical cognitive models to the wider community, Stud Health Technol Inform, 281-286, IOS Press, 2008.
7. McShane, M., Fantry, G., Beale, S., Nirenburg, S., Jarrell, B.: Disease interaction in cognitive simulations for medical training, Proceedings of the MODSIM World Conference, Medical Track, Virginia Beach, Sept. 11-13, 2007 (2007a).
8. McShane, M., Nirenburg, S., Beale, S., Jarrell, B., Fantry, G.: Knowledge-based modeling and simulation of diseases with highly differentiated clinical manifestations, Proceedings of the 11th Conference on Artificial Intelligence in Medicine (AIME 07), Amsterdam, The Netherlands, July 7-11, 2007 (2007b).
9. McShane, M., Nirenburg, S., Beale, S.: Resolving paraphrases to support modeling language perception in an intelligent agent, Proceedings of the Symposium on Semantics in Systems for Text Processing (STEP 2008), Venice, Italy, 2008 (2008a).
10. McShane, M., Nirenburg, S., Beale, S.: Two kinds of paraphrase in modeling embodied cognitive agents, Proceedings of Biologically Inspired Cognitive Architectures, AAAI 2008 Fall Symposium, Washington, D.C., Nov. 7-9, 2008 (2008b).
11. Nirenburg, S., McShane, M., Beale, S.: A simulated physiological/cognitive “double agent”, Proceedings of Naturally Inspired Cognitive Architectures, AAAI 2008 Fall Symposium, Washington, D.C., Nov. 7-9, 2008 (2008a).
12. Nirenburg, S., McShane, M., Beale, S., Jarrell, B.: Adaptivity in a multi-agent clinical simulation system, Proceedings of AKRR’08, International and Interdisciplinary Conference on Adaptive Knowledge Representation and Reasoning, Porvoo, Finland, Sept. 17-19, 2008 (2008b).
13. Nirenburg, S., Oates, T.: Learning by reading by learning to read, Proceedings of the International Conference on Semantic Computing (ICSC-07), Irvine, CA, 2007.
14. Nirenburg, S., Raskin, V.: Ontological Semantics, Cambridge Mass., MIT Press, 2004.
15. Schank, R., Abelson, R.: Scripts, Plans, Goals and Understanding, Hillsdale, NJ, Erlbaum, 1977.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 64

OPEN VIRTUAL PATIENT AUTHORING SYSTEM FROM MCGILL UNIVERSITY

David Fleiszer[1], Nancy Posel[1], Sean Steacy[1], Jason Murray[1], Ben Moss[1]

[1]McGill University, Canada

contact author: David Fleiszer, david.fleiszer@mcgill.ca

McGill University has created authoring software to produce on-line virtual patient encounters. These virtual patients simulate the process of taking a history, doing a physical examination and ordering appropriate laboratory tests and imaging. A differential diagnosis is created and modified by the student as they work through the case. Each action is scored for appropriateness and assigned a dollar value. When complete, the student compares their management of the virtual patient to that of an expert. These virtual patients can incorporate a wide variety of multimedia, hyperlinks and didactic teaching material. Cases can easily be modified for different types or levels of healthcare students. The entire process of authoring and publishing a case to the internet requires no technical expertise. The software is without cost to authors who are willing to share their cases with students and teachers around the world.

Keywords: virtual patient encounter, virtual patient authoring

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 65

DEMONSTRATION OF THE CAMPUS VIRTUAL PATIENT SYSTEM

Jörn Heid[1], Benjamin Hanebeck[1], Frank Hess[1], Simone Huber[1], Martin Haag[1], Sören Huwendiek[1]

[1]University Hospital of Heidelberg, Germany

contact author: Jörn Heid, heid@hs-heilbronn.de

The CAMPUS virtual patient system, developed at the University of Heidelberg, consists of different modules for learning and assessment with virtual patients (VPs). An easy-to-use authoring system enables the user to create VPs based on a controlled vocabulary for medical history, diagnoses, therapies and physical, laboratory and technical examinations. Using a vocabulary instead of free-text enables semi-automatic translations and fast development of VPs. The authoring system supports different import and export formats like XML, QTI, SCORM as well as the newly developed eViP format. Two presentation modules with different didactical approaches present the VPs to students: The Classic-Player is characterised by a simulative presentation mode where the student can choose from a wide variety of examinations and therapies. This approach perfectly suites for self-study as the student can feel and act like a real physician. In contrast to this, the Card-Player follows a card-based presentation mode with a reduced set of selection possibilities. Virtual patients presented in the Card-Player are mainly used to prepare for examinations allowing fast recapitulation of applied knowledge. Both players support the enrichment of virtual patients through different media files, interactive images, knowledge questions and expert comments. Feedback will be given by both players at several points to synchronize the decisions made by the student and the author. All user actions are recorded in the database for formative assessments. For secure, summative assessments a software was developed which offers a network fault tolerant client-server-architecture and certainty of law using automatically generated video files together with the support of keyfeature and advanced question types like long menu.

Keywords: virtual patients, assessment, vocabulary-based

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 66

BIT PATHWAYS – A FLEXIBLE GRAPHICAL EDITOR FOR E-LEARNING PURPOSES

ANDRZEJ A. KONONOWICZ[1]

[1]Department of Bioinformatics and Telemedicine, Faculty of Medicine, Jagiellonian University, Poland

contact author: Andrzej A. Kononowicz, a.kononowicz@cyfronet.pl

BIT Pathways is a template-based flow chart editor that can be applied for structuring knowledge in different disciplines. The editor has been developed at the Jagiellonian University (Poland), initially in cooperation with the Canton Hospital Aarau (Switzerland), to serve as a clinical pathways editor. Currently the tool is also used for other purposes including design of virtual patients, building cognitive maps, visualisation of chemical workflows and statistical procedures.

Being developed in Java Swing technology the BIT Pathways tool can be used on various operating systems and does not require complicated installation. The set of supported graphical elements includes standard shapes for block diagrams: rectangles, arrows, rhombi, ellipses, symbols for subpathways and commentaries. Each class of elements has an individual set of attributes defined by XML templates. Flow charts created by the BIT Pathways editor can be either stored on a native XML server (eXist) or as XML files. A set of XSLT transformations has been developed for publishing the pathways as web pages. The user interface of the program is available in three language versions: Polish, English and German.

The tool has been already introduced in teaching of postgraduate students (n=47) as part of a learning-by-teaching scenario in which constructing a pathway is one of the steps in the process of authoring a virtual patient. Recently, BIT Pathways has been also used by 3rd year undergraduate medical students (n=295) to present graphically the content of scientific papers. The feedback from the students on the tool's usability was positive and led to the development of new features of the application. The current work in progress focuses on implementation of functions for integration the tool with virtual patient systems.

Keywords: Authoring, Virtual Patients, E-learning

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 67

VPSIM – A STANDARDS-BASED VIRTUAL PATIENT AUTHORING SYSTEM

JAMES MCGEE[1]

[1]University of Pittsburgh School of Medicine, USA

contact author: James McGee, jbmcgeemd@gmail.com

The Laboratory for Educational Technology (the Lab) at the University of Pittsburgh School of Medicine has recently completed version 1.0 of an easy-to-use, virtual patient authoring system. Virtual patients (VPs) are computer-based simulations of medical cases for education and assessment. The Lab recognized barriers to development of VPs including high cost, complex authoring software, difficulty creating and visualizing complex branched decision paths, and a lack of standards compliance for exchange and sharing of cases. The Lab used agile programming techniques to rapidly prototype and test vpSim with potential users. The primary objectives were to create an authoring environment for medical educators that required minimal training and stimulated creative case writing. The design was based on iterative feedback from both VP experts and naive authors. vpSim uses a Flash-based drag-and-drop visual interface for case design by representing screens and decisions with a map of nodes and branches. Patient data is added to each node using simple web forms that approximate the resulting on-screen appearance of the case. Features, based on user feedback, include multimedia support and counters to track score, money, and time. vpSim exports XML files based on the MedBiquitous VP standard specification for use by other authoring systems and VP players. Planning for worldwide access to and distribution of vpSim software is underway.

Keywords: virtual patient, authoring, simulation

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 68

ENABLING INTEROPERABILITY, ACCESSIBILITY AND REUSABILITY OF VIRTUAL PATIENTS – FINDINGS FROM THE EVIP PROJECT

Nabil Zary[1], Inga Hege[2], Jörn Heid[3], Andrzej A. Kononowicz[4], Luke Woodham[5], Jeroen Donkers[6]

[1]Karolinska Institutet, Sweden
[2]Ludwig-Maximilians-Universität München, Germany
[3]University Clinical of Heidelberg, Germany
[4]Jagiellonian University, Faculty of Medicine, Poland
[5]St. George's, University of London, United Kingdom
[6]Maastricht University, The Netherlands

contact author: Nabil Zary, nabil@medicalsimulation.net

The electronic virtual patient project (eViP) is a 3-year programme co-funded by the European Union. One of the major goals of eViP is to enable the sharing of virtual patients (VP) across medical education centres. This addresses a frequent problem in the development of e-learning resources, namely the lack of available time and resources while at the same time a lot of effort is wasted on duplicative work. The foundation of a successful and efficient bank of educational resources is a common interoperability standard that would facilitate the migration of data between diverse systems. A common standard (eViP profile), based on the MedBiquitous specifications for VPs, was implemented by the partners' VP systems in order to support the exchange process. The participating systems are CAMPUS, Casus, OpenLabyrinth and Web-SP, which offer a variety of functionalities and each of which has its own technical and didactical approach. All systems implemented the eViP profile at the end of 2008 which enabled a standardized import and export of the VPs. The export procedures were designed to be completely automatic and contain as much of the virtual patient content as possible. The import had in some cases to be customized. The implementation of the eViP profile, being its first large-scale implementation, also constituted a major driving force in the further development of the MedBiquitous specification for virtual patients. The great variety of the included systems turned out to be a major challenge for the project. We will present the crucial steps and issues encountered during the implementation of the eViP profile.

Keywords: healthcare standards, interoperability, virtual patient, MedBiquitous, technical implementation

Development of Virtual Patient Systems

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 69-72

REPURPOSING VIRTUAL PATIENTS FOR CLINICAL REASONING: DEVELOPMENT OF A GUIDELINE AND ASSESSMENT OF TIME AND EFFORT

Benjamin Hanebeck[1], Burkhard Tönshoff[2], Sören Huwendiek[1]

[1]Department of General Paediatrics, University Hospital for Paediatric and Adolescent Medicine and Center for Virtual Patients, Medical Faculty of Heidelberg University, Heidelberg, Germany [2]Department of General Paediatrics, University Hospital for Paediatric and Adolescent Medicine, Heidelberg, Germany

Abstract:
Introduction: Fostering clinical reasoning is considered to be one of the major learning goals in medical education. However, there is only limited access to real patients to learn clinical reasoning. This deficiency can be overcome by providing virtual patients as an adjunct to real patient encounters. Research has been carried out on design features for virtual patients, especially to improve clinical diagnostic reasoning skills. However, developing new virtual patient cases from scratch is costly, making it reasonable to repurpose existing cases. Efforts to apply these to already existing virtual patients are, as yet, unreported, but are considered to be considerably lower than creation of new cases.
Methods: We established a guideline for repurposing virtual patients for fostering clinical reasoning, which was developed from the literature and from our own experiences in repurposing 15 virtual patients. Furthermore, we documented the associated effort in terms of work hours.
Results: The established guideline for repurposing virtual patients for clinical reasoning includes the following six major steps: (1) Case selection and initial check; (2) Literature review; (3) Development of a repurposing concept; (4) Enrichment for fostering clinical reasoning; (5) Reduction of cognitive load; (6) Final checks including review by expert and completion. The six steps are described in detail. The associated time and effort were calculated on average by 33 hours per case.
Conclusion: We describe a guideline for repurposing virtual patients for clinical reasoning and its associated time and effort. We hope that others planning to repurpose virtual patients for clinical reasoning find this guideline helpful.

Keywords: virtual patients, repurposing, clinical reasoning, electronic virtual patients

Introduction

Clinical reasoning is one of the main learning goals in medical education. It enables the physician to filter and weigh the gathered information in order to find the most plausible of all hypothetic diagnoses. In medical teaching several strategies can be used to facilitate learning of the diagnostic reasoning process [1]. Clinical reasoning is learned mainly through experience, i.e. via seeing many patients and getting appropriate feedback [2]. However, in undergraduate medical education only a limited number of patients can be presented to students [3]. In order to bypass this shortcoming virtual patients are increasingly implemented into medical curricula as a supplement to real patient encounters [4, 5, 6]. It was pointed out in a recent study on the design principles of virtual patients to foster clinical reasoning which strategies a virtual patient should imply [7].

The development of virtual patients from scratch requires a considerable amount of time and financial effort [8]. Therefore, the idea has recently been developed that repurposing and reusing an existing virtual patient case is more cost-effective than building a case from scratch [9]. For the same reason the eViP project was founded to expedite the repurposing idea.

To our knowledge, so far, there is no study about the implementation of strategies to foster clinical reasoning in already existing virtual patients. We therefore share our experiences with repurposing virtual patient cases for clinical reasoning. We describe the resulting guideline and the associated time and effort.

Methods

The CAMPUS system is a vocabulary-based virtual patient shell [10, 11]; www.campusvirtualpatients.com. Virtual patients are constructed with an easy-to-use authoring system, with the unique and particular feature of displaying one case in two different player types: the CAMPUS Classic Player, a more simulative environment, and the CAMPUS Card Player, which is easier to use, with a more predetermined itinerary. Especially the flexibility to enrich a casuistry with comments, prompts, different question types and media at virtually any given point in the case's course makes it an ideal platform for enhancing already existing cases to support clinical reasoning. The virtual patient cases used for repurposing in clinical reasoning were developed for the CAMPUS Classic Player from 2001 to 2005. They all take a linear pathway through the case and have mainly been used within the medical curriculum for self-study purposes with a duration of approximately 45–60 min. From this database 15 cases were selected for repurposing and changed by a number of consecutive steps. The time and effort involved were documented. The principles used for the repurposing process were adopted from a recent review by Bowen on educational strategies to promote clinical diagnostic reasoning as well as from a focus group study about design principles of virtual patients by our own group [1, 7]. As described by Bowen these include the elements of acquisition and selection of data, the summary of presenting problems, the generation of hypotheses, providing cognitive feedback, asking typical presentations for potential diagnoses, defining and discriminative features. Although Bowen's educational strategies focus more on a face-to-face teaching scenario, these strategies were implemented as questions for the simulation of an interactive dialogue between a student and a clinical teacher in the virtual patients. Whereas our design principles describe several general design features, those factors, which our repurposing for clinical reasoning was focused upon, were mainly interactivity, specific feedback, recapitulation of key learning points and, above all, questions and explanations to enhance clinical reasoning. However, where possible, the other mentioned design strategies were also applied, although they were not the focus of this repurposing. The experiences of repurposing 15 existing cases for clinical reasoning were then translated into a guideline and the associated time and effort were documented by the eViP repurposing effort sheet [12].

Results

Guideline for repurposing virtual patients for clinical reasoning:

1. Case selection and first check

The very first step in our repurposing was to select a case from the existing database. The repurposing author advanced through the case as a user to note possible strengths or shortcomings. In the case of an existing pre-evaluation by students, these data were also used, especially as a comparison with the author's own impression of the case.

2. Literature review

With a specific case in mind the author performed a thorough literature review on that case's topic. On the one hand, this was necessary in order to be aware of any recent changes concerning the content. On the other hand, it assisted the editor in not overlooking crucial elements when he developed the scheme of the case's clinical reasoning process.

3. Developing the repurposing concept

To visualize this process the case's structure was mapped onto a graph to display the clinical decision-making pathway from beginning to end. On the left of this graph all possible differential diagnoses were displayed, after the initial basic problem was presented at the beginning of the case. In a case's due course more information becomes available to either strengthen or weaken certain differential diagnoses and hypotheses until such time as the final diagnosis can be made, which is then displayed on the right side of the graph. After completing the differential diagnoses the defining and discriminative features were assigned to either one or a group of diagnoses. The graph was supposed to function as the mind map of the clinical reasoning design both as a guide through the editing process and also to be displayed at the end of the case.

Before the contents of the case were revised, the intended learning goals of this specific virtual patient case were defined. By comparing the defined learning goals with those of the existing case, a profile of the required changes was generated, which included not only enrichment but also reduction or deletion of those parts deemed unnecessary with regard to the desired learning outcome.

4. Enrichment for fostering clinical reasoning

With a clear scheme at hand the case was edited within the authoring system, adding open-ended free-text questions, consistent with the mind map, to prompt for all reasonable differential diagnoses, which followed the initial problem presentation. During the case's due course more and more of the features of the disease become known to the user. To guide towards a proper problem representation the user was prompted to summarize these in abstract terms. Consecutively, further questions were added to the case to prompt for discriminative or defining features of a differential diagnosis, or for the significance of a feature concerning the possible diagnoses. Whenever a question was implemented, the author tried to embed it into the virtual patient scenario, e.g. a senior consultant asking for a case summary or a nurse asking for prescriptions. Wherever the editor deemed it useful to comment on features or illnesses he implemented expert comments or prompted for important details of the case. This was done with open-ended free-test questions with comments included in the ideal answer to engage the student more actively.

As the case progressed, important aspects of the learning goals were commented on and repeatedly asked about. The goal was to focus the student on these case features and to increase the chances that each student would be able to identify these after the completion of the case. A final summary was composed and added at the case's end, together with a recapitulation of the most important features as a take-home message. In addition, the clinical reasoning graph was embedded at the end of the case.

5. Reduction of cognitive load

As the case was rechecked, another focus was to remove unnecessary content in order to reduce the cognitive load. If this was the case the information was reduced to the most important parts with referral to resources (e.g. Internet links) for further reading. If this was not possible the information was split into several smaller passages to be displayed at different points during the course of the case. The layout of the text was also improved for readability by subdividing and marking important information with bold letters.

6. Final checks including review by expert and completion

With an expert the repurposing author discussed and checked the virtual patient to resolve unclear content questions and to make sure the virtual patient would match a typical real patient in as many ways as possible. After revision and a final check by the expert, the case was cleared for release to the students' self-study database.

Table 1: Efforts

Activity	hours
1. Case selection and first check	2
2. Literature review	4
3. Development of a repurposing concept	4
4. Enrichment for fostering clinical reasoning	11
5. Reduction of cognitive load	5
6. Final checks including review by expert and completion	7
Total	33

Efforts

The efforts for these steps are displayed in Table 1. In total, an average of 33 hours was needed to repurpose a virtual patient from beginning to end.

Following the repurposing effort sheet developed by the eViP project we calculated an average of 1 hour for alterations in the structure of the case, 2 hours for storyboard changes, 6 hours for addition or alteration of questions and solution of questions and 3 hours for adding, rearranging or creation of pictures and tables. The other efforts were subsumed under the missing information category.

Discussion and Conclusion

We established a guideline for repurposing virtual patients, which evolved by a literature review and our own experiences in repurposing 15 virtual patients: (1) Case selection and first check; (2) Literature review; (3) Development of a repurposing concept; (4) Enrichment for fostering clinical reasoning; (5) Reduction of cognitive load; (6) Final checks including review by expert and completion. On average, 33 hours' work were needed in order to repurpose a virtual patient in this way. The associated time and effort were calculated on average as 33 hours per case.

The main element in our repurposing process was the completed clinical reasoning mind map. It functions as a road map, displaying the differential diagnoses and defining or discriminating features that it is important to implement in the case. Although Bowen described educational strategies to promote clinical reasoning skills mainly for face-to-face education, this is not an element of self-study with virtual patients. In order to compensate for this deficiency, questions were added to the case to simulate a dialogue. Embedding them within a situation of a young doctor being asked in a realistic way (e.g. by his virtual clinician supervisor) is supposed not only to simulate a face-to-face setting but also to help create a self-contained virtual scenario.

Open-ended questions were not assessed in terms of right or wrong, but the student was given a prototype answer in abstract terms to facilitate self-study. It is an attempt to mimic face-to-face feedback in a real situation. This enables the student to identify the differences in comparison with his statement. Although it does not directly point to the mistakes in the student's input, the provision of the correct answer is meant to facilitate the separation of the important and unimportant bits of the gathered information. Consecutively, the student can match the symptoms to a differential diagnosis, which facilitates the development of an illness script.

Recapitulation of the key learning points is also a major principle of virtual patient design. By displaying a graphical pathway of the clinical reasoning process, the student will not only comprehend more easily how the final diagnosis was made, but will also better memorize this pattern of features with all the correlating defining and discriminating characteristics.

Repurposing an existing virtual patient case to new design criteria proved to be more time-consuming and costly than initially expected. One factor may be that the cases used were rather elaborate, as efforts are dependent on the intended level of complexity and the length of the case. Consulting an expert earlier in the process might have speeded up the repurposing process and reduced the risk of altering the case towards an unintended goal, although the latter did not occur. Consulting an expert more often, or even have an expert conduct all of the repurposing themselves, would help to minimize the time accounted for in the literature review. However, the greater the expertise of a clinician the higher is their cost. In addition, it should be borne in mind that an expert on content is not automatically an expert on instructional design. It also has to be taken into account that an expert is not always available and is quite a limited resource. This is why our repurposing was done mainly by a resident with a focus on virtual patient design, estimating it as a more cost-effective way to do the repurposing.

The step to reduce the cognitive load could be regarded as separate from the intended repurposing process. Although not part of clinical reasoning, we considered it an important step in the overall process. It is an example of a possible obstacle when repurposing a virtual patient case: you may not find the case that is ideal for your purpose, thus you need to change it to repurpose it. As the original cases were intended more for self-study by providing lots of information, they contained passages that were not suitable for the new purpose. During the repurposing more content was added to the case to facilitate clinical reasoning, which made it necessary to reduce the information in the case to avoid a cognitive overload.

With regard to the efforts generated by repurposing it is questionable whether creating a virtual patient case from scratch might not be more efficient. A new virtual patient can incorporate all the necessary design features without the need to invest time in tampering with an existing case. However, we consider that having an already existing elaborated virtual patient case at hand is a very valuable resource. Repurposing saves all the efforts required for the basic layout, such as patient history, physical and other examinations, all the valuable media and is, in total, more time-saving than time-consuming.

Since our repurposing was done within the same content system, no efforts were generated by the occurrence of technical mismatches. From the technical point of view not crossing between platforms is certainly a less complex way to repurpose. Two major benefits are that the author can avoid almost all technical difficulties and can focus on the content and the target educational scenario.

We have previously reported that students perceive virtual patients designed according to the proposed principles and guideline as fostering their learning and an excellent preparation for clinical reasoning in real patient encounters [7]. We hope that the guideline described here will be of help to others who plan to repurpose virtual patients to foster clinical reasoning. Yet, there is no study to date that quantifies the effect of these on clinical decision-making and clinical reasoning. Quantitative controlled trials will be conducted to find out whether students perform better in assessment situations after they have been exposed to virtual patients designed to foster clinical reasoning.

Acknowledgements

We thank our colleagues from the centre for virtual patients (www.campusvirtualpatients.com) for their excellent support in further developing the CAMPUS virtual patient software: Dipl. Inform. med. Jörn Heid, Dipl. Inform. med. Frank Hess, Dipl. Inform. med. Simone Huber and Prof. Dr. Martin Haag.

Furthermore, we thank the Euopean Union for co-funding the eVIP project (www.virtualpatients.eu), and Prof. Dr. F. Resch, Dean for students of the Faculty of Medicine, Heidelberg University and the commission on study fees for financial support of this project.

References

1. Bowen J. L.: Educational strategies to promote clinical diagnostic reasoning, N. Engl. J. Med., **355**(21): 2217-2225, 2006.
2. Eva K. W.: What every teacher needs to know about clinical reasoning, Med. Educ., **39**(1): 98-106, 2005.
3. Irby D. M.: Teaching and learning in ambulatory care settings: a thematic review of the literature, Acad. Med., **70**(10): 898-931, 1995.
4. Fall L. H., Berman N. B., Smith S., White C. B., Woodhead J. C., Olson A. L.: Multi-institutional development and utilization of a computer-assisted learning program for the pediatrics clerkship: the CLIPP Project, Acad. Med., **80**(9): 847-855, 2005.
5. Huang G., Reynolds R., Candler C.: Virtual patient simulation at US and Canadian medical schools, Acad. Med., **82**(5): 446-451, 2007.
6. Leong S. L., Baldwin C. D., Adelman A. M.: Integrating Web-based computer cases into a required clerkship: development and evaluation, Acad. Med., **78**(3): 295-301, 2003.
7. Huwendiek S., Reichert F., Bosse H. M., de Leng B. A., van der Vleuten C. P. M., Haag M., Hoffmann G. F., Tönshoff B.: Design principles for virtual patients: a focus group study among students, in print, 2008.
8. Huang C.: Designing high-quality interactive multimedia learning modules, Comput. Med. Imaging Graph., **29**(2-3): 223-233, 2005.
9. Ellaway R., Poulton T., Fors U., McGee J. B., Albright S.: Building a virtual patient commons, Med. Teach., **30**(2): 170-174, 2008.
10. Garde S., Bauch M., Haag M., Heid J., Huwendiek S., Ruderich F., Singer R., Leven F. J.: CAMPUS – Computer-Based Training in Medicine as part of a Problem-oriented Educational Strategy, Studies in Learning, Evaluation, Innovation and Development, 10-19, 2005.
11. Huwendiek S., Köpf S., Höcker B., Heid J., Bauch M., Bosse H. M., Haag M., Leven F. J., Hoffmann G. F., Tönshoff B.: Fünf Jahre Erfahrung mit dem curricularen Einsatz des fall – und webbasierten Lernsystems “CAMPUS-Pädiatrie” an der Medizinischen Fakultät Heidelberg. GMS Z. Med. Ausbild., **23(1)** (Doc 10), 2006.
12. Poulton T., Fors U., Fischer M., Davies D., de Leng B., Huwendiek S., Muntean V., Roterman I., Balasubramaniam C.: The European electronic Virtual Patient programme – the story so far, AMEE Conference 2008 Abstract, 2008.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 73-77

ENRICHING VIRTUAL PATIENTS WITH INTERACTIVE IMAGES

Simone Huber[1], Frank Hess[1,2], Jeroen Donkers[3], Jörn Heid[1], Bas De Leng[3], Sören Huwendiek[1], Martin Haag[1,2]

[1] University Hospital of Heidelberg, Centre for Virtual Patients, [2] Heilbronn University
[3] Maastricht University, Department of Educational Development and Research

Abstract
Background: At the University of Heidelberg and Maastricht University, virtual patients are primarily used for training clinical reasoning. Adapting virtual patients for undergraduate students has included the realisation of new features for embedding applied knowledge besides the already existing knowledge questions.
Methods: The literature related to interactive images was analysed and scenarios of the usage for various interactive image types were evaluated against the background of virtual patients. A template-based and easy-to-use animation editor was implemented to develop interactive images that were made available to undergraduate medical students. Using such interactive images can help students learning basic facts and fundamental concepts more efficiently. Actually, there are different types of interactive images available, e.g. mouse-over or drag-and-drop labelling images. These interactive images are realized in Adobe Flash and can either be used stand-alone or integrated as media files in CAMPUS virtual patients. The latter has the advantage of combining pre-clinical with clinical knowledge and providing students a consistent interface to E-Learning content during their whole study. In a different scenario, the CAMPUS Animation Editor can be made available to the students to create their own interactive images and deepen their medical knowledge.
Results: Currently, selected interactive images are used within virtual patients in an undergraduate course. While working through the virtual patient the students can take part in a survey for focus group analysing. Until now, the students are presented a standardized questionnaire for virtual patients containing only general questions about the strengths and weaknesses of the virtual patients and the used virtual patient system. Individual statements by students indicate the usefulness of interactive images especially for self-study. A questionnaire concentrating on the interactive images is planned for spring 2009.
Conclusion: Interactive images are a valid tool for applied knowledge transfer. However, an easy-to-use editor for each interactive image type is required to lower the creation barrier.

Keywords: virtual patients, interactive images, animation, CAMPUS, Animage, medical education

Introduction

At the University of Heidelberg medical students were offered the chance to participate in a survey for the further usage of the student fees in spring 2008. One result was the demand for a more consequent use of virtual patients (VPs) during the whole medical study. A closer look at the so-far used virtual patients indicated, that virtual patients mostly have been used for training clinical reasoning and almost none virtual patients existed for undergraduate students. The challenge for the creation of virtual patients for undergraduate students was to introduce clinical knowledge (patient-related teaching) but also to integrate a high amount of applied knowledge. Especially the latter is not an easy task because basic knowledge from different medical areas like anatomy, biology, chemistry, histology and physiology has to be treated. As a starting point, existing virtual patients were analysed and a selection of virtual patients was chosen. The story behind these VPs was used as a context to present the applied knowledge, allowing training of applied knowledge as well as the transfer towards practical knowledge. One possibility to encourage student interest and to help them understand basic concepts is the inclusion of multimedia content [1]. Different kinds of animations/interactive images allow varying interaction degrees. While animations like videos are destined to be used in lessons with students being more or less passive learners, interactive images will enable the students to actively deal with the content of teaching. All interactive images apply the possibility to give the student immediate feedback regarding their learning progress and to be used in summative assessment scenarios.

Animations like videos may intuitively seem more effective than static graphics for teaching, but there is no significant effect for the superiority of simple computer-based animations in medical education [2]. For that reason we have decided to concentrate on interactive images supporting the approach of test enhanced learning [3].

Methods

In this section, we highlight the different types of interactive images and describe which types we have implemented in CAMPUS [4]. Furthermore, we address the issues of creation and handling of these interactive images and present the way using them within a virtual patient or stand-alone.

Below, we distinguish two categories of animations: movie-like animations and interactive self-testing images [5]. A movie-like animation is a kind of video demonstrating dynamic phenomenons which can be paused and continued. As discussed before there is often no significant effect on learning outcome, because the students act as passive, consuming only learners [2]. Due to this fact the first category is not evaluated further on.

The second category is labelled as interactive self-testing images and is characterized by a higher interaction degree. It includes three different types of interactive images: mouse-over visualisation, drag-and-drop labelling and type-in labelling.

The first type, mouse-over visualisation, uses colour coding to illustrate structures and helps students associating medical terms and the corresponding structure or region. To highlight a structure in form of a transparent coloured border the students have to move the mouse over the structure. At the same time the corresponding medical term is displayed (Figure 1). Adding text to the interactive image can help students understand the shown content much better. To not detract students from the relevant content, it is possible to show further information about the structures by clicking on them.

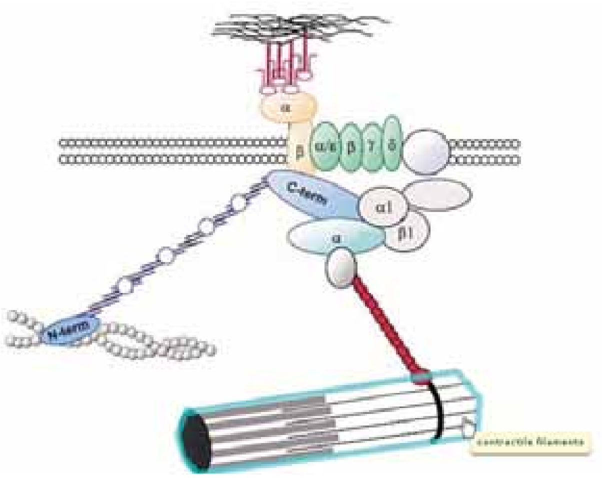


Figure 1: Example of mouse-over visualisation

Depending on the scenario it is also possible to implement some modifications, e.g. mouse over the labels and highlighting the structure(s) or a quiz mode giving the students limited time to select requested structures.

Another kind of interactive self-testing image is drag-and-drop labelling. Here, the students have to assign medical terms presented in a list to the correct structure (Figure 2). If a label is dropped in the correct location, it remains in place. Incorrectly placed, the label automatically returns to its original place within the list, allowing the student unlimited trials to associate the label with the correct appropriate structure. This allows self-testing at the most basic level of knowledge [5]. Optionally, a counter displaying how many attempts the student has needed can be shown in the lower part of the image. We have decided not to show a button to display the solution, because the students have to actually find the answers of these tasks by themselves.

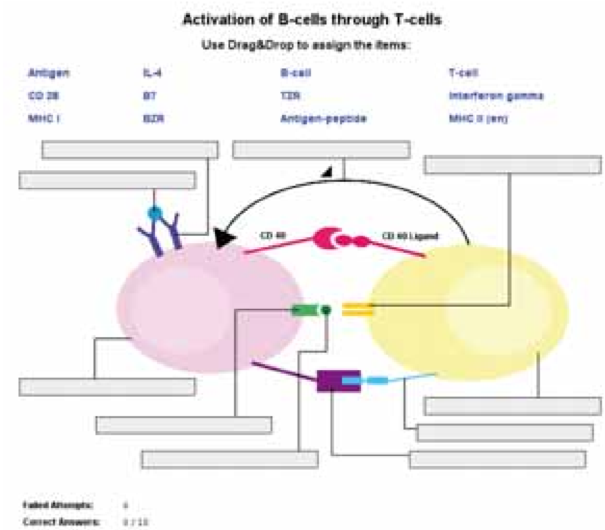


Figure 2: Example of a drag-and-drop labelling self-testing image

A third type of an interactive self-testing image is the type-in labelling image. In this case, the student has to write the correct answer as free text into an input field. The difficulty, compared with the previously presented image, is higher because the student has to know the medical term instead of choosing one from a small list. In general, automatic evaluation of free-text answers for feedback is not feasible because this requires intricate natural language processing.

An alternative to free text is the long-menu question, which is considered as a valid replacement for free-text questions in computerized assessment [6]. However, creating good long-menu lists is a time-consuming task and it is left to the virtual patient author if this is worth the effort.

The drag-and-drop labelling images are not limited to term/structure assignments, but also can be used for visualizing clinical reasoning. In a table-like structure, the students have to assign and weight findings to (three) possible diagnoses.

To realize such interactive images, the following requirements have to be met: flexible use in different virtual patient systems, intuitive authoring requiring no informatics skills and easy adaptation for language.

There are several possibilities for the technical realisation of these interactive images: e.g. Adobe Flash [7], Java-based or JavaScript.

Due to the facts that Adobe Flash is platform and browser independent, widely-used and commonly used to create animations, the decision was made to realize the interactive images in Flash. Interactive images converted in a Flash compatible format can then be easily embedded in the Java based player (CAMPUS Classic-Player) as well as in the JavaScript based player (CAMPUS Card-Player).

It is desirable that these interactive images can be easily developed and produced, even by the physicians themselves who have mostly little or no programming skills. For this reason, an intuitive and easy-to-use animation editor is needed.

The editor can then also be used by students for creating their own interactive images thus deepening their knowledge.

Because the CAMPUS virtual patient system is used in several projects in Germany as well as in other countries, e.g. England or Bosnia and Herzegovina, the animation editor should also support creating interactive images in several languages.

Two approaches for the authoring tool of interactive images have been realized, sharing common parts: Animage and the Campus Animation Editor. They are described in the following sections.

Animage

Animage [8], developed by Maastricht University, is a Flash-based tool for presenting interactive images to learners in which either the learners themselves or the educational developer can determine the level of interaction. This allows for adjusting the level of scaffolding to a level required by the teacher or to a level that fits the student's learning style.

The tool shows a given image and offers on top of this hotspots with several types of behaviour, an active or inactive legend, and labels and lines (in multiple languages). Animage takes as its input a standard image and a XML-based script containing hotspot and label definitions.

This XML file can be created using the open-source drawing tool Inkscape [9] (Figure 3). Animage itself is a tiny flash movie that can be embedded in and configured inside a HTML web page. The level of interaction (i.e. the behaviour/visibility of hotspots, labels and legend) can either be fixed or Animage can show three small buttons in the left upper corner of the image that allows students to change the behaviour (Figure 4).

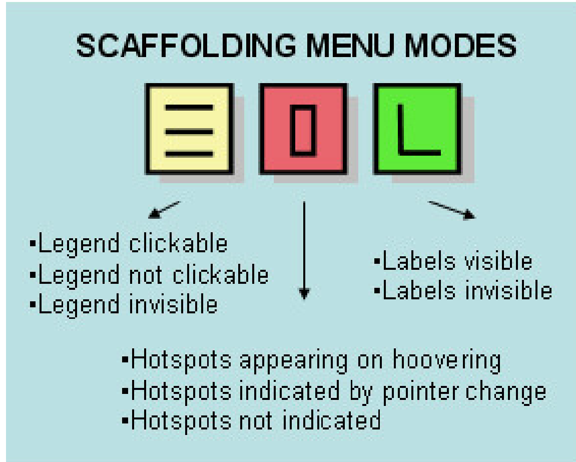


Figure 4: Scaffolding menu modes

The CAMPUS development team developed a module that allows incorporating Animage in a CAMPUS virtual patient. This makes it possible to reuse labelled images in several languages, without need to edit the image; to offer authentic image materials (e.g. X-ray) with labels that can be temporarily removed by the students; and to offer an interactive image on the anatomy relative for the virtual patient, which students can use to memorize.

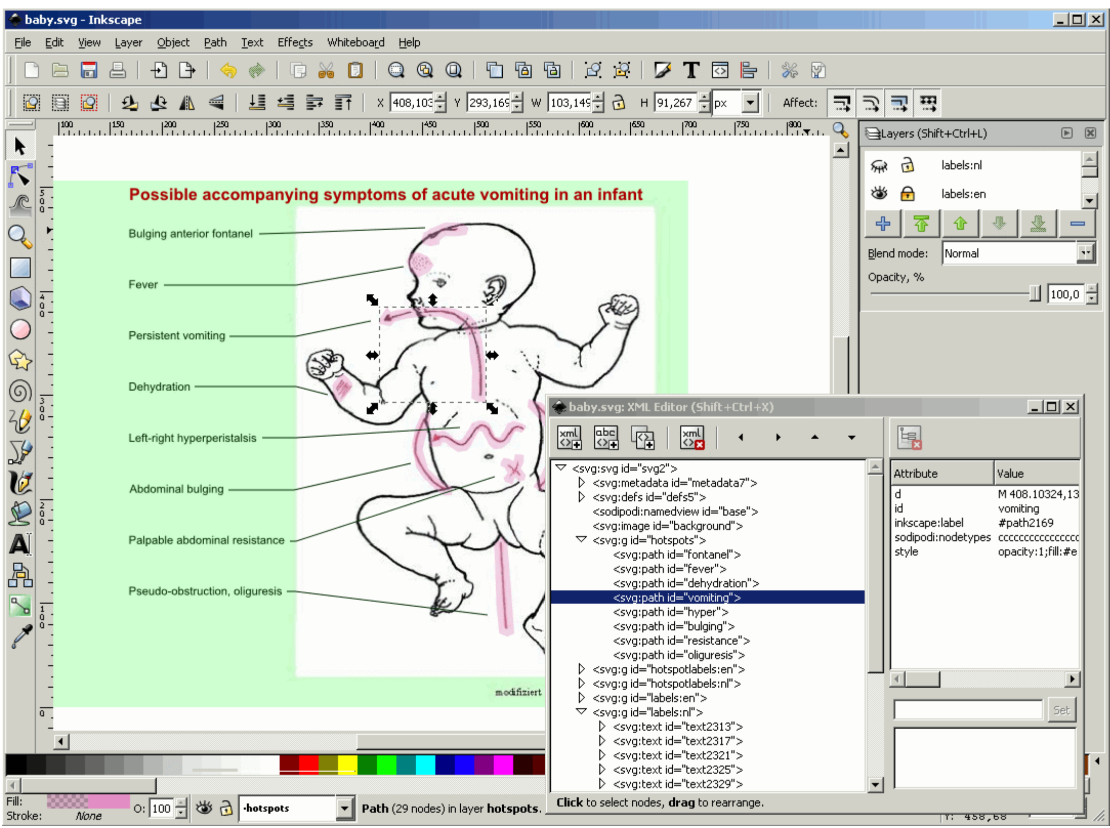


Figure 3: Creating an interactive image using Inkscape

CAMPUS Animation Editor

The CAMPUS Animation Editor is a Java-based tool for creating interactive images of different interaction degrees, based on Animage. In order to further ease the process of creating interactive images, the CAMPUS Animation Editor tries to offer the user predefined templates for each supported interactive image type. The Animation Editor offers a flexible structure that can be extended with plugins for new image types. The user is guided through the creation process by wizards whenever possible, reducing the creation process basically to three steps.

In the first step the author has to select a template from the list of supported interactive images (Figure 5).

In the second step an image has to be loaded as well as, depending upon selected type, further labels, text fields or polygons have to be added (Figure 6). Each animation type has its own editor to reduce the complexity.

To internationalize labels the author has the possibility to insert the translated terms into a translation table. Furthermore, the author has at any time the opportunity to get a preview to make sure the result is as intended. Once the image is completely created, the author can export this image into the appropriate format (Figure 7) in the third step. The generated image can then be used, for example, as part of a virtual patient.

The usual way of including interactive images in a CAMPUS virtual patient is adding them as media files in the CAMPUS authoring system. To use them in multiple VPs the images are stored in the CAMPUS media database.

Results

An exploratory experiment concerning a memorizing task indicates that adaptable interactive images as supported by Animage (and by CAMPUS Animation Editor) empower students to use their own learning strategy. In the experiment we offered life-science students the possibility to use either a classical interactive image (with fixed scaffolding) or an interactive image in which they could change the level of scaffolding themselves. The memorizing task involved the global anatomy of a chicken. After memorizing, the students were asked to point to requested organs in the unlabeled version of the image. Since Animage is able to detect and store all mouse movements of the student, we could register not only the learning outcome, but also the learning behaviour of the students. From these logs, we learned not only that each of the students using adaptable scaffolding used a different strategy, but also that the students using adaptable interactive images seemed to outperform students that were offered non-adaptable interactive images.

With the presented tools, physicians are able to provide interactive images in a simple and intuitive way. Although there are further tools like the well-known Adobe Flash offering the same or even more functionality, the reduction to the needed features enables non-programmers handling the creation of interactive images much better.

Discussion

Interactive images are already being used in different undergraduate courses at the University of Heidelberg as well as at the Maastricht University. After obtaining some first feedback from the students by individual statements as part of a questionnaire about the strengths and weaknesses of the virtual patient and the used virtual patient system, it is planned to conduct a survey containing more detailed questions about the interactive images in spring 2009. One target of the survey is to collect information about the scenarios students use the images and the usefulness of such interactive images in general and especially for self-study.

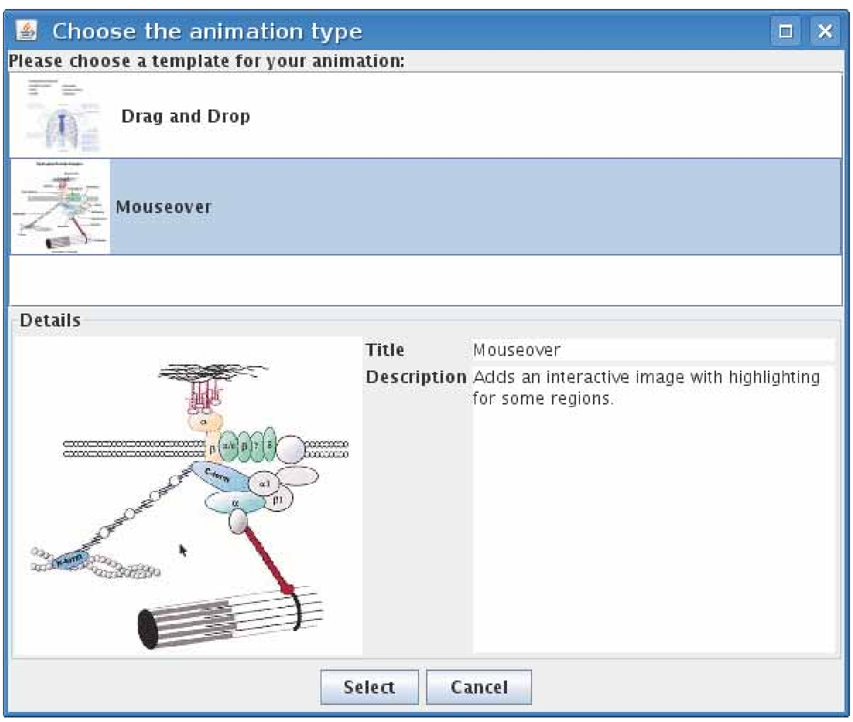


Figure 5: Wizard for creating a new interactive image, step 1: Choosing a template

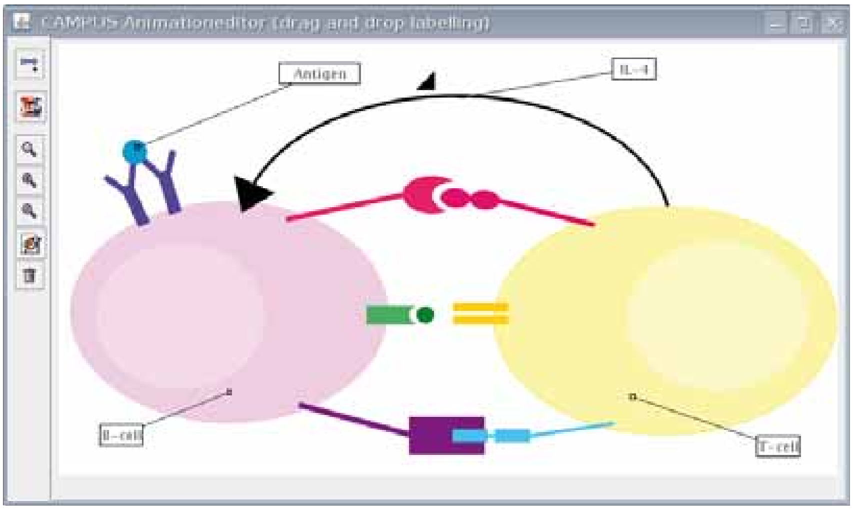


Figure 6: Wizard for creating a new interactive image (drag and drop), step 2: Adding labels

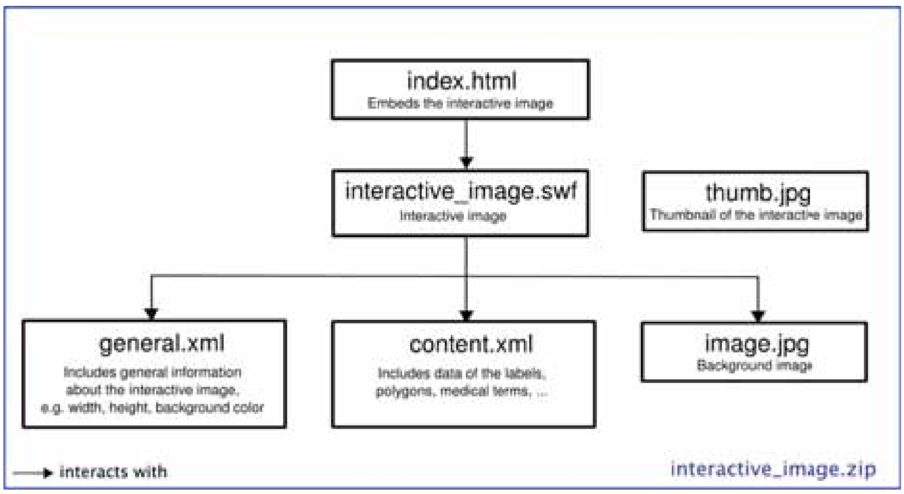


Figure 7: Components of an interactive image in CAMPUS

References

[1] Reddy U., Sripada B. N., Kulkarni R. (2006). How to Teach Medical Concepts Using Animations by Designing Multimedia Instructional Application. In IEEE International Conference on Systems, Man and Cybernetics. 1778-1785.

[2] Tunuguntla R., Rodriguez O., Ruiz J. G., Qadri S. S., Mintzer M. J., Van Zuilen M., Roos B. A. (2008). Computer-based animations and static graphics as medical student aids in learning home safety assessment: a randomized controlled trial. In Medical Teacher. 30:8. pp. 815-817.

[3] Larsen D. P., Butler A. C., Roediger H. L. (2008). Test-Enhanced Learning in Medical Education. In Medical Education. pp. 959-966 (8).

[4] http://www.campusvirtualpatients.com

[5] O'Byrne P., Patry A., Carnegie J. (2008). The development of interactive online learning tools for the study of Anatomy. In Medical Teacher. 30:8. pp. 260-271.

[6] Rotthoff T., Baehring T., Dicken H. D., Fahron U., Richter B., Fischer M. R., Scherbaum W. A. (2006). Comparison between Long-Menu and Open-Ended Questions in computerized medical assessments. A randomized controlled trial. In BMC Med Educ. 2006. 10(6):50.

[7] http://www.adobe.com

[8] Donkers J., De Leng B., Muijtjens A. (2008). Animage: Learner-adaptable Scaffolding in Interactive Images supporting Individual Learning Strategies. In Proceedings of the EARLI Special Interest Group Text and Graphics. pp. 174-175.

[9] http://www.inkscape.org

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 79-82

REPURPOSING VIRTUAL PATIENTS FOR THE PRECLINICAL YEARS – A PILOT STUDY

Stephan Oberle[1], Simone Huber[2], Burkhard Tönshoff[3], Ralph Nawrotzki[4], Sören Huwendiek[1]

[1]Zentrum für Kinder – und Jugendmedizin, Zentrum für Virtuelle Patienten, Universitätsklinikum Heidelberg, Heidelberg, Germany
[2]Zentrum für Virtuelle Patienten, Universitätsklinikum Heidelberg, Heidelberg, Germany
[3]Zentrum für Kinder – und Jugendmedizin, Universitätsklinikum Heidelberg, Heidelberg, Germany
[4]Anatomie und Zellbiologie II, Universität Heidelberg, Heidelberg, Germany

Abstract
Introduction: Electronic virtual patients are becoming increasingly more popular in medical education. These interactive clinical scenarios seem to be well suited to integrate clinical case examples into preclinical education, thereby demonstrating relevance of the subjects studied and fostering transfer between theoretical and clinical subject matter. We report on a pilot study dealing with the repurposing of an existing clinical virtual patient to the preclinical part of medical education, with an assessment of the associated effort.
Methods: For this pilot study, a CAMPUS virtual patient (www.campusvirtualpatients.com), originally created and implemented for teaching and assessment within the regular pediatric curriculum, was taken and repurposed for the preclinical part of medical education. According the preclinical learning objectives, this virtual patient was redesigned and the clinical level of difficulty was simplified. For the first time interactive graphics were used in the CAMPUS system. 26 second year medical students voluntarily worked through the virtual patient as self study, then completed a questionnaire.
Results: 26 students took part in this pilot study. The results indicate a very high acceptance of virtual patients as learning tools and attest to a successful combination of clinical and preclinical elements. Students wish to have more virtual patients like the one presented, with cases in different preclinical subjects. The level of difficulty with respect to clinical features and the required knowledge needed to successfully complete the virtual patient is rather sophisticated for the preclinical part of medical education. The calculated associated effort for repurposing was 68 hours.
Conclusions: This pilot study indicates that students appreciate using virtual patients as a part of their preclinical education. It seems worthwhile to repurpose clinical virtual patients for the preclinical years. However, confirmation with a larger student population is needed and studies higher up within the Kirkpatrick levels would be beneficial.

Keywords: virtual patient, campus, medicine, education, basic science, pilot study

Introduction

Only 10 to 15 % of the (preclinical) basic science knowledge, such as biochemistry, physiology and histology, can be transferred by medical students into applied clinical thinking and clinical problem solving [Norman 2008]. According to Norman [2008], this transfer can be greatly increased by: a) teaching "preclinical basic concepts" with clinical examples; b) teaching these basic concepts within clinical examples – examples in addition to those mentioned during the introduction of the concept; and c) repetition within many clinical examples covering the entire period of study.

As real life patients are becoming less available, virtual patients are a tool to engage students with clinical problems as adjunct to real patients. The development of virtual patients "from scratch" is very time consuming and costly [Huang et al. 2007]; "repurposing" virtual patients, as is done within the eVIP project, [Poulton et al. 2008] seems more efficient.

Integrating knowledge of basic science concepts into already existing clinical virtual patients, and adapting them for use in the preclinical years seems to be well suited to support the above mentioned strategies to foster the transfer of basic science knowledge. We are not aware of any other study with this aim: to investigate the repurposing of existing clinical virtual patients for the preclinical years. Therefore, we performed a pilot study to investigate the effort needed to repurpose virtual patients from clinical to preclinical medical education, and evaluated the response of the preclinical students.

Methods

Setup

For this pilot study, a virtual patient originally created and implemented for education and assessment within the regular pediatric curriculum was taken and repurposed for the preclinical years.

First, a basic science teacher and a clinician chose the existing virtual patient, thereby ensuring suitability for the pilot study in terms of content as well as organizational aspects, such as planning which existing teaching event will receive the virtual patient. The next step was to define detailed preclinical and clinical learning objectives for the virtual patient. To approach this, basic scientists, clinicians and students exchanged materials and literature, and discussed the learning objectives for the planned virtual patient. This virtual patient was then accordingly redesigned and simplified in terms of clinical level of difficulty. As a last step, the case was reviewed amongst senior physicians and basic scientists to assure the accuracy.

Virtual patient software

CAMPUS is a vocabulary-based virtual patient shell [Garde et al. 2005]. Its authoring system allows easy development of virtual patients with integration of background knowledge, such as expert comments. The system supports multiple choice or free-text questions, and the use of multimedia, such as pictures, audio and video. In this study the card-player was used (www.campusvirtualpatients.com). This card-player can be used on HTML-basis with every web browser. In the presented study interactive graphics were used for the first time to verify student's knowledge in a new way (for more details, refer the article by Huber et al. in this issue).

Testing and Evaluation

The virtual patient was presented in the context of a cell biology seminar. Students in their second year of medical education attending the seminar were encouraged to test this virtual patient. They could do so at home on a voluntary basis in addition to recapitulation of the seminar's content.

A student questionnaire was developed and tested for conformance with students. It was integrated as an online questionnaire at the end of the virtual patient. It consists of 10 questions covering 'linkage of preclinical and clinical content', 'handling of the player', 'increase of knowledge', 'difficulty', 'wish to have virtual patients as part of other seminars', 'overall grade'. Answers could be given on a Likert-scale from 1='strongly disagree' to 5='strongly agree'. Furthermore, free text answers could be given concerning 'weaknesses and strengths' of the virtual patient.

Results

26 students in the second year of their medical studies completed the questionnaire. In the following figure a summary of these results is shown (Fig. 1).

92.3% declared a successful linkage of preclinical and clinical content and 84.6% attested to having learned something useful. 92.3% wished to have virtual patients as a part of other seminars in the future. 88.5% had no problems handling the program (3.4% gave no answer, 3.4% had problems, the rest had no opinion). 69.2% attested an adequate level of difficulty, whereas 11.5% thought the difficulty was too high (the rest had no opinion). The overall grade in a scale from 6='very good' to 1='very bad' was given with an average of 5.7. An extract of the freetext answers is given in table 1.

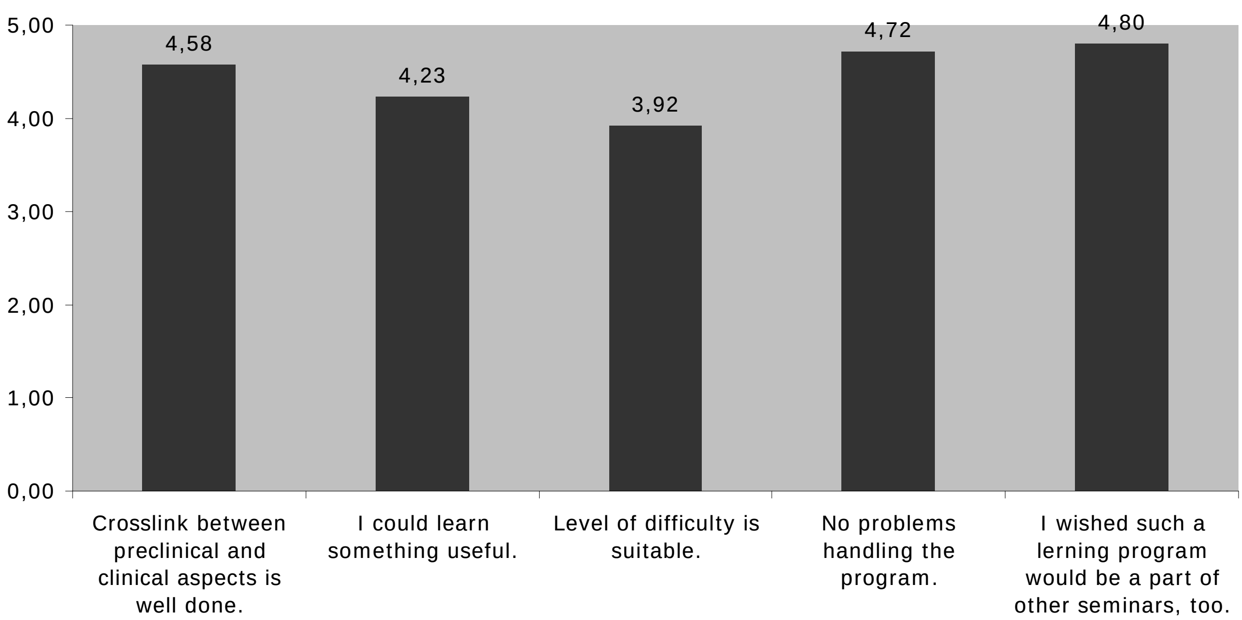


Fig. 1: Acceptance and relevance of the project. Values are given as mean on a Likert-scale from 1='strongly disagree' to 5='strongly agree'.

The effort to repurpose this virtual patient consumed 68 hours. A summary of the repurposing steps is displayed in table 2.

About 2 hours was needed for carefully selecting the case suitable for preclinical content, 10 hours for defining preclinical and clinical objectives, 12 hours for literature review with respect especially to the preclinical content, 15 hours for setting up questions and creating of expert comments within the virtual patient, 7 hours for simplifying the clinical content for preclinical students, 15 hours for development, setup and testing of interactive graphics, and about 7 hours for final checkup including review by experts and final completion.

Discussion

In this pilot study we repurposed a clinical virtual patient to suit the preclinical years. The results indicate a high acceptance rate and attest to a successful combination of clinical and preclinical content. Students wish to have more virtual patients like the one presented in other preclinical subjects.

To our knowledge, this is the first report on repurposing a clinical virtual patient for the preclinical years. Concerning Norman [2008], the transfer of preclinical knowledge into clinical problem solving is very important, but seldom realized by medical students. Virtual patients might support this transfer by early crosslinking of preclinical and clinical learning contents. In our study, students appreciated crosslinking very much. According to our experiences, repurposing clinical virtual patients to the preclinical years is feasible, and more efficient than developing virtual patients from scratch [Huang et al. 2007]. However, extensive effort is needed for integration of the virtual patient into the preclinical learning content, and for revising the clinical content for use in a preclinical environment.

However, due to our small study population, further studies are needed, preferably designed higher up the Kirkpatrick levels.

We are convinced that virtual patients are a powerful vehicle to foster the transfer of basic science knowledge into the clinical part of medical education. We are in the process of integrating further virtual patients into the preclinical years. The overall goal is to integrate virtual patients at Heidelberg Medical School into each preclinical and clinical discipline, in order to foster the transfer of basic science concepts to clinical reasoning through a longitudinal virtual patient project. Future studies will address whether or not our approach is successful.

Acknowledgement

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 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. Huang G., Reynolds R., Candler C., Virtual patient simulation at US and Canadian medical schools, Acad Med, 82: 446-51, 2007 DOI: 10.1097/ACM.0b013e31803e8a0a
3. Poulton T., Conradi E., Fors U., Fischer M., Huwendiek S., Ellaway R., de Leng B., Davies D., Muntean V., Laidler P., eViP: an EC-funded project to create a bank of multilingual, multicultural, virtual Patients. AMEE (Association for Medical Eucation in Europe) Conference 2007; 25-29 Aug 2007; Trondheim, Norway, Abstract 2O/P14, p. 20, 2007
4. Garde S., Bauch M., Haag M., Heid J., Huwendiek S., Ruderich F., Singer R., Leven F. J.: CAMPUS – computer-based training in medicine as part of a problem-oriented educational strategy, Studies in LEID, 2: 10-19, 2005

Table 1: Extract of freetext answers

Comments about the crosslink between preclinical and clinical content:

Good crosslink between preclinical-biochemical knowledge and clinical examination methods.
Preclinical theory is directly shown in a practical example.
Crosslink between preclinical knowledge and clinical aspects always gets explained.
The theoretical basis from lectures, histology and cellbiology seminars are explained via a virtual patient. Clinical techniques and anamnesis get trained.
Knowledge from cellbiology can be applied in clinical context.
Realistic example for daily routine in hospital.
It has become clear, why this preclinical knowledge is needed later on for clinical practice; playful extension of knowledge about diseases.
Repetition of preclinical knowledge and introduction into clinical therapy and diagnostics.

Strengths of this virtual patient:

Interactivity. *(3 entries)*
Different question-types and interesting videos.
Proactive labeling of figures; great figures.
Selfcheck-function.
Commentaries.
Step-by-step.
Playful teaching of still unknown content.
Very descriptive program, well chosen and answerable questions.
Good setup.
Easy handling, clearly arranged.
Comments.
Conceptional relation between biochemical events and clinic.
Connection between actual preclinical knowledge and clinic.
Crosslink between cellbiology, human genetics and clinic. It's really fun!

Weaknesses of this virtual patient:

None. *(5 entries)*
Too few cases, at the moment.
A test with grading at the very end would be fine.
Too difficult for preclinical medical students. *(4 entries)*
More explanations of technical terms needed.
More information and explanations about clinical examination needed.

Table 2: Efforts

Activity	*hours*
1. Case selection	2
2. Setup and definition of preclinical & clinical objectives	10
3. Literature review	12
4. Setup of questions and expert comments	15
5. Simplifying of clinical content	7
6. Development of interactive graphics	15
7. Final checks incl. review by experts and completion	7
Total	68

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 83

EFFECTS OF INTERFACE MODALITY ON A VIRTUAL PATIENT LEARNING EXPERIENCE

Olivier Courteille[1], Klas Karlgren[1]

[1]Karolinska Institutet, Sweden

contact author: Olivier Courteille, olivier.courteille@ki.se

Although the primary goal of a VP experience is not to entertain a user, communication research has shown that highly engaging and challenging interactive media interfaces do promote deeper motivation and concentration. Experimental studies have also shown that virtual encounters providing a social and natural interactive conversational interface lead to heightened involvement and decreased cognitive overload. It is therefore of special interest for the medical simulation community to investigate what users feel and experience when they engage in learning activities with VPs and how – and to what extent – they are affected by different interface modalities. More research is thus needed to unravel behavioural indicators of various VP learning experiences. This could, for instance, be achieved by means of video-based observational coding of behavioural responses exhibited during the VP encounter. Continuous recording of psychophysiological measures like galvanic skin response, electromyography or heart rate can be a supplemental and valuable option. Experiments have been conducted in order to assess the effects of different media modalities with VPs (like e.g. text-based vs. video-based answers; keyboard-based vs. voice-controlled dialogue). A coding scheme, based on observational verbal and non-verbal cues (like human facial expression, vocal behaviour, body gesture, gaze, think aloud, etc.) has also been applied for observing and assessing the different behaviours of students interacting with a VP. This research area has led to new insights about the impact of human factors in VP-based teaching. The preliminary findings will be presented and the implications of the results on VP design will be discussed.

Keywords: engagement, virtual patient encounter, interface modality, behaviour, conversational interface

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 84

REPURPOSING VIRTUAL PATIENTS WITHIN THE ELECTRONIC VIRTUAL PATIENT (EVIP) PROJECT

Claudia Frey[1], Inga Hege[1], Patricia Hinske[1], Martin R. Fischer[2]

[1]Ludwig-Maximilians-University München, Germany
[2]University Witten-Herdecke, Germany

contact author: Claudia Frey, cl@udiafrey.de

Background: eViP is a 3-year project for the provision of more than 300 repurposed and enriched multicultural virtual patient (VP) cases from across Europe. Taking advantage of existing VPs should reduce the effort for using them in contrast to creating them anew from a real patient's history. The participating online educational systems include Campus, Open-Labyrinth, WEB-SP and CASUS®.

Goal: We describe the process and effort of repurposing and adapting VPs from the different systems and educational scenarios into CASUS®.

Methods: LMU Munich and Universität Witten-Herdecke are repurposing and enriching 85 VPs for eViP and int them into their curricula for different target groups in the health sciences. The structures of the participating systems and their VPs are analyzed with regard to structure of information and didactical approach. All efforts necessary for repurposing, including the educational scenario and related media, are documented and compared to creating a new VP.

Results: The process varies largely, depending on complexity of the root VP. Exemplary repurposing of cases into CASUS® from the root-system Campus took 60 hrs and from OpenLabyrinth 29 hrs, about half of which was devoted to analysis of structure. Repurposing within CASUS® ranged from 1 to 6.5 hrs.

Conclusion: Repurposing significantly saves time compared to the new creation of a VP. It is especially time-consuming to (1) provide information to encourage diagnostic and therapeutic reasoning for the learner and to (2) collect material like findings, images, videos etc. This can be saved by adjusting existing cases.

Keywords: repurposing, VP, process, effort

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 85

AUTHORING VIRTUAL PATIENTS FOR MEDICINE AND NURSING CURRICULA – SIMILARITIES AND DIFFERENCES

Ingela Lennström[1], Carina Georg[1], Nabil Zary[1]

[1]Karolinska Institutet, Sweden

contact author: Ingela Lennström, ingela.lennstrom@ki.se

Background: Web-SP is a virtual patient system, among many others, with a core aim to improve students' clinical reasoning capabilities. Web-SP was initially designed for medicine but its flexibility has enabled the authoring of virtual patients (VPs) for dentistry and pharmacy. The aim of this study was to investigate the differences and similarities between VPs created for medicine and nursing curricula.

Method: Two experienced teachers from the early and late terms were recruited to the study. They iteratively mapped a standardized evidence based nursing care process to the virtual patient medicine template provided by default by Web-SP. The final result was agreed using a consensus decision model and then validated using peer-teachers and finally piloted with students from the second and fifth term of the nursing programme at Karolinska Institutet in Sweden.

Result: The teachers were able to customize the medicine template to represent the nursing care process. Similarities lied in the semi-linear mode of interaction with the patient and the shared collaborative clinical judgment that focused on the diagnosis and treatment of the patient disease conditions. The differences resided mainly in the terminology used, how the information was categorized and the manner the history questions were formulated. Furthermore the second autonomous part of the clinical judgment in nursing had to be implemented, which relates to treating human responses to actual and potential health problems. These findings implies that there may be opportunities of sharing VPs between the two disciplines and welcomes further studies on the authoring of integrated VPs for interprofessional education.

Keywords: virtual patient, authoring, medical education, nursing education, clinical reasoning, clinical judgment

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 86

THE IMPACT OF REPURPOSING TO DIFFERENT EDUCATIONAL LEVELS ON THE ATTITUDES OF MEDICAL STUDENTS TOWARDS VIRTUAL PATIENTS

Zofia Mazurek[1], Andrzej A. Kononowicz[2]

[1]Jagiellonian University, Poland
[2]Department of Bioinformatics and Telemedicine, Faculty of Medicine, Jagiellonian University, Poland

contact author: Zofia Mazurek, zofia.mazurek@gmail.com

Background: Virtual patients are gaining importance as part of the medical education. During the adoption process an existing virtual patient case must be not only translated, but also updated and modified according to the local culture, the characteristics of health-care system as well as the study curriculum. An important but sometimes overlooked element of the repurposing is the adjustment of the case to the educational level of the target group. The aim of the study: to present the workflow for repurposing a case to different educational levels as well as to evaluate attitudes of medical students towards two versions of the same virtual patient case destined for different target groups.

Methods: The original virtual patient presenting the diagnosis and treatment of cystic fibrosis was obtained from the eViP project repository. The case was initially developed at the Ludwig Maximilian University in Munich, translated from German into Polish, modernized and localized. The simplified version of the case was based on the original case and repurposed according to 3rd year curriculum objectives of the Medical Faculty at Jagiellonian University. The students were randomly allocated to receive the original or the simplified version of the case. An electronic questionnaire prepared by the eViP consortium was used to evaluate the attitudes of medical students.

Results and Conclusion are pending.

Keywords: Virtual Patient Implementation, Curriculum, Attitudes of medical students

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 87

AUTHORING AND IMPLEMENTATION OF VIRTUAL PATIENTS IN NURSING – THE NEW CHALLENGE AT THE JAGIELLONIAN UNIVERSITY MEDICAL COLLEGE

Aleksandra J. Stachoń[1], Elżbieta Walewska[1], Lucyna Ścisło[1], Dorota Matuszyk[1], Małgorzata Dziedzic[1], Andrzej A. Kononowicz[1]

[1]Jagiellonian University Medical College, Poland

contact author: Aleksandra J. Stachoń, orchis@o2.pl

Virtual patients (VP) have been used in teaching medical procedures and clinical reasoning in Western Europe and North America for many years. The idea of including virtual patients in Polish medical universities is just emerging. An example of this trend is the new initiative started in 2008 at the Jagiellonian University Medical College (JUMC) aiming at authoring and implementation of virtual patients in nursing. This activity – being carried out as part of the Electronic Virtual Patients project (eViP, http://www.virtualpatients.eu) – is particularly challenging because there were no previous attempts of using VP-based learning in the local nursing departments. Our goal is to create a repository of virtual patients concerning different nursing specializations and introduce these cases in actual courses. We are following two pathways for adding new cases to the virtual patient database. One method is to repurpose existed German cases (created primarily for medical students) obtained from the CASUS® system. The second approach is to create new cases by Polish nurses. Both types of workflows are currently being tested and during the summer term 2009 a few VP cases will be presented in nursing courses at JUMC within PBL or self study sessions. This short communication will summarize the key findings from the first year of the eViP project at the JUMC's nursing departments and also outcomes of implementing VPs in their curriculum. Our experience could be helpful for many medical schools willing to teach nursing students with virtual patients.

Keywords: eViP, nursing courses, virtual patients,

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 88

STUDENTS LANGUAGE PROFICIENCY AND CROSS-CULTURAL USE OF VIRTUAL PATIENTS

VALENTIN MUNTEAN[1], UNO GH FORS[2], NABIL ZARY[2], TUDOR CALINICI[1]

[1]University of Medicine and Pharmacy "Iuliu Hatieganu", Cluj-Napoca, Romania
[2]Karolinska Institutet, Sweden

contact author: Valentin Muntean, valentin.muntean@gmail.com

Background/rationale: Sharing educational resources, specifically virtual patients (VP's), among medical schools, is a way to improve education. However, several cultural aspects may have an impact on the development and the use of VP's.

What was done: As a part of the eViP-project, 30 Romanian medical students, with previous training exclusively in Romanian and good understanding of English, participated in a pilot study with VP's. We used three cases developed by our faculty with WebSP player. Every case had two identical versions, English and Romanian. Students were randomly assigned two different cases, one English and one Romanian. The students logged to the cases through the Internet from home. Interestingly, the average time per case was longer for the Romanian versions of VP's (55.7 +/ – 21.3min) versus English versions (48.2 +/ – 18.8min). We also found high differences for correct diagnosis and treatment plan among Romanian and English VP's. The diagnosis was correct in 13 of the Romanian VPs and 9 of English VPs, incomplete in 7 Romanian and 9 English cases and wrong in 2 Romanian and 4 English cases. The student answers were in Romanian for all Romanian versions and for 19 out of 22 English VPs.

Conclusions: We found unexpected high differences of student performance on Romanian and English versions of VP's.

Take-home messages: Further studies are necessary to refine those differences and to understand their significance. VP's could play a role in addressing the cultural diversity that exists in the society and increased mobility of healthcare professionals, students and patients.

Keywords: Virtual Patients, VP's, Language Proficiency, VP's Cross-Cultural Use, Web-SP

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 89

COMPUTERIZED VIRTUAL PATIENT PROGRAM SUPPLEMENTING MEDICAL EDUCATION. A PRELIMINARY EXPERIENCE IN KAOHSIUNG MEDICAL UNIVERSITY

Wen-Chan Tsai[1], Keh-Min Liu[1], Chung-Sheng Lai[1]

[1]*Kaohsiung Medical University, Taiwan*

contact author: Chung-Sheng Lai, d740094@kmu.edu.tw

Virtual patients increase the availability of training opportunities for medical students, making them less dependent on actual cases to learn how to handle different situations. Unlike real patients, simulated patients can be accessed on demand and they can be endlessly replayable to allow the user to explore different options and strategies. They can be structured with narratives that represent real situations while challenging the user with a wide range of tasks. Virtual patients may take a number of different forms: physical simulators: mannequins, models or related artifacts and electronic case study and scenarios where users work through problems, situations or similar narrative-based activities. Recently we installed a computerized virtual patient program in our campus as supplementary education for our medical students. Each scenario had 10 blocks including from present illness, physical examination to diagnosis and treatment. Students can interact with the virtual patients by pressing some buttons on the screen to invite for history, to do auscultation or search for X ray finding. We can analyze students' response by accessing to "student record files". We found that in total 84 students visited this program, 16 of them (19%) ran through all blocks in the scenario they visited spending from 25 to 192 minutes (median 91 minutes). 68 patients (81%) fail to complete the scenario, 45 of them (66%) quit the interaction at first block – present illness. Of particular interest, there were 12 students who re-visited the same scenario several times (from 2 to 8 times), but most of them quit at the first block (only 2 of them proceeded to blocks other than present illness). In conclusion, for a computerized virtual patient program, the first part of the scenario – present illness, should be the major impact to attract students' interest. Much effort should be taken to make the story more vivid at the beginning of the scenario.

Keywords: Computerized virtual patient program, medical education

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 91-98

REPURPOSING EXISTING VIRTUAL PATIENTS; AN ANGLO-GERMAN CASE STUDY

Chara Balasubramaniam[1], Terry Poulton[1] and Sören Huwendiek[2]

[1] *e-Learning Unit at St George's, University of London, United Kingdom*
[2] *Centre for Virtual Patients & Children's Hospital, University of Heidelberg, Germany*

Contact author: Chara Balasubramaniam, chara@sgul.ac.uk

Abstract: Virtual Patients (VPs) are expensive to make from scratch. An attractive solution is to take those from one institution and transfer them to another. However, is it educationally feasible to simply translate the language of a VP from one country to another?
The Repurposing Existing Virtual Patients (REViP) project between St George's, University of London and the University of Heidelberg has repurposed and content-enriched existing German VPs to English language, culture and pedagogy. These VPs were then embedded, tested and evaluated as core components within the paediatrics module and then ultimately made open to the wider community for free.
The project has confirmed that repurposing and enriching is an effective way to share and reuse VPs as opposed to creating from scratch. However, much care should be taken to make the VPs suitable for the educational needs of the student, in their local context.
This case study explores how the project was implemented and highlights the key outputs and conclusions.

Keywords: Virtual Patients, Repurposing, Paediatrics, German, UK, Virtual Learning Environment, REViP

Background

Electronic virtual patients (VPs) are defined as "interactive computer simulations of real-life clinical scenarios for the purpose of medical training, education, or assessment" [1]. Medicine and healthcare face the same problems: a need for interactive scenario based learning that provides alternatives to student-patient contact, which is declining because of the healthcare budget constraints that limit clinical teaching, and the reduction in the time that patients stay in hospital. VPs are now recognised by the medical education community as an effective tool for developing clinical reasoning. Such simulations provide students with a reliable and safe environment in which they can test their knowledge and reasoning skills safely and frequently, whilst at the same time drawing upon learning resources designed to extend their understanding.

The courses in these subjects are largely supported by workplace learning, and in the clinical years these are the 'clinical attachments'. There are a number of initiatives to support these attachments with virtual patients. Despite persuasive evidence of their effectiveness, virtual patients are not widespread in medical and healthcare curricula. VPs are "time and resource intensive to produce" [2], which is completely prohibitive to institutions that lack robust e-learning programs. These challenges and others have severely restricted the impact of VP simulation on the undergraduate medical curriculum. Where VPs are produced, development tends to be confined within single institutions, with little evidence of sharing. Those institutions that do prepare VPs have little opportunity to make them for more than one subject area.

So, is repurposing of existing VPs from one institution to another an effective way to progress rather than continually reinventing the wheel in isolation?

The REViP Project

The Repurposing Existing Virtual Patients (REVIP) project is a 1-Year project funded by the Joint Information Systems Committee in the UK and is a partnership between St George's, University of London (SGUL) and the University of Heidelberg (HD) that aims to:

- repurpose six VPs from the Germany to UK language, culture, and pedagogy and subsequently share with the wider community
- embed the repurposed VPs within an appropriately accredited SGUL module and subsequently evaluate the impact of the resources

In order to achieve the above, the content had to be transferred from CAMPUS (the HD VP shell) [15] and then repurposed to play within OpenLabyrinth (the SGUL VP system) [16]. This transfer of content was more than just a mere export of the data as the true repurposing involved conversion from the linear CAMPUS structure to a more branched OpenLabyrinth structure.

Methodology and Implementation

From the start of the project, the decision was taken by the project team to follow a project management methodology in order to achieve the project outputs to the desired quality within the agreed budget. This methodology was based on PRojects IN Controlled Environments 2 (PRINCE2) which is a recognised project management method in the UK [3]. All of this work was implemented according to an agreed project plan.

Start-up and Initiation stage

Firstly, the Project Director started the project by appointing a Project Manager and then jointly selecting a project management team. This was all done within the first month of the project, having consulted the key stakeholders, i.e. e-learning staff, module administration staff, subject matter experts (SMEs), project sponsors, intellectual property officer, learning technologists, technical developers and module validation team.

All stakeholders were involved in reviewing previous resources given to students as well as reviewing and selecting the most appropriate topics within the field of paediatrics to be supplemented with virtual patients.

Planning stage

The team then got together to review and refine the project plan. During this process, the critical success factors were identified and analysed. The next step in this process was to identify the activities that were necessary to complete the work, along with any interdependencies. Resource estimating and scheduling was also done during this process. A summary of all the work carried out during this stage was compiled into a plans dossier.

Controlling stage

The six virtual patients (VPs) from Heidelberg were then made available to the subject matter experts at St George's. The next stage was to carry out the repurposing and enrichment tasks according to the project plan. This controlling stage involved: Authorising work packages to start

- Assessing progress of the tasks
- Capturing any project issues or risks and taking corrective action
- Reporting any highlights and disseminating to the wider community via the project website

Repurposing and enrichment stage

Due to the unique nature of this project involving repurposing and enrichment of content from one country in one VP system into another country and another VP system, a detailed workflow was constructed to outline this process. As such, the process of quality assurance was built into this workflow too (Figure 1).

Quality assurance stage

Once the virtual patients were repurposed and enriched, the outputs went through rigorous peer review and quality assurance processes (as illustrated at key points on the workflow in Figure 1), in order to meet the requirements outlined in the quality plan.

A quality assurance scheme was followed to ensure the maintenance of standards in five key areas:

1. The educational validity of each re-purposed VP;
2. The attractiveness and overall quality of the content;
3. The usability and overall quality of the interface;
4. Consistency of presentation within and between VPs;
5. Technical conformance to any standards for the sharing of resources

Intellectual Property Rights clearance stage

The role of intellectual property rights was a key issue to be resolved in the project. When digital content is shared with other schools and distributed widely, digital copyright issues come into play. Unless all intellectual property rights (IPRs) and plans of the authors regarding the VP are confirmed upfront, the ability of the school to share the VP may be inhibited. So, the team had to start the process of resource clearance at the very beginning of the project so that it did not delay the project. This process also had to take into account giving content providers a cooling-off period so that they had the opportunity to revoke or cancel the agreement if they so wished, particularly as the content was often medically related and in some cases personal. The team worked closely with the eViP Programme [4] to develop the following workflow for IP clearance for virtual patient content (Figure 2).

The team, lead by the institutional intellectual property officer then adopted the eViP common consent form for appropriate retrospective clearance of content. All content contained with the VPs used in REViP were subject to this sign-off procedure. Refer to the eViP site [4] for a copy of this consent form.

Once this consent form was implemented and completed, the team identified a suitable licensing/sharing model for distributing the VPs. This model is the Creative Commons [5] model and the team decided to use an Attribution-Non-Commercial-Share Alike license to ensure maximum exposure of all content in a way that can be easily used by anyone from the wider community.

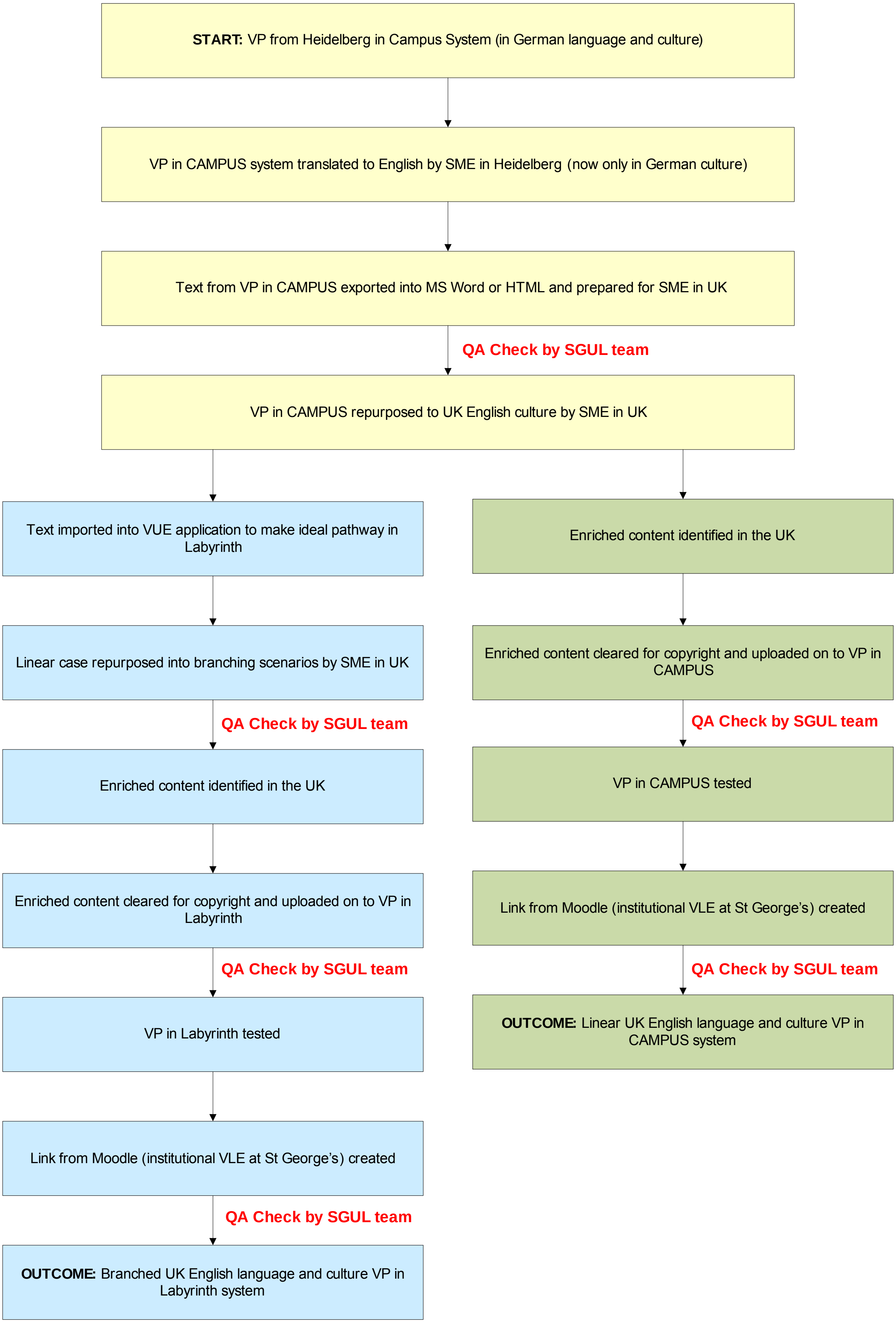


Figure 1 (above) illustrates the key steps in the repurposing workflow as identified by the project team.

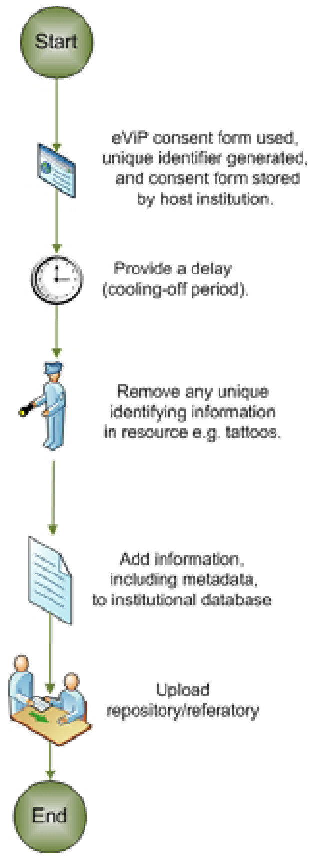


Figure 2 (above) illustrates the eViP workflow for handling IPR issues with respect to new content.

Creation of VLE infrastructure stage

The next step was to ensure that the module page on St George's virtual learning environment (VLE) was created and suitably customised to incorporate the newly repurposed virtual patient content. Once again, this was subject to rigorous peer review in order to meet the requirements outlined in the quality plan. See below for a screen-shot of the new module page in St George's virtual learning environment (Figure 4).

Testing stage

All content was tested before it was released to the students. Any bugs were identified and fixed as a result of this testing. All content was then finally released to the students on weekly basis for the entire 6-week duration of the course. Figure 5 is a screen-shot of a repurposed and enriched virtual patient.

Evaluation stage

Once the virtual patients were repurposed and enriched, a number of different evaluation studies, conducted with different stakeholders, were carried out. The objectives of the evaluation were concerned less with the processes by which the project went about its activities, and more with gathering information on the ease of adaptation of VPs and effectiveness of the repurposed VPs, feeding back to the wider community.

The evaluation was primarily to establish the worth of what had been achieved. Given the aims of the project, it was important to capture the experiences of the students, academic staff

Figure 3 (above) illustrates the specifics of the Creative Commons license attached to the repusposed and enriched VPs as part of the project.

Figure 4 (above) illustrates the VLE layout and structure of the new module site for paediatrics, created as part of the project in Moodle.

Figure 5 (above) illustrates a screenshot of a final repusposed and enriched VP case called Catherine Miller.

and subject matter experts to provide data which would provide insight to inform future developments. A mixed-methods approach was employed to provide a cost-effective approach to collecting and analysing data. This included the following evaluation studies:

1. Student individual VP questionnaire
2. Student collective VP questionnaire
3. Student focus group report
4. Staff interview
5. Critical friend group report

Awareness and dissemination stage

Over the course of this project, a number of awareness and dissemination activities were carried out by the project team. In fact, at the start of the project, a website and Blog was created to help with these activities. There was much national and international interest in repurposing, enriching and sharing Virtual Patients. A key part of REViP was to disseminate best practice and feed directly into some of the other major initiatives. The REViP team had engaged in collaborations with:

- The eViP Programme on the issues concerning repurposing from one country to another [4]
- The MedBiquitous consortium on implementing a common technical standard to share content effectively from one system to another [6]
- The Creative Commons Learn group on scoping and devising a process to clear an intellectual property rights issues relating to digital medical content [7]

The team also produced a video case study summarising the key stages of repurposing and enriching content from a staff perspective [8] (Figure 6).

Project closure stage

Finally, the project was closed and formally decommissioned once any follow on actions, exit and sustainability plans and project evaluation review had been conducted. The REViP team has agreed to make ALL repurposed and enriched VPs available for free with open access via an online referatory or repository. It is anticipated that once Jorum Open (the UK Educational National Open Repository) is 'live' [9], this will become the sustainability model of choice for the REViP project and will be subsumed into Jorum's Business As Usual processes for maintenance. In the meantime, the VPs will be hosted and disseminated on the REViP site.

Outputs and Results

The main outputs and results from the REVIP project are described below.

The repurposed Virtual Patient resources

The team has repurposed, enriched, implemented, and delivered 8 open VPs for the wider community. This is in fact more VPs than originally committed. It is envisaged that these resources will impact all three stakeholder groups (staff, students and the JISC wider community) but will significantly improve the quality of students' learning.

As mentioned before, there have been two styles of VPs using the same narrative/story being used (CAMPUS and OpenLabyrinth) by this group of students. They are different in style. The CAMPUS system originates from Heidelberg and is linear in terms of steps through the case. Whereas, the OpenLabyrinth is the St George's VP system and is branched in structure as it gives students different options and pathways to explore.

The latest REViP VPs are available on the project website [10].

Figure 6 (above) illustrates a screenshot of the YouTube video created by the team to showcase the process of repurposing and enriching from a staff perspective [8].

Virtual Patient evaluation with students

Three separate studies were conducted with students and the repurposed Virtual Patients:

1. Student individual VP questionnaire (n=12). This was conducted with students on a weekly basis for 6-weeks during the course of their module immediately after the VPs were deployed. The overall feedback from the students was in favour of such learning resources. The students used both types of VP systems to feedback on. The majority of students who took this questionnaire felt that after completing such a resource, they were better prepared to care for a real life patient. This is a bold statement that shows that these types of resources fit a gap in the curricula with regards to teaching students clinical decision making skills. In fact, over 90% of the students who completed the questionnaire reported back favourably again by adding that resources were a worthwhile learning experience.
2. Student collective VP questionnaire (n=25). This was conducted with students at the end of their module to capture their feedback on VPs as a collective. Interestingly 40% of the students who completed this questionnaire felt that VPs were an effective way to learn data interpretation. This came as a surprise to the team as it wasn't something that they felt that students would use VPs for. Another interesting statistic that arose from this questionnaire was that over 56% of the respondents used electronic resources more often than and about the same as a traditional textbook. This clearly shows a change in the student culture over the years in comparison with data from other projects in the past such as REHASH [11]. There was also a spread with regards to how much time the students spent on completing the VPs, ranging from less than 5 minutes to over half an hours. It later transpired that this was due to the different ways in which students were using the VPs (some for revision, some to learn generally, some before lessons).
3. Student focus group report (n=3). This was conducted with students at the end of their module to capture their detailed feedback on VPs in a qualitative manner. Students were enthusiastic to try out the VPs, and once started, highly motivated to choose correct options. They believed VPs provided excellent learning, in a context which mimicked the making of their profession. It provided them with opportunities to practice clinical reasoning, then take decisions and explore the consequences of their decisions. VPs provided them with opportunities for learning by collaborative discussion and in tutorials, but it also provided opportunities for individual safe practice, personal revision and self-assessment. The students described VPs as quick and easy to use, easily integrated into their study time, and available anytime, anyplace. There were a few improvements suggested to aspects of the VP structure, notably a request to batch the tests up in the way that clinicians would normally practice; students did not like trawling through series of test one after another. Most improvement requests were easily addressed.

Virtual Patient evaluation with staff

This was conducted by interview with two subject matter expert staff at the end of the module to capture their detailed feedback on the process of repurposing VPs and integration into the curricula in a qualitative manner. The staff commented that their repurposing was done in two steps. The existing content was already translated to English by the German team in Heidelberg.

Firstly, the subject matter experts at St George's would repurpose the existing content from German culture, and German interpretation of the English language to English (and specifically London) culture, and native English language. In addition to this the expert would also check the validity of units, reference ranges for laboratory tests, and healthcare NHS protocols like the National Institute of Clinical Excellence [12] guidelines to fit the UK requirements. This was a straight forward process and took approximately an hour per case as there weren't many changes in how a patient is treated and cared for between Germany and the UK.

Secondly, the content was then repurposed from linear to branched in structure and this is what took time. The existing linear scenario needed to be story-boarded and expanded. This was done during an initial brainstorm meeting between two subject matter experts. Once this was done the narrative of the case had to also be created using the third party Visual Understanding Environments tool developed by the University of Tufts [13]. This second step took a total of 10 hours per case.

In total, 11 hours were taken to repurpose the case to fit the needs of the students and staff at St George's. All of this means that once content such as VPs are made open, it has the power to make an impact internationally. In fact, Heidelberg are now using the branched repurposed and enriched REViP cases to implement back with their students in the OpenLabyrinth system. This supports the notion that a number of VP systems can work in tandem without the need for competition provided their unique selling points are different. In this case, OpenLabyrinth has the ability to include different branches, allowing different clinical consequences of different options. The CAMPUS system provides students with an opportunity to learn from the feedback after making different investigative and therapeutic decisions.

Dissemination of Virtual Patients and OpenLabyrinth to the wider community

In order to achieve maximum exposure, the 8 repurposed and enriched VPs (with their Creative Commons licenses) will be made available to the wider community by the following sites:

- The REViP website
- Jorum Open (once the site is live)
- MedEdPortal VP repository [14]
- eViP referatory of VP content

Since the start of the project, a number of other European institutions have adopted and trialled the use of OpenLabyrinth and CAMPUS as their preferred Virtual Patient systems of choice. This is mainly due the branching nature of the OpenLabyrinth system and the flexibility of the CAMPUS system.

These institutions from Norway, Greece, Holland, Australia, Germany and the UK have seen presentations by the team in conferences such as AMEE and have already adopted the two systems for testing. In fact, SGUL and HD now run both the linear and branched systems in parallel.

Improvement in e-learning support for module

The paediatrics module at St George's did not have a web presence on the institutional virtual learning environment before the start of the project. Since then, the REViP team have had the opportunity to design a suitable web infrastructure for their module page, populate it with relevant e-learning resources, add the repurposed and enriched VPs, and integrate it into their learning weeks. Having gone through this process, this institutional change will position the module in a way that it can now be self sustained by the module team in the future years and adapted efficiently as a result of any curricular changes.

Conclusions

In practice the straightforward repurposing of a linear virtual patient from one healthcare culture to another (i.e. from HD to SGUL) was an efficient use of time and resources. This study demonstrated that even though there is often a strong requirement for contextualisation each time a learning resource is repurposed, it can still be worth the time and effort, if the learning resource has sufficient value in its new context.

However in this study, the repurposing went further and took on the task of turning the linear VP into a branching VP with options and consequences. In effect this was new work, and so the same time and effort was required as if an English linear case was being similarly adapted.

It was clear that the value attached to VPs arose from the possibility of learning something that was essential to future practice, but difficult to acquire by other methods. This learning was the opportunity for decision-making, exploring consequences of actions, and for safe practice. Students were enthusiastic to use these resources in a variety of different ways and learning styles, and recognised the value of a resource that mimicked practice. It clearly personalised their learning. Teachers, developers and students described the outcome as highly successful.

References

[1] Ellaway, R., Candler, C., Greene, P., and Smothers, V. (2006), An Architectural Model for MedBiquitous Virtual Patients, Baltimore, MD, MedBiquitous.

[2] Huang, G., Reynolds, R., Candler, C. (2007), Virtual Patient Simulation at U.S. and Canadian Medical Schools, Academic Medicine.

[3] PRINCE2 description on the Office of Government Commerce UK website, ONLINE, accessed on 7th February 2009. http://www.ogc.gov.uk/methods_prince_2.asp

[4] eViP Electronic Virtual Patients official website, ONLINE, accessed on 7th February 2009. http://www.virtualpatients.eu/

[5] Creative Commons official website, ONLINE accessed on 7th February 2009. http://creativecommons.org/

[6] MedBiquitous Consortium official website, ONLINE accessed on 7th February 2009. http://www.medbiq.org/

[7] Creative Commons Learn official website, ONLINE, accessed on 7th February 2009. http://learn.creativecommons.org/

[8] REViP Impossible Mission video on YouTube, ONLINE, accessed on 7th February 2009. http://www.youtube.com/watch?v=uCZp30tQ3MM

[9] Jorum UK national repository official website, ONLINE, accessed on 7th February 2009. http://jorum.ac.uk/

[10] REViP project official website, ONLINE, accessed on 7th February 2009. http://www.elu.sgul.ac.uk/revip/

[11] REHASH project official website, ONLINE, accessed on 7th February 2009. http://www.elu.sgul.ac.uk/rehash/

[12] National Institute of Clinical Excellence official website, accessed on 7th February 2009. http://www.nice.org.uk/

[13] Visual Understanding Environments official website, accessed on 7th February 2009. http://vue.tufts.edu/

[14] MedEdPORTAL repository official website, accessed on 7th February 2009. www.aamc.org/mededportal

[15] CAMPUS Virtual Patient official site, accessed on 7th February 2009. www.campusvirtualpatients.com

[16] OpenLabyrinth Virtual Patient official download site, accessed on 7th February 2009. http://sourceforge.net/projects/openlabyrinth/

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 99

MEDEDPORTAL: PEER REVIEWING, PUBLISHING AND DISSEMINATING VIRTUAL PATIENTS

Robby Reynolds[1], Gabrielle Campbell[1]

[1]Association of American Medical Colleges, USA

contact author: Robby Reynolds, rreynolds@aamc.org

Medical educators devote significant time and effort into creating virtual patient (VP) cases, simulation patient cases, standardized patient cases, and numerous other forms of educational resources. Peer-review and sharing of such resources encourages the creation of high quality educational scholarship and promotes adoption of innovative materials in the VP community. The Association of American Medical Colleges (AAMC) developed MedEdPORTAL (www.aamc.org/mededportal) 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 VPs and all the other various types of educational resources relevant to medical and dental education. MedEdPORTAL currently consists of over 1,000 successfully peer-reviewed published medical and dental educational resources. There are currently over 100 published VPs, simulation patient cases, and standardized patient cases available in MedEdPORTAL. MedEdPORTAL publications are being utilized in over 2,000 medical schools, teaching hospitals and other institutions in 57 countries. MedEdPORTAL receives on average 40-50 new submissions each month.

The presentation will consist of an overview of the MedEdPORTAL system and provide examples of the VP cases already published and available for free to educators and learners around the globe. 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.

Keywords: Peer-Review, Publishing, Scholarship, Virtual Patients, Simulation, Standardized Patients, Utilization, Dissemination

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 100

CHALLENGES AND OPPORTUNITIES IN SHARING VIRTUAL PATIENTS

Angela Miller[1], Gabrielle Campbell[2]

[1]*St. George's, University of London, United Kingdom*
[2]*Association of American Medical Colleges, USA*

contact author: Gabrielle Campbell, gabriellecampbell@yahoo.com

The increasing recognition of virtual patients (VP) as a valuable resource for training healthcare practitioners has led to a demand for VPs that cover a variety of medical case scenarios. Due to the significant time, cost and effort required to create robust VPs, the only practical means of obtaining a wide range is by sharing created VPs between organisations. However, sharing digital content that incorporates medical information presents challenges of its own, not just the interoperability of the software but also the practicalities of sharing protected and regulated digital content to a wider audience than initially intended. Considerations should include: patient consent issues regarding the case information or recordings used in the VPs; jurisdictional differences in legal frameworks for data protection and copyright laws that relate to the developed resources; and matters about how shared and repurposed or jointly developed VPs will be used and distributed. Unless these factors are considered and confirmed upfront, the ability of an organisation to share the VP may be inhibited.

This presentation explains some of the challenges to sharing VPs and proposes possible approaches to overcoming them.

Keywords: sharing virtual patients; copyright; intellectual property rights

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 101

NET-BASED TRAINING FOR WORK RELATED MEDICINE (NETWORM)

LAURA WENGENROTH[1], MARIA JULIA CALVO[2], ALAIN CANTINEAU[3], DENISE CARVALHO[4], INGA HEGE[5], VERONICA HERRERA[6], MONIQUE ISLER[7], STEFANIE KOLB[1], TIINA LEHTONEN[8], BEGONA MARTINEZ-JARRETA[9], EDUARD MONSO[10], ELENA ANA PAUNCU[11], PAUL SMITS[12], ARUN DEV VELLORE[13], KATJA RADON[1]

[1]Ludwig-Maximilians University Munich, Institute for Occupational Social and Environmental Medicine, Germany
[2]Universidad Austral de Chile, Nursing School, Chile
[3]Louis Pasteur's University, Faculty of Medicine, France
[4]Federal University of Paraná, Brasil
[5]Ludwig-Maximilians-Universität München, Germany
[6]Universidad de Chile, Chile
[7]University of Montréal, Canada
[8]Finnish Institute of Occupational Health, Finland
[9]University of Zaragoza, School of Occupational Medicine, Spain
[10]Institute for Research in Health Sciences Germans Trias i Pujol, Spain
[11]University of Medicine and Pharmacy "Victor Babes", Romania
[12]University of Amsterdam, Academic Medical Centre, The Netherlands
[13]Birmingham Heartlands Hospital, Occupational Lung Disease Unit, Dept of Thoracic Medicine, United Kingdom

contact author: Laura Wengenroth, Laura.wengenroth@med.uni-muenchen.de

Since 1999 NetWoRM (www.networm-online.eu) has provided an international platform for sharing e-learning cases related to occupational medicine (OM). Centers in Europe (funded by the EU), Latin America (funded by DAAD), North America (funded by the Bavaria-Quebec programme) and Africa are joining NetWoRM.

Each virtual patient case implemented in CASUS® ; represents an important OM topic, presented from the perspective of a student, doctor or patient. The user interacts with the case by answering questions (multiple choice, free text, etc.) on which feedback is provided. Besides the case story; each case provides background information by expert comments, hyperlinks to relevant web pages or multimedia material (e.g., images, radiological findings, video clips)

The cases have been repurposed, enriched and adapted for local OM practices in France, Spain, the Netherlands, Germany, UK, Romania, Poland and Finland. It is important that the cases fit for the local health situations. Altogether 125 cases are available for medical students, nurses and postgraduates covering a broad range of training for OM today. Another focus is the development of cases for continuing medical education programs.

Evaluation results indicate the high acceptance rate and appreciation amongst users. Currently NetWoRM teams across the globe are joining resources to establish NetWoRM as a sustainable platform with independent economic viability along with the worldwide dissemination and update of the learning cases.

In summary, case-based e-learning as developed in the NetWoRM project represents a dynamic approach to international education and training in OM, which seeks to improve workers' health in the longer term.

Keywords: case based learning, virtual patients, occupational medicine

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 103-108

E-LEARNING *VERSUS* T-LEARNING

JAN MADEY, LESZEK RUDAK

Centre for Open and Multimedia Education, Institute of Informatics, University of Warsaw

j.madey@uw.edu.pl, l.rudak@uw.edu.pl

ABSTRACT: In this paper we will discuss the differences between the traditional, face-to-face education (*t-learning*) and the education supported by means of computers connected to the Internet (*e-learning*). We will present the main advantages of the latter one – which result from the very nature of this form of teaching – but also point out the disadvantages (real or imaginary). The conclusions are formulated in terms of "the Decalogue" of e-education, that is the collection of ten rules which makes the e-instruction at least as effective as the traditional one.

Keywords: education, e-learning, blended-learning

STRESZCZENIE: W niniejszym artykule omawiamy różnice pomiędzy tradycyjnym procesem nauczania, z nauczycielem spotykającym się z uczniami w sali (*t-learning*), a e-nauczaniem – edukacją zdalną poprzez Internet, wspomaganą komputerowo (*e-learning*). Przedstawiamy główne zalety tej ostatniej, wynikające z samej natury takiej formy nauczania, ale wskazujemy także jej prawdziwe lub pozorne ograniczenia. Konkluzje formułujemy w postaci „dekalogu", tzn. zestawu 10 reguł, których stosowanie przyczyni się do zapewnienia wysokiej jakości e-nauczania.

1 Introduction

It seems that education is one of the least slowly changing life domains. The present form of the organization of teaching in schools: the graded level system, has not changed for almost 500 years (from the time of J. Sturm and J. A. Comenius). At universities the instruction based on lectures: the meeting at the same place and the time, one lecturer for many students, has lasted even longer. Even introducing the modern equipment in education has also brought just a slight change – computers are used in stationary classes as regular tools (compasses, a ruler, etc.). The remote education has existed for a long time indeed. It was based on sending educational materials by post in the form of textbooks, lecture notes and course books from the college to students and the other way round – the solutions of the assignments were sent by students to the college. However, the range of this form of teaching and learning was quite limited.

The crucial change in the organization of the instruction may be in the offing now. The development of the Internet caused introducing and developing e-education. The modern technology allows for the rapid transfer of not only texts and images, but also sound records and films. However, the most important value is the possibility of getting in contact with people (in the synchronous and asynchronous mode). Modern e-learning platforms make it possible to transmit teaching materials (from a student to the teacher and from the teacher to students), consultations (the exchange of questions and comments between the lecturer and individual students), and even the leading of real discussion between all participants of the course (with the possibility of referring back to the previous opinions).

What changes are brought into teaching by this new medium – the global computer network? First of all the basic rule should be stated: education is a certain process, which can be carried out in different forms. The *t-education* (the tradition instruction: face-to-face meetings of the teacher and students) and the *e-education* (the instruction by means of computers connected to the Internet) are different forms of the same phenomenon: transferring the knowledge and skills from the teacher to learners. What decides about the effectiveness of e-instruction is the set of factors less dependent of the applied technology rather than the way of using the medium and the use of didactic rules suitable for this form of teaching.

The next section discusses the differences between e-instruction and t-instruction, which are natural advantages of education by means of the Internet. The following section shows "the seamy side" of the classes conducted by the Internet: disadvantageous differences between the two forms of teaching, at the same time some ideas how to get rid of the defects or just minimize their results were given. The last section contains "the Decalogue" of e-education, that is the collection of ten rules which makes the e-instruction at least as effective as the traditional instruction.

The ideas presented in this article bear upon the asynchronous model of e-education with the teacher. This means that it cannot be demanded from the student to do certain things in the strictly determined, punctual term in the network. Particularly, within the framework of an e-course, fulfilling the concept of this model, any obligatory chats are not organized and any communicators are not used. The participation of the teacher in activities can be done in various ways: from the consultation (the two-way communication initiated by a student), the commenting and evaluating the solutions of open exercises (the two-way communication initiated by the teacher) to the scheduled participation of the lecturer in all activities of students including discussions (the full multilateral communication).

2 Advantages of e-learning

We will now discuss the differences between t-learning and e-learning which make e-instructions superior to t-instructions. These advantages result from the very nature of this form of teaching, but they must be properly used in order to reach the high efficiency in education. Such conditions in the traditional teaching could not be obtained in any way or this process would cost too much (in the financial, organizational and methodical aspect).

2.1 Any Time, Any Place

The most often mentioned (and probably the most important) difference between t-learning and e-learning is the lack of the *unity of the place, time and action* in the latter case. Traditional teaching in schools[1] takes place in a class in which students meet the teacher at the appointed date (at universities this are classical academic classes: lectures, tutorials, seminaries etc.) and the teacher makes effort to cause profitable changes in the consciousness of the students. This process can happen only in the appointed place, at the appointed hour, in the presence of the teacher and pupils. The disturbance in any of these elements makes it impossible to begin the didactic process. In e-learning these conditions do not have to be fulfilled. The participant of the didactic process in the distance education may stay in the any place on earth. The only condition is the access to the Internet and the properly equipped computer. From every place of the globe one can log in to any educational platform, receive files with materials, watch animations or listen to the recordings. One can also take part in a discussion, prepare own solutions of assignments and do the tests. The lack of geographical limitations is a simple result of using the Internet as the medium for communication.

E-student is also not a subject to punctual limited times: he[2] need not come to lessons at a certain time. Didactic materials situated in electronic space of the course are accessible through a long period of time. It depends only from the student when (which day and at which hour) he will use them. The rule is similar as in case of a course book which can be studied day-and-night, but there are also fundamental differences: materials delivered by the network within the frame of e-course are usually considerably more varied than printed manuals, they can be interactive and full of movement. There are also accessible more easily: to get the manual it is necessary to go to the library, which can be difficult for students who live in places distant from the seat of the college. In case of e-courses, one can log in to the e-learning platform from his home, from an Internet Café or from any other place.

The third postulate of the unity – the action, is also not important in e-learning. As opposed to the school-class in which the process of the education takes place as the result of the actions performed by the teacher and students, the educational process in the instruction by the network is contained in the course itself. The student enters this process in the moment of logging in on the platform regardless of what the lecturer currently does and what is done by other participants of the training.

Therefore, in e-education the above discussed iron-rule of the traditional education – the unity of the place, time and action of the teacher and pupils – is no longer obligatory. This solves many problems, especially for adults who work and yet want to study, handicapped persons, parents with young children. It is easier to find time for studying, if one can determine himself both time and place of learning.

2.2 Variety of Forms

The second extremely important difference between the traditional educational model and the education by the Internet is the variety of organizational forms of classes. Stationary classes are always organized lineally, which means one activity (of the teacher or of students) at a time. In the traditional school the lecturer does not apply several teaching methods for the same group of students, or teaches them a few subjects simultaneously. However, there were some experiments taken with worksheets: every schoolboy received a form prepared in a certain way which had to be filled in individually during the lesson, gaining knowledge and new skills at the same time. He could ask the teacher for help in case of difficulties. The teacher had to select cards for individual learners so that they could gradually learn the whole material required. Such lessons were not the same as the traditional ones, with the teacher at the board and pupils sitting at desks and listening attentively, yet their efficiency was higher. Experiments described above concerned only elementary mathematics at primary school and unfortunately, introducing this idea to the more advanced themes is very difficult or almost impossible to convey. Therefore, in traditional instruction the linear model is still dominant.

The instruction through the Internet eliminates some problems which make it impossible to build other models of instruction. In this mode one can construct classes in many different ways. A course in which all course-materials will be made available to students on the first day will be different from the course in which the access to certain contents will be determined by the course of time. In the first case there is no certainty that in the specific time all participants would recognize the same content, though everyone had learnt from the materials avail-

1 Problems talked over in this article bear upon all types of schools, including higher educational institutions.

2 We will be using "he" for „he or she", "himself" for "himself or herself" etc.

able. Such approach evokes attractive discussions and group work. In the second case the instructor synchronizes students' work. He might assume what part of knowledge they managed to get and what they will do next. The other organization of the e-course might be done by making materials available only after getting the pass: the credit of all themes necessary to understand the new problem. Such structure fosters very systematic and effective acquisition of material.

Different forms of the organization of e-classes, based not only on the differentiation of the access to materials, which has been discussed above, but also on different degrees of communication and various structures of the transfer of the content make it possible to find the best form of classes to the contents taught, and consequently the enlargement of the efficiency of the instruction (Rudak, Sidor 2008).

2.3 Individual Fitting

What is connected directly with the variety of the organization of e-courses and with the freedom of choice of the place and time of learning, is the adjustment of the pace of the cognition of new themes to the possibility of the pupil, which is considerably better than in t-learning. Every e-student decides himself how much time he wants to spend on learning subjects required. As opposed to the traditional lecture, he can repeatedly return to the same fragments of the text, to the same exercises, to the same explanations. In addition, he does this independently, on his own computer, so he does not need to be embarrassed with the presence of the others. Thanks to this, a clever schoolboy is not bored during classes, when they are adapted to average students and he does not lose time. Yet, the pupil below the average can take as much time as possible to study the materials required.

Adjusting of the content of the e-course to the individual level of recipients can be automatized too. There are proposals of leading a student to the path adapted to his current possibilities automatically: the better results in the initial phase, the more advanced material can be presented to the student in the further part, and vice versa (taking into account, of course, the knowledge and skills a student is expected to acquire).

Adjusting the e-course to individual expectations and possibilities of a participant takes place in two areas. The first of them concerns learner's independent decisions about the amount of time he wants to spend on certain problems and the ways of learning. The other concerns the adjustment of structure of the course to the most effective teaching methods. In e-learning it is very regular solution, strongly supported by the technology (e.g. the e-learning platform Sakai).

2.4 Instant Testing

Yet another advantage of e-learning is a variety of possibilities of automatic evaluation of participants. Each e-learning platform is equipped with mechanisms for creating quizzes, presenting them to students and automatic check of answers.

It is obvious that every class test should be graded. In case of manual checking (which is the most common way of checking in the traditional instruction), the teacher must evaluate all tasks himself. This is very arduous work, even if the test consists of closed tasks and the key of solutions are well-known. Such tests are best for the automatic check. Unfortunately, in the traditional instruction one cannot easily use a computer, because test-sheets are filled by hand and it is necessary to digitalize them. However, in e-learning all activities take place by means of a computer. Therefore, tests are both ready in electronic form straight off and fitted for the automatic mark. This has another important aspect of testing by means of computer. The student recognizes its own test results just after having solved it. Then the emotional relationship of student with the test itself is sufficiently strong, to make the result of the whole test as well as the result of and thus evoke the reaction strengthening effects of learning.

At the same time e-teacher is exempt from the arduousness of checking the tests, and he can devote his time to the preparation of other assignments. Thanks to this, the e-course can contain more quizzes concerning certain problems than in traditional teaching. Such tests have a formative meaning first of all, so this significantly influences the rise of the efficiency of education in the remote mode with the use of the computer network.

3 Disadvantages of e-learning

In this chapter we will discuss some features of e-learning which are often indicated as week points of this form of education and which demand very careful planning of the didactic process. For every such a "disadvantage" we suggest the way to improve the situation. This is so much important because the features described below result from the very idea of the instruction by the Internet, and avoiding them requires changing of the organization of classes or abandoning certain elements of this form of education.

3.1 Not Everything…

Many academic subjects, such as philosophy, mathematics, cultural studies, political science can be learned entirely from lectures and textbooks, supplemented by consultations with specialists and discussions with other students. This kind of subjects can be easily changed for Internet courses (although it is necessary to work out a suitable didactic process, taking into account the specificity of e-instruction and differences between the traditional learning and e-learning). However, there are areas of knowledge that are difficult or even impossible to be acquired via the Internet. In (Bednarczyk, Rudak 2008) three rules describing subjects which cannot be taught this way are presented. Such subjects or topics are called *unsusceptible of e-learning*.

The subject is unsusceptible of e-learning if it demands either:

- the relation with the real thing, or
- the direct interaction with other people, or
- conveying the experiment in reality (acquiring practical manual skill).

Examples of such subjects are: archaeology – one cannot become an archaeologist, not having learnt how to examine the ancient monuments of culture and art; therapeutic psychology – the ability to have a conversation-interview with another person is the basic ability a therapist must learn; biology – every biologist must learn how to make preparations to the inspection by means of a microscope, and this skill must be learned in practice, the theory itself and watching video is not enough.

The disadvantage that results from the fact that smells, tactile impressions, feelings of the weight cannot transmitted by the net, is not easy to overcome without changing the fundamental part in the organization of the classes. Its importance in the effectiveness of e-teaching and e-learning can be slightly diminished by means of modern technologies, e.g. the 3D visualization (Miziołek 2007), interactive animations (Powell 2007), elements of the artificial intelligence to the expression of emotions (Alexander 2007), but this will be only a model still a far cry from the reality.

It is necessary to seek for the solutions of the problem in changing the organization of e-learning. Instead of teaching everything by the Internet, one should divide the things to be learned into two parts – the ones that could be taught and learnt by the Internet and the ones that need to be taught at face-to-face meetings. Thus, the whole course will consist of two alternating parts: Internet and traditional. Such form of education: *blended learning* (*b-learning*), seems most effective. It combines all good points of t – and e-learning, reducing defects of these systems to a great extent. The only problem is administering such courses, which becomes more difficult, but still the advantages surpass the disadvantages considerably.

3.2 Left Alone?

The starting point in creating the school system in the 16th century and its success in the school-organization, was (constantly confirmed) the observation that students obtained better results, if they learned in groups rather than when they learned themselves or only with the teacher (Wieczorkowska, Madey 2007). Leaving aside the reasons for such a situation it would be good to think what the mechanism of creating t – and e-education group is.

In the traditional school a social group is created regardless the students at the moment when they enter the school. One look, smile, a few usual words, looking around in search of the place, etc. is enough. All these factors make the others react to each other, and this means that a social group comes into being (Kenrick, Neuberg, Cialdini 1999). An additional element is the common aim – they all come because of the same reason: to listen to the lecture.

In the e-education the situation is completely different. The participants of a course do not see each other, they do not talk to each other directly, one person does not have an impact on another one, everyone is isolated from the others by means of their computer. Therefore, considering e-course participants as a social group is not possible. Moreover, the participants who feel not too comfortable with the modern technology are afraid of being left alone to cope with possible technical problems (concerning the computer, the Internet, the software being used in e-teaching).

However, fortunately the situation is not so bad. The group has the same aims: they all want to complete the chosen course. This element can be taken into account while forming the group, but it will not arise automatically. The teacher, assistants and the so called integrators must put additional effort into creating a social group from participants of the course. They must initiate the interaction between students and the staff. The creating a social group consisting of the participants of the course is one of the crucial elements ensuring the success in the online education. The integrator, in particular, should know all members of the group and be ready to help in solving possible problems they are facing (including the technical ones).

3.3 Teacher – the End User

Evaluating plays several roles in education. The most important thing for the efficiency of education is formative assessment made by a teacher in different phases of the didactic process. Evaluating in class means praising for good solutions or even a good beginning noticed by the teacher, plus preventing from making a big mistake and indicating the mistake in analysing the problem, etc. Such activities are undertaken by the teacher ad hoc on the basis of students' observation.

In the e-learning one cannot observe pupils at work. The only thing the teacher can notice is the solution of student's task sent to the e-teacher. In addition, because of the character of the data carrier (the computer file) this solution is "clean" – without any corrections, the individual handwriting, the specific arrangement of the text on a page, etc. This impression is enhanced by the fact that it is not possible for the e-teacher to observe students while working on a certain task. The final product is sent to be marked. It does not contain any information about the way of coming to the solution or the effort that had to be put by the student while obtaining the result. Such conditions can be treated as the advantage, but only when the final mark matters, which has a slight influence on the efficiency of education. Looking at it from the point of view of the efficiency of the didactic process, the formative assessment is much more valid, but it cannot be as so effective tool of the e-teacher as it is in t-learning (Keegan 2004).

The procedure for the improving the situation in formative assessment can be found in the part referring to the advantages of e-learning presented above: a huge number of tests which are checked automatically and with the feedback given immediately. Moreover, it is necessary to use the possibilities of the individualizing the educational paths and to modify the course on the basis of evaluation forms. We also have to remember that in e-education everything is recorded and can be inspected, if needed – including the performance of the students and the teacher.

3.4 Non-natural Communication

Everyone who was suddenly put into the unknown group of people, had some difficulties in communicating. The best example is a person who is not a native speaker of a language and knows this language just a bit and who joined a group of native speakers using this language fluently. It is quite common that such a person avoids the direct conversation or does not start interaction with others. This is the situation of inexperienced computer users who start an internet course. All contemporary e-learning platforms demand the use of a keyboard to write in the text. Great majority of announcements addressed to the students has a form of inscriptions on the screen. Therefore, in order to use this form of education one has to develop certain abilities and additional skills: written communication and efficient using computer keyboard. The lack of such skills can considerably diminish the student's chance for being successful learning by network.

Such problems practically do not exist (or there are far less) in traditional learning, because it is more difficult to find a person who does not want to express their opinion in a class than a person who cannot use the computer.

The solution of the problem with communicating by means of the text is preparing future e-students to the work in the network. It is necessary to train them in using the computer, writing on the keyboard, communicating by the written text. At the same time they should be mentally prepared for using the Internet in teaching (Rudak 2008).

Obviously it cannot be presumed that all students will have a suitable training, and that is why the e-teacher must be flexible. He must be aware of difficulties which participants may encounter and he should react on such signals whenever they appear. As it has already been mentioned (cf. Section 3.2), the integrator on an e-course should play such a role (Bednarczyk, Michałowicz, Rudak 2008).

4 Ten Commandments

The socio-psychological analysis of the instruction on the distance learning by the Internet led to the formulation of ten rules (in the form of commandments) bearing upon the work of authors of e-courses and e-teachers (Wieczorkowka, Madey, 2007):

(1) "Be blended" – combine the Internet education with the traditional one.
(2) Put more stress on interaction with the students than on preparation of sophisticated automatic tools.
(3) Make a social group out of e-course participants in co-operation with an integrator and assistants.
(4) Personalize the course requirements by adjusting the level of its difficulty to the participants.
(5) Set-up clearly defined goals and do not overload the syllabus.
(6) Use multimedia as widely as possible and, in particular, record the sound files.
(7) Plan the student's activity, check the level of knowledge acquisition but try to grade the tests automatically.
(8) Separate the teaching process from the knowledge certification – let the students repeat the tests as much as needed during the learning stage.
(9) Monitor the educational process – in the evaluation questionnaires ask open questions.
(10) Be flexible.

Notice that rules given here contain described above recipes able to improve well-known defects of e-learning. In this context, the commandment (1) and (6) help to enlarge possibilities of e-education within the range of subjects which are difficult to transfer en bloc to the network. Commandments (2) and (3) concern building and support a social group of participants of the course. The usage of commandments (4), (7) and (9) facilitate formative assessments and make possible the better adjustment of the content of the course to the level of students. At last commandments (8) and (10) contain the answer for problems with the communication.

It is necessary to return the attention on the commandment (5). In the time of a lecture one cannot express more than the determined limit of words, so there is a natural bound for the content of the course. However, in e-learning, the structure of the medium of the communication brought the ease of placing of educational materials in the network (on the e-learning platform). This leads to possibility of exceed natural limitations. The number of files situated in the network and their size are limited only by capacities of hard disks which however already are so great that this limitation is rather theoretical. Causes this that often internet courses contain far more of the content than analogous stationary courses, even more than students can learn (supposing standard conditions).

5 Conclusions

Achieving similar efficiency in e- and t-learning requires a very careful planning the didactic process and taking into consideration the rules given in the Decalogue. Moreover, it is necessary to take several important decisions defining the category of a course which would best fit the content. Thus, is it worth to put so much effort in teaching and learning on-line? The answer is positive: it is really worth. Below some other advantages, of the economic, didactic and social character, resulting from e-education have been listed.

In the e-teaching a very good lecturer, an expert in his field, can share his knowledge with more students than he would do on a traditional course, in which the number of listeners cannot be exceeded, e.g. because of space limits. Thanks to the mechanisms built into the e-learning platform, the lecturer only once answers questions that are repeated by many students. His answers are published and all course participants can read it. The posts on fora are also available for all students. In this way all participants are in contact with the expert. That is true that such classes require the assistants (for example to check open assignments), but the traditional instruction also requires assistants presenting the tasks.

The use of a computer and the global network facilitates or rather makes it possible to have an easy access to virtual laboratories, which are often used in stationary classes, so transferring them to the on-line classes does not change their educational effect. Therefore, in e-education they become the most regular didactic help.

Contrary to what might be assumed, the e-teacher is available more easily for students than a "regular" teacher, because the students do not need to wait until the day when the teacher has his consultation hour (often once a week) to ask a question. It is enough to send an e-mail to the lecturer or to raise a question on the forum. The teacher gives answers not on consultations but in the network and these answers reach the student before the official duty of the lecturer.

E-learning is an answer to the paradigm of the continuous gaining of new skills and acquiring the knowledge throughout one's life in the information society (LLL). Breaking up with the unity of the place, time and action considerably lets the staff adjust to the requirements of the future courses and trainings. The student can really learn whenever and wherever he wants.

Acknowledgments

We are very grateful to Justyna Jonatowska for her help in the preparation of the English version of our paper.

References

1. Alexander, S. (2007), Affective Tutoring Systems: Adapting Like A Human Tutor, from Sam Alexander: http://iims.massey.ac.nz/research/ngits/xview.php?page=sam/sam
2. Bednarczyk, I., Michałowicz, B., Rudak, L. (2008), Activities of the e-learning courses integrator (practical examples), EUNIS 2008, VISION IT – Vision for IT in higher education, Aarhus, Denmark, June 2008, http://eunis.dk/papers/p58.pdf
3. Bednarczyk, I., Rudak, L. (2008), Podatność przedmiotów akademickich na e-nauczanie, in: M. Dąbrowski, M. Zając (red.), E-edukacja dla rozwoju społeczeństwa, pp. 132-139. Warszawa: Fundacja Promocji i Akredytacji Kierunków Ekonomicznych (in Polish).
4. Keegan, D. (2004), The Role of Assessment in Distance Education and E-learning, New Assessment for a New Learning, RAMIE Conference, 2004, http://www-deis.cit.ie/ramie/downloads.htm
5. Kenrick, D. T., Neuberg, S. L., Cialdini, R. B. (1999), Social Psychology. Unraveling the Mystery, Boston: Allyn & Bacon.
6. Miziołek, J. (2007), Villa Laurentina CD, Warszawa: Biblioteka Narodowa (video recording).
7. Powell, A. (2007), Featured 3D Projects: Virtual Worlds, Real Learning? Education in Second Life, 3DVisA Bulletin (3).
8. Rudak, L. (2008), E-learning – non-discovered territory (a course on studying by the Internet), accepted for the International Conference "Student Mobility and ICT: can E-LEARNING overcome barriers of Life-Long learning?", Maastricht, Netherlands, November 2008.
9. Rudak, L., Sidor, D. (2008), Taxonomy of E-courses, submitted to on-line International Conference on Engineering Education, Instructional Technology, Assessment, and E-learning (EIAE 08), December 2008.
10. Wieczorkowska, G., Madey, J. (2007), On Psychology of E-learning, EUNIS 2007, Proc. of the 13th International Conference of European University Information Systems, 26-29 June 2007, Grenoble, France.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 109

E-LEARNING AND BLACKBOARD PLATFORM AT ACC CYFRONET AGH

KAZIMIERZ WIATR, MAREK KWASNIEWSKI, MARIA WIELGUS

Academic Computer Center CYFRONET AGH, 30-950 Krakow, Nawojki 11

Most institutions of higher education currently face an urgent need to develop effective e-learning systems. The aim is to create a student-centric system, offering diverse training and educational courses, suited to the needs of respective individuals. The use of the Internet enables universities to transcend the traditional boundaries of teaching. By using computer networks students can now communicate with teachers and with their peers across the globe, both synchronously and asynchronously.

In 2005 ACC CYFRONET AGH CYFRONET AGH decided to provide e-learning services to academic community of Krakow. We chose e-learning platform Blackboard because it was successfully used at many universities in the world. We have installed Blackboard Academic Suite with Learning and Community Systems.

Blackboard system properties:

- Using a relational database to store information about courses, users, organizations etc.
- Diversification of content according to needs of users (students, teachers, administrators)
- Providing information on the available courses (categorized course catalogue) with a search interface
- Focus on import of materials created with third-party software (creating courses is easy and does not require knowledge of HTML)
- Each user can access his/her personal information, including the courses he/she participates in, via a customized portal.
- Synchronous and asynchronous communication among course participants.
- Ability to monitor students' progress
- Automated performance statistics.
- Minimal hardware requirements

We are the first Polish center which provides Blackboard e-learning platform to students and academic teachers.

From the very beginning we have had inquires from our users about Polish version of Blackboard Academic Suite.

To facilitate the use of the Blackboard platform by Polish students, the Blackboard Team at ACC CYFRONET AGH developed the corresponding Polish Language Pack in 2006 year. Every year in September the Blackboard Academic Suite is upgraded to a new release and Polish Language Pack too.

In 2008 year we extended our Blackboard installation adding Content System.

The Blackboard software deployed at ACC CYFRONET AGH currently utilizes SunFire 6800, SunFire 490, SunFire V880 and SunFire T2000 servers, enabling simultaneous creation of over 2 000 user accounts.

Now we have a computer infrastructure and fast academic network (a bandwidth of 2x10 Gbps) to provide access to e-learning platform Blackboard for all universities in Krakow and whole south part of Poland.

Nowadays we have users from Jagiellonian University, AGH University of Science and Technology, Technical University of Krakow and Pedagogical University.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 111-115

E-LEARNING IN STUDENTS EDUCATION IN MEDICAL UNIVERSITY OF BIALYSTOK, POLAND

Wiesław Półjanowicz[1], Robert Latosiewicz[2], Andrzej Niewiński[2], Robert Milewski[3]

[1] *Institute of Computer Science, University of Bialystok*
[2] *Department of Rehabilitation, Medical University of Bialystok*
[3] *Department of Medical Statistics and Informatics, Medical University of Bialystok*

Introduction

At a time when the development of IT, computers and Internet is very fast, a change of methods of knowledge transfer from traditional to based on network and electronic forms is visible. Different social groups and unions, forming information society, raise their professional skills and develop their knowledge and interests. Among them there is a wide group of doctors and medical students. They increasingly go to modern technologies in education and training. They can reach knowledge using "traditional" means of learning, but for some time it has become very fashionable to use e-learning, or complementary learning (b-learning) using mix of traditional teaching and learning through the Internet network.

E-learning will not replace the traditional forms of training, however. The approach to e-learning should rather emphasize that it is a good way to increase and extend the knowledge transferred by traditional methods (blended learning – *b-learning*). Despite of that in Poland e-learning is spreading from a few years, it is still a new phenomenon particularly in field of medical education. It is relatively little known and used only in some regions of the country. Still, with the growing popularity and with the higher degree of computerization it will slowly replace traditional teaching and "classical" self-education.

Our system (basing on the mechanism of b-learning) covers topics of theoretical preparation for basic massage techniques for bachelor grade students of physiotherapy at the Medical University of Bialystok, Poland. In this project, complementary teaching system used in distant education, uses Moodle platform (Fig. 1). Moodle stands for Modular Object-Oriented Dynamic Learning Environment. It is a class of LMS/LCMS based on the GNU GPL license (Open Source – free, unpaid software) [2]. The initiative to implement a distance learning was jointly attempted by Wiesław Półjanowicz, MSc., Ass. Prof. Robert Latosiewicz MD, Ph.D, Andrzej Niewiński, PT and Irena Rutkowska, MD. The b-learning course called "Classical massage" was attended and successfully finished by 15 students. The course contained several topics of theoretical knowledge which have been prepared by above mentioned team and the control system (quizzes, questions) of knowledge of students at the end of each part.

The project wants to emphasize that the b-learning can take advantages of e-learning and traditional teaching in order to achieve a better grasp of knowledge. The effectiveness of this method in teaching of group of students helps to raise the level of knowledge of the subject. In the future, advantages of complementary learning by this method and its benefits should be confirmed by deeper studies.

Organization of b-learning

Complementary teaching used in the process of b-learning is a fully steerable proportion of time between work with teachers and independent work of students. Another important factor is the individualization of teaching, resulting from the mixed proportion of distant and traditional way related to the content of knowledge and the number of people in the group. Activation of students and the ability to motivate them both in direct contact, as well as using a distant form (examples of practical issues, work on a joint project, testing knowledge, the tasks to be performed, interactive lectures, consultations) are of great value.

In the traditional classes strict organization of working time is required (e.g. lessons). This is quite free in classes of distant learning. For the implementation of information technology issues were developed in the form of electronic materials (lectures, tasks-to-do, repetitions, tests). In direct contact with the teacher, students carry out activities and problem-orientated tasks. They also can examine some examples to be given in educational platform. In distant part of education, students perform tasks for self-realization, which are placed on the platform in smaller parts, but much more frequently. It results in convinc-

Figure 1. The window of e-learning platform Moodle
Source: Own compilation

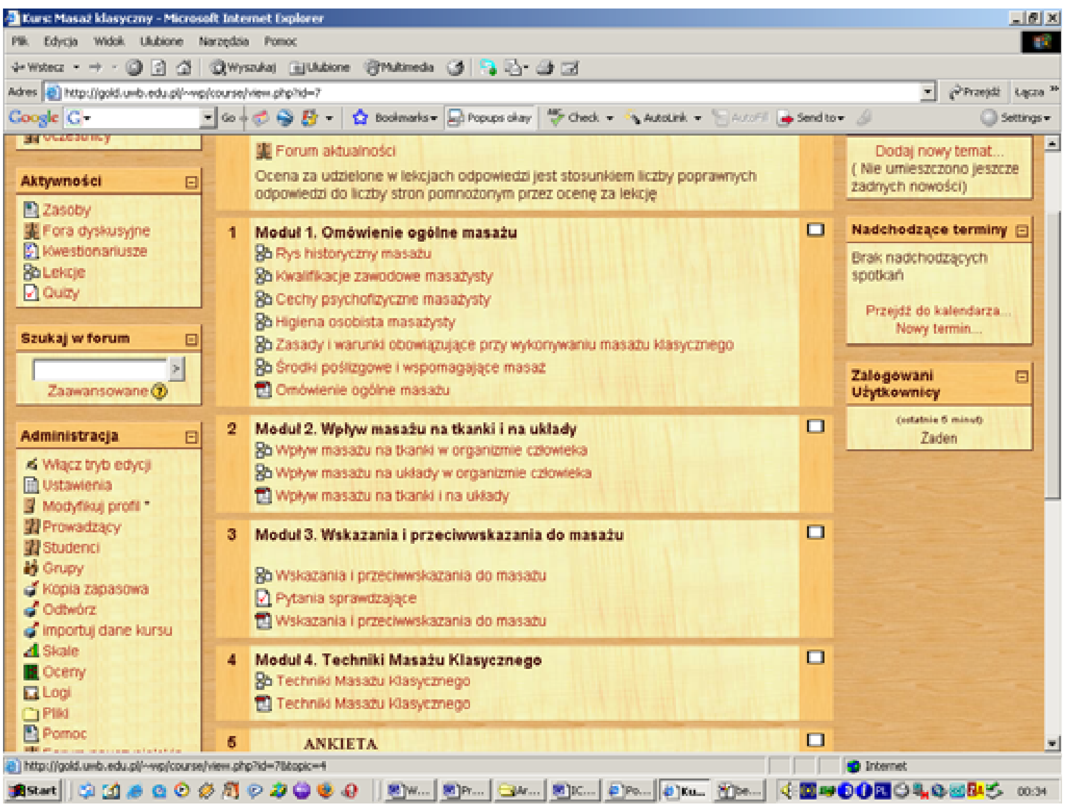


Figure 2. The sample window of course “Classical massage” on e-learning platform Moodle
Source: Own compilation

ing compulsory habits, the ability to improve skills and deepen knowledge, enhance the professional and social activity [1].

The basic functions of the system allows, *inter alia*, to:

- register and manage users, divided into administrators, teachers (conducting courses), students (groups) and guests,
- plan and manage the courses or a groups of courses in a chronological (weekly) or thematic order,
- create and/or provide various types of electronic educational materials with different rules of access,
- keep contact by users through discussion forums (public or dedicated), e-mail, chat and a system of messages,
- verify knowledge by tests, tasks, discussions,
- analyze the activity of participants (log analysis),
- import of completed courses (usually standardized, such as SCORM – Sharable Content Object Reference Model,
- make the archives of course, including log files and users,
- collect information through the modules: poll, voting and a diary.

In our studies e-learning courses in the field "Classical massage" for students of the Medical University of Bialystok have been placed on the Moodle platform. There have been also developed (and now are waiting for implementation) the courses of manual medicine (chiropractic) and massage therapy for treating patients, mainly with the spine and shoulder problems.

In the above-mentioned form of classes, students log on to the virtual platform (Fig. 2). They have access to educational materials contained there, to the forum, chat and surveys. At the laboratory classes, students carry out the content indicated by the teacher, and during the course based on e-learning they have examples of practical knowledge in the different forms, such as lesson, quiz, task or resource page. Teacher, using previously prepared tests, can conveniently check the substantive student's knowledge and each student sees his/her results immediately (Fig. 3 and 4). That raises the efficiency of education. Student repeatedly refers to the issues considerate earlier, better assimilates and possess knowledge of the subject, also checks his/her own expertise in that area [3]. The system records the changes and the teacher is able to look into the educational progress of students (Fig. 5).

The costs of preparing and implementing activities in b-learning formula are slightly higher only in the early (1-2) years of development of educational materials, but are smaller than cost of "traditional" system.

Summary

The main benefit of complementary methods of teaching is, among all, maximum use of the time a trainee. Student is able to learn in a convenient place and time. In addition, during direct meetings with "traditional" form of training participant has access to the assistance of teacher and has the possibility to improve the skills and deepen his/her knowledge. Mixed teaching may be more effective, because students are involved in working with components on-line, set by the operator, and the tasks assigned to them are clear and legible. Students also have the freedom to contact in the forum, chat, etc. with their

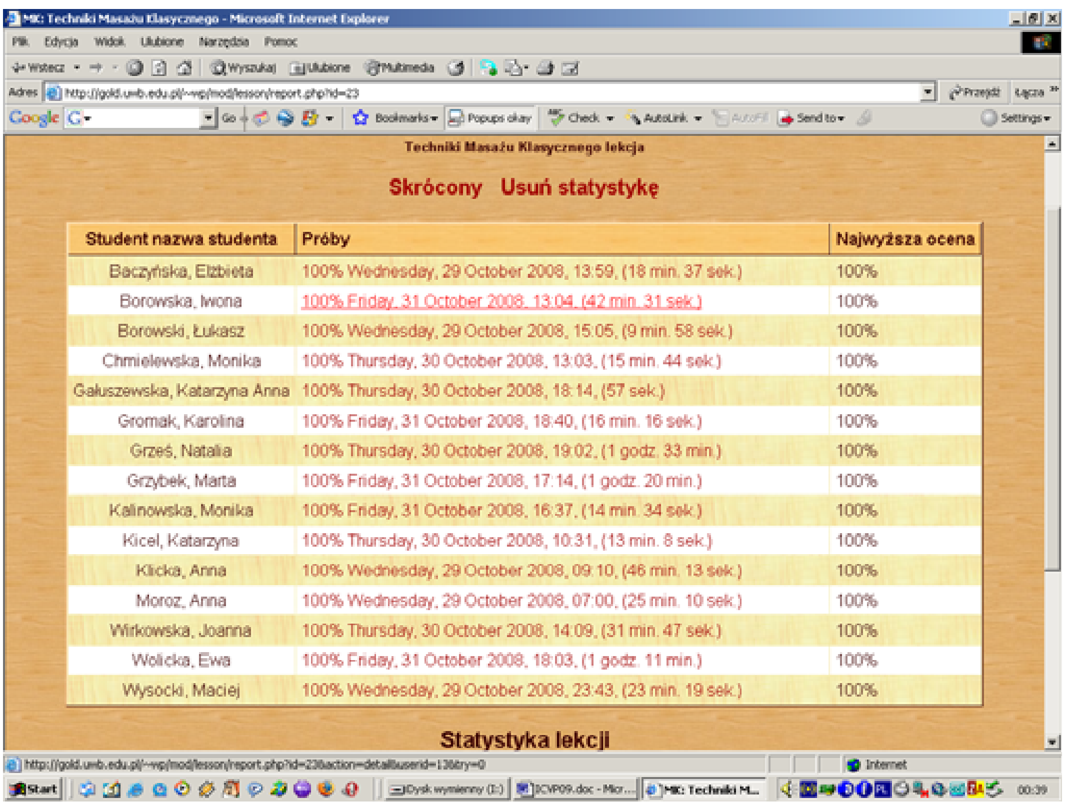
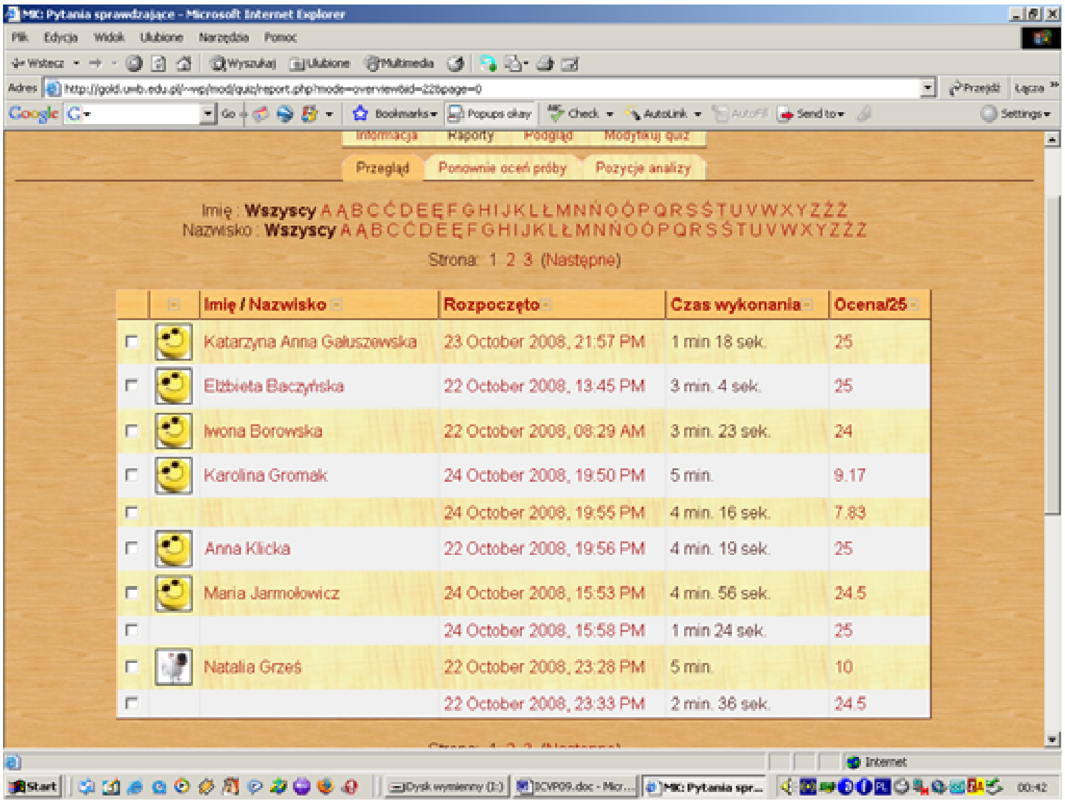
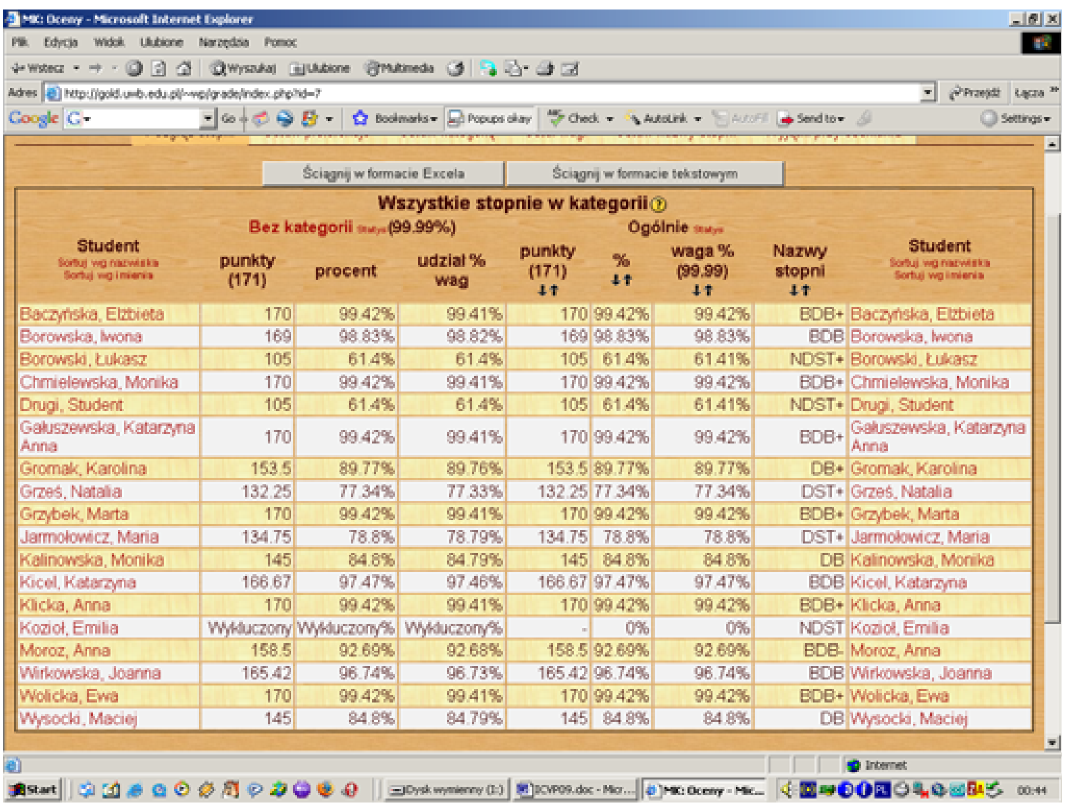


Figure 3. The sample window of lesson module on e-learning platform Moodle
Source: Own compilation



		Imię / Nazwisko	Rozpoczęto	Czas wykonania	Ocena/25
		Katarzyna Anna Gałuszewska	23 October 2008, 21:57 PM	1 min 18 sek.	25
		Elżbieta Baczyńska	22 October 2008, 13:45 PM	3 min. 4 sek.	25
		Iwona Borowska	22 October 2008, 08:29 AM	3 min. 23 sek.	24
		Karolina Gromak	24 October 2008, 19:50 PM	5 min.	9.17
			24 October 2008, 19:55 PM	4 min. 16 sek.	7.83
		Anna Klicka	22 October 2008, 19:56 PM	4 min. 19 sek.	25
		Maria Jarmołowicz	24 October 2008, 15:53 PM	4 min. 56 sek.	24.5
			24 October 2008, 15:58 PM	1 min 24 sek.	25
		Natalia Grześ	22 October 2008, 23:28 PM	5 min.	10
			22 October 2008, 23:33 PM	2 min. 36 sek.	24.5

Figure 4. The sample window of evaluation module (quiz) on e-learning platform Moodle
Source: Own compilation



Student	Bez kategorii punkty (171)	procent	udział % wag	Ogólnie punkty (171)	%	waga % (99.99)	Nazwy stopni	Student
Baczyńska, Elżbieta	170	99.42%	99.41%	170	99.42%	99.42%	BDB+	Baczyńska, Elżbieta
Borowska, Iwona	169	98.83%	98.82%	169	98.83%	98.83%	BDB	Borowska, Iwona
Borowski, Łukasz	105	61.4%	61.4%	105	61.4%	61.41%	NDST+	Borowski, Łukasz
Chmielewska, Monika	170	99.42%	99.41%	170	99.42%	99.42%	BDB+	Chmielewska, Monika
Drugi, Student	105	61.4%	61.4%	105	61.4%	61.41%	NDST+	Drugi, Student
Gałuszewska, Katarzyna Anna	170	99.42%	99.41%	170	99.42%	99.42%	BDB+	Gałuszewska, Katarzyna Anna
Gromak, Karolina	153.5	89.77%	89.76%	153.5	89.77%	89.77%	DB+	Gromak, Karolina
Grześ, Natalia	132.25	77.34%	77.33%	132.25	77.34%	77.34%	DST+	Grześ, Natalia
Grzybek, Marta	170	99.42%	99.41%	170	99.42%	99.42%	BDB+	Grzybek, Marta
Jarmołowicz, Maria	134.75	78.8%	78.79%	134.75	78.8%	78.8%	DST+	Jarmołowicz, Maria
Kalinowska, Monika	145	84.8%	84.79%	145	84.8%	84.8%	DB	Kalinowska, Monika
Kicel, Katarzyna	166.67	97.47%	97.46%	166.67	97.47%	97.47%	BDB	Kicel, Katarzyna
Klicka, Anna	170	99.42%	99.41%	170	99.42%	99.42%	BDB+	Klicka, Anna
Kozioł, Emilia	Wykluczony	Wykluczony%	Wykluczony%	-	0%	0%	NDST	Kozioł, Emilia
Moroz, Anna	158.5	92.69%	92.68%	158.5	92.69%	92.69%	BDB-	Moroz, Anna
Wirkowska, Joanna	165.42	96.74%	96.73%	165.42	96.74%	96.74%	BDB	Wirkowska, Joanna
Wolicka, Ewa	170	99.42%	99.41%	170	99.42%	99.42%	BDB+	Wolicka, Ewa
Wysocki, Maciej	145	84.8%	84.79%	145	84.8%	84.8%	DB	Wysocki, Maciej

Figure 5. The sample window of statistics of student evaluations on e-learning platform Moodle
Source: Own compilation

E-learning

colleagues from the group and conducting classes, which raises the advantages of learning.

We pay particular attention to the concept of b-learning physiotherapy to students in the Medical University of Bialystok. According to our knowledge this is the first attempt to use such a system in this field in Poland. We believe that this form of teaching will deliver real benefits in the form of a deeper understanding of the scope of the provision of health services. In the future, we plan to extend the teaching material for news of physiotherapy. We are working also with ophthalmologists to create b-learning course for medical students in the field of ophthalmology-related issues.

Using the above-mentioned measures of b-learning and e-learning systems encourages for widening of these forms of education. We believe that with this framework it is possible to achieve the objectives in teaching, while optimizing the quality of education and economic efficiency.

References

1. Hyla M., Przewodnik po e-learningu, Oficyna Ekonomiczna, Kraków 2005.
2. Valiathan P., Blended Learning Models, American Society for Training & Development, http://www.learningcircuits.org/2002/aug2002/valiathan.html.
3. Półjanowicz W., Citko U., Wykorzystanie b-learningu w kształceniu studentów informatyki Uniwersytetu w Białymstoku, [w:] Fenomen Internetu, red. Szewczyk A., Krok E., Uniwersytet Szczeciński, WNEiZ, Szczecin 2008.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 117-120

CHEMICAL PATHWAYS – APPLICATION TO THE CLASSIFICATION OF THE MOLECULAR POINT GROUPS

Elżbieta Broniatowska

Department of Bioinformatics and Telemedicine,
Jagiellonian University, Faculty of Medicine
Lazarza 16, 31-530 Krakow, Poland

Abstract: The article concerns the application of the flow chart in the teaching of the aspects of group theory used in chemistry. It presents the diagram showing particular steps in the process of molecular classification in the sense of symmetry. The problem of recognition of the correct molecular point group is troublesome for students. Such diagram could facilitate the understanding and studying of the assignment of the point group to a particular molecule. The picture of the algorithm was prepared using authoring tool called BIT Pathway Editor.

Introduction

A flow chart [1] is a scheme of the visualization of all the stages of an algorithm or process. It is applied for analyzing, designing and documenting a process in various branches of science [2]. Flow charts are widely used as an effective method in education, especially in medicine [3] where they are called clinical pathways. Using the flow charts instead of traditional methods (e.g. tables, texts) can improve the process of education leading to faster learning. This paper focuses on the application of the flow chart in the determination of molecular point group.

The concept of molecular symmetry [4] is important in chemistry as it explains [5] a number of molecular properties such as dipole moments and spectroscopic transitions. It is used in many fields of chemistry like ligand field theory [6], Woodword-Hoffman rules [7] and in crystallography [8]. Assigning correct type of point group to a molecule is often a difficult task for the chemistry students and requires a lot of practice. However, there are particular rules which can help in finding the molecular point group which can be easily captured into flow chart.

Background

The molecular point group [4] is the set of all operations of symmetry which are possible for being performed on one chemical molecule. The term symmetry operations is connected with the symmetry elements. Operating on a symmetry element results in a molecule indistinguishable from the original, i.e. rotating ammonia (NH_3) molecule at 360° around the axis coming through the nitrogen atom one obtains three times molecule exactly the same as the original. The name "point group" means that each molecule possesses at least one point which remains exactly in the same place at any symmetry operation.

There are 5 symmetry elements (see tab. 1): symmetry axis, plane of symmetry, centre of symmetry (inversion centre), rotation-reflection axis and identity. Taking into consideration these all 5 symmetry elements each molecule can be assigned to one of the 34 point groups. These groups can be divided into 4 types (see tab. 2) depending on the number of rotation axes presented in the molecule with the exception of linear molecules. Schoenflies notation is used to completely describe the symmetry of molecules and thus the molecular point groups (see the right column in the tab. 2).

Methods

Flow chart is used for the visualization of the rules which govern the assigning of the molecular point group. There are different types [1] of flow charts which differ in the kind of boxes. This work presents two popular types of boxes which are the rectangles denoting processing steps (activity) and diamonds denoting the decision steps. Additional symbols used in this article are arrows manifesting the way from one point to another and symbols representing the start and end of a flow chart.

There are many programs (ConceptDraw, SmartDraw, EDraw Flowchart, Visio, OmniGraffle) which are used for preparing flow charts. This work is based on authoring tool BIT Pathway Editor [10] especially designed for creating clinical pathways. The BIT Pathway Editor is implemented in Java Swing technology. It provides all the graphical elements characteristic for flow charts (rectangles, diamonds, arrows) and enables adding comments for the elements. Elements in the program are colored automatically. The color of element is important in clinical pathway because it manifests the profession of staff responsible for the work of particular task.

Results

Figure 1 shows the flow chart representing all the stages of the molecular point group determination. It is based on the identification of particular symmetry elements presented in the molecule. The scheme shown in the fig. 1 contains the questions which should facilitate leading to appropriate point group.

Table 1. Molecular symmetry elements and operations

Element	Operation	Symbol
symmetry axis	**rotation around** the axis by 360°/n; the axis with the highest n is called principal	$\mathbf{C_n}$
plane of symmetry	**reflection in** the plane (σ_v – plane parallel with the principal axis named vertical, σ_h – plane perpendicular to the principal axis named horizontal)	▯
center of symmetry **(inversion center)**	**reflection in** the reference to a point	**I**
rotation-reflection axis (improper axis)	**rotation around** the axis 360°/n followed by a reflection in a plane perpendicular to it	$\mathbf{S_n}$
identity	**no changes** are observed, every molecule has this element	**E**

Table 2. Molecular point groups

Symbol	Characteristic of point group	Group type description
C_1	lack of rotation axis reflection plane and inversion centre	groups without any rotation axis
C_s	only one reflection plane is present	
C_i	only inversion centre is present	
C_n	n-fold rotation axis	groups with one principal rotation axis
C_{nh}	n-fold rotation axis and plane perpendicular to the principal axis	
C_{nv}	n-fold rotation axis and plane parallel with the principal axis	
D_n	n-fold rotation axis and n two-fold axes perpendicular to the principal axis	
D_{nh}	axes like in D_n group and plane perpendicular to the n-fold axis	
D_{nd}	axes like in D_n group and plane parallel with the principal axis	
S_n	n-fold rotation-reflection axis	
T_d	tetrahedron symmetry (4 3-fold axes, 3 2-fold axes, 6 reflection planes)	groups with 2 or more principal rotation axes
O_h	octahedron symmetry (3 4-fold axes, 4 3-fold axes, 6 2-fold axes, 9 reflection planes)	
I_h	icosahedron symmetry (12 5-fold axes, 20 3-fold axes, 15 2-fold axes, 15 reflection planes)	
$C_{\infty v}$	infinty-fold axis and infinitely number of parallel reflection planes	groups for linear molecules
$D_{\infty h}$	C_∞ axis and infinitely number of 2-fold axes perpendicular to that axis and perpendicular reflection plane	

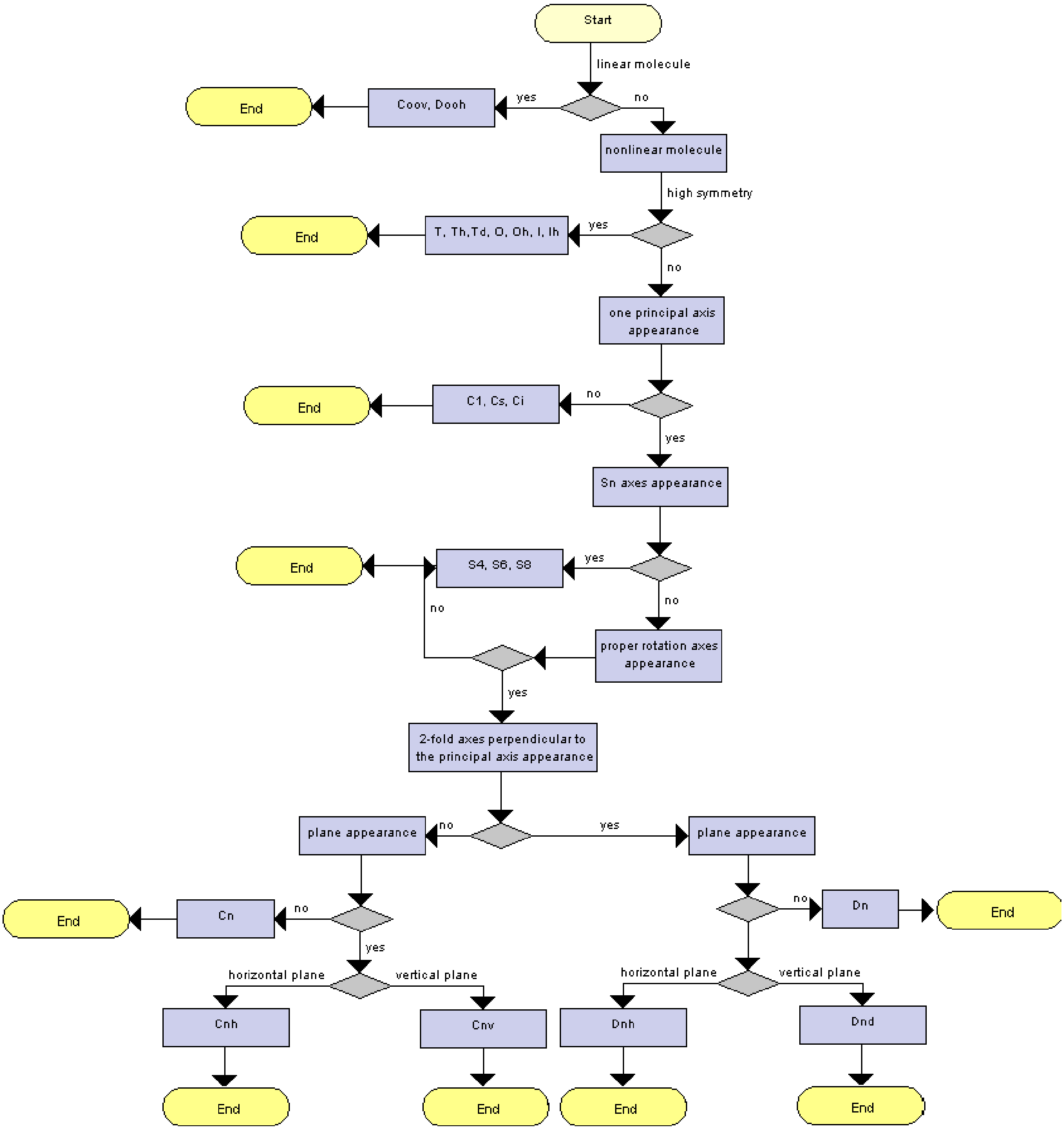


Fig. 1 Flow chart describing the determination of the molecular point group.

Conclusions

The article shows the usefulness of flow chart in teaching such chemical problem as designation of the molecular point group. It shows also the flexibility of the BIT Pathway Editor for application in creating different pathways not only medical.

References

1. “Flowcharts: Plain & Simple: Learning & Application Guide”, Joiner Associates Inc., 1995.
2. Brody R., “Effectively Managing Human Service Organizations”, SAGE, 2004; De Luc K., Kitchiner D., “Developing Care Pathways: Includes Tool Kit”, Radcliffe Publishing, 2000; Raschid L., Data Integration in the Life Sciences: Second International Workshop, Springer, 2005; Conrad J., “Environmental Management in European Companies: Success Stories and Evaluation”, CRC Press, 1998.
3. Lighter E. D., Fair C. D., “Principles and Methods of Quality Management in Health Care”, Jones & Bartlett Publisher, 2000.
4. Cotton F. A., “Chemical Applications of Group Theory”, Interscience Publisher, 1963.

5. Tinkham M., "Group Theory and Quantum Mechanics", Courier Dover Publications, 2003.
6. Wulfsberg G., "Inorganic chemistry", University Science Books, 2000.
7. Gołębiewski A., "Chemia kwantowa związków organicznych", PWN, Warszawa, 1973.
8. Chojnacki J., "Elementy krystalografii chemicznej i fizycznej", III wyd., PWN, Warszawa 1973.
9. Kononowicz A. A., "BIT Pathways – a tool for teaching and learning clinical pathways" [in preparation].

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 121-126

CHEMICAL PATHWAYS – VISUALISATION OF CLASSICAL ANALYTICAL PROCEDURES IN CHEMISTRY BY THE USE OF FLOW CHARTS

Andrzej A. Kononowicz, Irena Roterman

Department of Bioinformatics and Telemedicine,
Jagiellonian University, Faculty of Medicine
Lazarza 16, 31-530 Krakow, Poland

Abstract: Aim of this paper is to present a set of flow charts (called chemical pathways) implemented to facilitate learning of chemical workflows involved in identification of ions (cations) present in solutions. A service containing 34 pathways has been created and published on-line. For authoring of flow charts the BIT Pathway editor, developed by one of the authors, has been used.

Introduction

The use of flow charts in industry has a long tradition dated back to the works in early 20-ties of the last century. Since that time block diagrams presenting activities in form of rectangles, transitions as arrows and decision nodes as rhombi have been successfully applied in many disciplines. The list of permitted symbols has been extended many times to include further symbols like start/end elements, input/output processes, issue of documents, manual operations, etc. Flow charts are normalised by industry standards like ISO 5807:1985 and DIN 66001. Probably the most prominent application of block diagrams is the visualisation of algorithms in computer science. Block diagrams are also frequently used in business modelling, project management, laboratory experiments (chemistry [1,2]), and recently, as part of medical workflow planning and quality assurance techniques – so called clinical pathways [3].

The aim of this paper is to demonstrate a further potential usage of flow diagrams which is visualisation of chemical workflows for the purpose of education. As an example a classical process of analytical chemistry is taken aimed on the identification of ions (cations) present in the solution. This procedure of qualitative analysis of ingredients in solution for cations identification is rather old-fashioned because of the usage of large amount of solutions (relatively high concentrations of salts necessary). Nowadays, spectroscopic methods are able to identify the traces of particular chemical compound more efficiently. However, in the belief of the authors, the knowledge of classic reactions: synthesis of salts, their solubility in different conditions and by different solvents, colours of solutions, colour in flame etc are of general character and still fundamental for chemical specialization.

Background

The procedure of identification of ions is step-wise. One may distinguish a "main stream" path leading to the separation of ions belonging to particular groups (Fig. 1). Among the most common reactions in qualitative analysis are those involving the formation or decomposition of complex ions and precipitation reactions. These reactions may be performed directly by adding the appropriate anion, or a reagent such as H_2S or NH_3, dissociate in water to furnish the anion. Strong acid may be used to dissolve precipitates containing a basic anion. Ammonia or sodium hydroxide may be used to bring a solid into solution if the cation in the precipitate forms a stable complex with NH_3 or OH^-. The chemical conditions are very important to make the expected reaction possible. For that reason each step is equipped with a commentary describing specific conditions. The most important parameter is the pH (concentration of H^+ ions – expressed as the value of negative logarithm of H^+ ions concentration" – influencing the acidity of the solution).

Visualisation of the procedure in form of an algorithm helps to take decisions at particular steps to achieve defined goal. In order to identify the presence of a given ion (cation) in the mixture of different salts a series of decisions expressing elimination of particular ion is taken. Before this happens the complete group of ions needs to be isolated. The group recognition is accordant to the reaction to the group of chemical components which is specific to each group of cations.

When a group gets isolated the detailed analysis oriented on identification of particular ion belonging to the group under consideration is performed. The identification of cations from a particular group may have the form of a step-wise elimination of one of them. This allows recognition of each cation. Alternative possibilities are given for some groups because the specific reactions are available to identify each cation independently of the presence of others. Each group is separated using so called "group reagent" which causes the synthesis of insoluble salts. The appearance of the insoluble salts eliminates cations reacting with "group reagent". This is the way to isolate particular group of cations. The reaction with the next group reagent isolates the second group of cations. The repetition of such reactions with group reagent separates four groups of cations. The fifth group of cations is characterized by no group reagent. Cations belonging to the fifth group can be isolated according to specific chemical reactions or by a "flame test". Each cation present in the fifth group is characterized be the specific colour of the flame appearing when the drop of sample is put to the flame of relatively high temperature (gas flame temperature) (Fig. 2). The algorithm shows the cation identification on the basis of the flame colour. The mixture of two or more cations produces a colour combination. K^+ cations can be identified independently of the presence of others due to the very specific white-violet colour seen through the cobalt glass.

The step-wise isolation of each cation in a given group can also be performed as long as all cations belonging to particular group get identified (Fig. 3).

The set of cations divided into five groups depending on the reaction (insoluble salt synthesis) according to the group of chemical compounds makes possible a step-wise elimination of each group leading to the group V which has no group compound.

Materials and methods

The traditional way of presenting the identification procedure is the ordering of reactions in tabular form. Tab. 1. presents the cations' group classification.

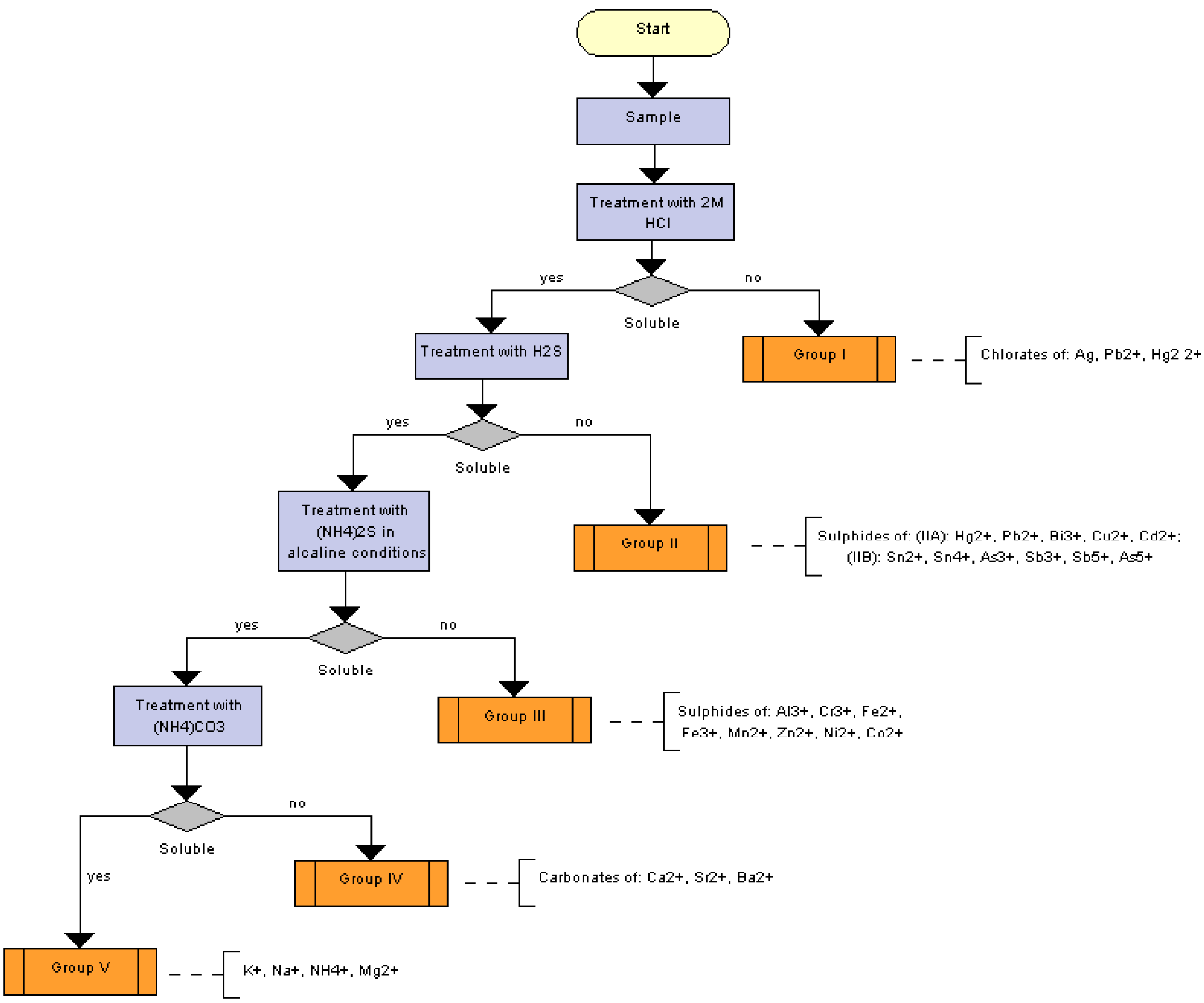


Fig. 1. The "main stream" path to isolate the groups of cations.

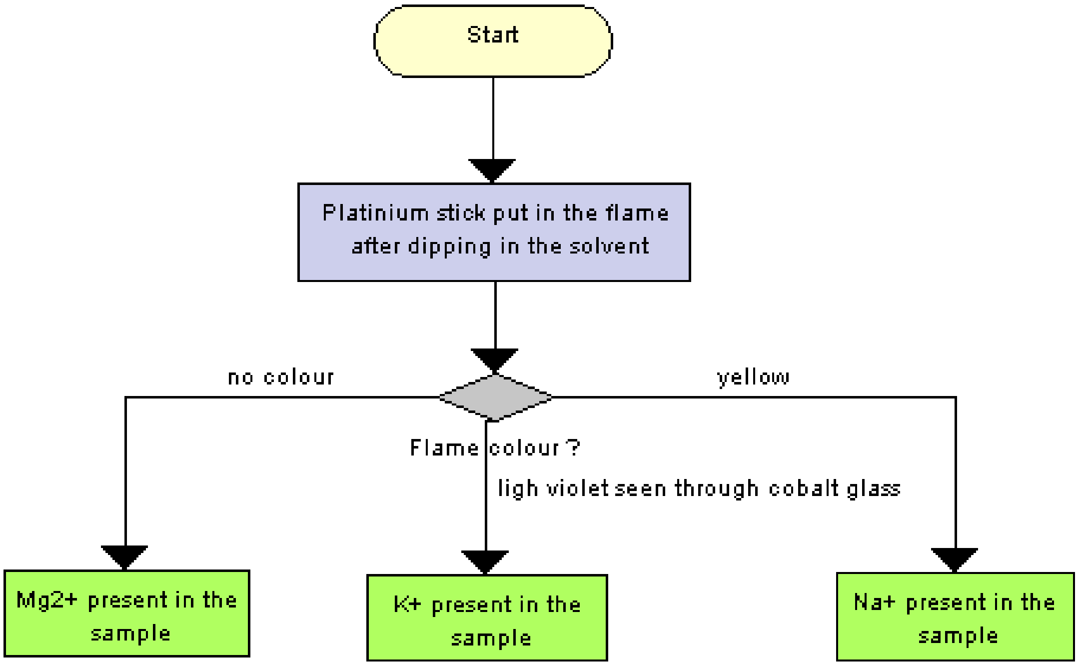


Fig. 2. The “flame test” to identify the cations belonging to the group V

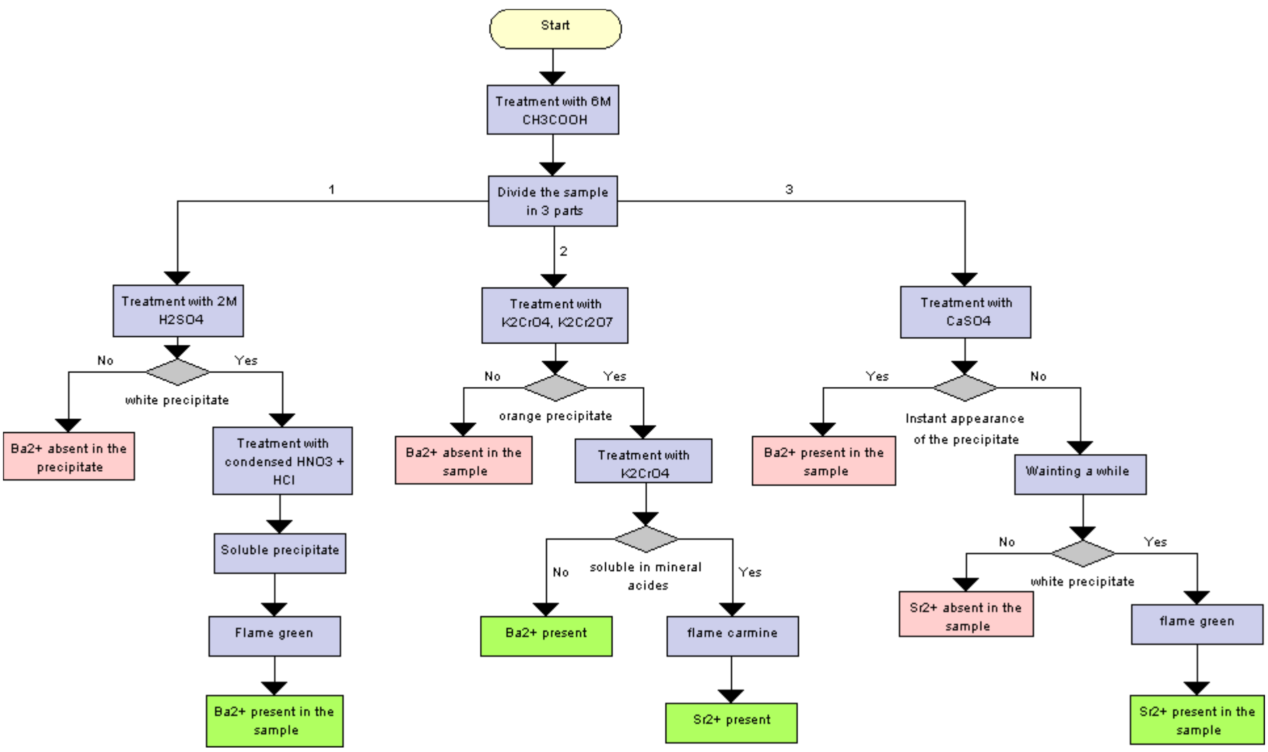


Fig. 3. The decision path to identify the cations belonging to the group Group IV Ba2+

Tab.1. Cations as classified into five groups

GROUP	CATIONS	GROUP REAGENT chemical conditions	SALT – PRECIPITATE
I	Ag^{+} , Pb^{2+} , Hg_2^{2+}	2 M HCl	AgCl, $PbCl_2$, Hg_2Cl_2
II	SUBGROUP IIA Hg^{2+}, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}	H_2S in acidic conditions (0.3 M HCl)	HgS, PbS, Bi_2S_3, CuS, CdS Unsoluble in $(NH_4)_2S_2$
	SUBGROUP IIB Sn^{2+} ,Sn^{4+}, As^{3+}, Sb^{3+}, Sb^{5+}, As^{5+}		SnS, SnS_2, As_2S_3, As_2S_5, Sb_2S_3, Sb_2S_5 Soluble in $(NH_4)_2S_2$
III	Al^{3+}, Cr^{3+}, Fe^{2+}, Fe^{3+}, Mn^{2+}, Zn^{2+}, Ni^{2+}, Co^{2+}	$(NH_4)_2S$ in the presence of NH_{3aq} and NH_4Cl	$Al(OH)_3$, $Cr(OH)_3$, Fe_2S_3, FeS, NiS, CoS, ZnS, MnS
IV	Ca^{2+}, Sr^{2+}, Ba^{2+}	$(NH_4)_2CO_3$ in the presence of NH_{3aq} and NH_4CL	$CaCO_3$, $SrCO_3$, $BaCO_3$
V	K^{+}, Na^{+}, NH_4^{+}, Mg^{2+}	No group compound	

However, the application of flow charts (as presented in Fig 1-3) to present ion identification seems to improve the orientation in the description.

All diagrams of the chemical pathways presented in this paper have been prepared in the BIT Pathways editor (Fig. 4) developed initially to serve as a clinical pathways editor [3] [4]. The tool has been implemented in Java Swing technology providing the benefit of not restricting the application's usage to any particular operating system. It has not been decided to develop BIT Pathways entirely as a web application due to the complexity of the flowchart editor, which is still very difficult to write efficiently for a generic web browser. The editor can store diagrams locally as files or remotely in a native XML database (accessed using the XML:DB interface). Users can view and navigate through selected pathways with a JavaScript-enabled web browser. The data in the XML database is accessed by XQuery scripts, translated into HTML using XSLT. The tool provides symbols for start and end elements, components (corresponding to the major task steps of the described procedure), branches, edges (connections) and comments. There are also graphical elements that represent the whole pathway and sub-pathways. Each element has its own attribute set categorised into one or more attribute groups. The list of available attributes and attribute groups is defined by templates in XML format and may be changed easily. This feature facilitates the usage of BIT Pathways in various institutions and for diverse purposes including clinical pathways, genealogy chats, chemical pathways and also virtual patients. For the last option an export function in MedBiquitous Virtual Patient (MVP) Specification [5] is being implemented.

Attributes of elements in diagrams may be of various types (e.g. numerical values, formatted text, terms from controlled vocabularies and classifications) and have their own dedicated editors. The colour of elements can be set arbitrarily. However, for particular applications (like clinical pathways) the choice is usually restricted to a limited set of colours with a predefined meaning (e.g. the colour of elements in clinical pathways created with BIT Pathways indicates the profession of the employees involved in carrying out the particular task). In chemical pathways the rule has been obeyed to use violet colour for generic analytical tasks, green for identification of ions, pink for ruling out the presence of a particular ions. Start elements are in light yellow, sub-pathways in orange.

Results

The complete set of chemical pathways created to illustrate the process of qualitative analysis of cations is available on-line (http://149.156.12.33/chempath). Thirty four pathways have been created comprised of 552 nodes in total. The user starts browsing the algorithm on a flow chart presenting the initial isolation of five major groups of ions (Fig. 5). Then by clicking on selected sub-pathways elements (boxes in orange colour) the subordinated diagrams are displayed. Using the menu on top of the page the user may access the index of pathways and a short theoretical introduction into the analysis of ions.

No formal evaluation of the effectiveness of the new presentation method has been performed yet.

Conclusions

It is often said that a picture is worth a thousand words. Taking this for granted the paper demonstrated an alternative method of teaching identification of cations in a mixture of different salts by the usage of dynamic flow charts presented on-line. The results of this paper also prove the flexibility of the BIT Pathways application, which can be used not only for clinical pathways development, but also to visualize complex workflows in other disciplines than medicine.

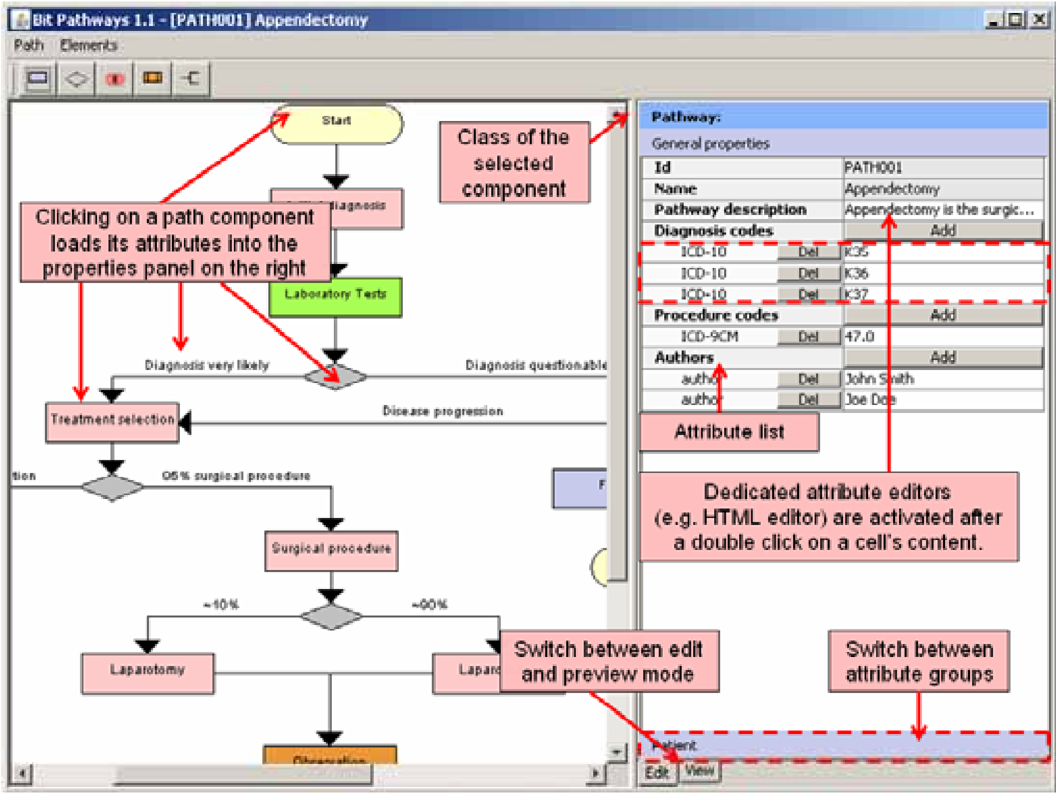


Fig. 4 The BIT Pathways editor [4]

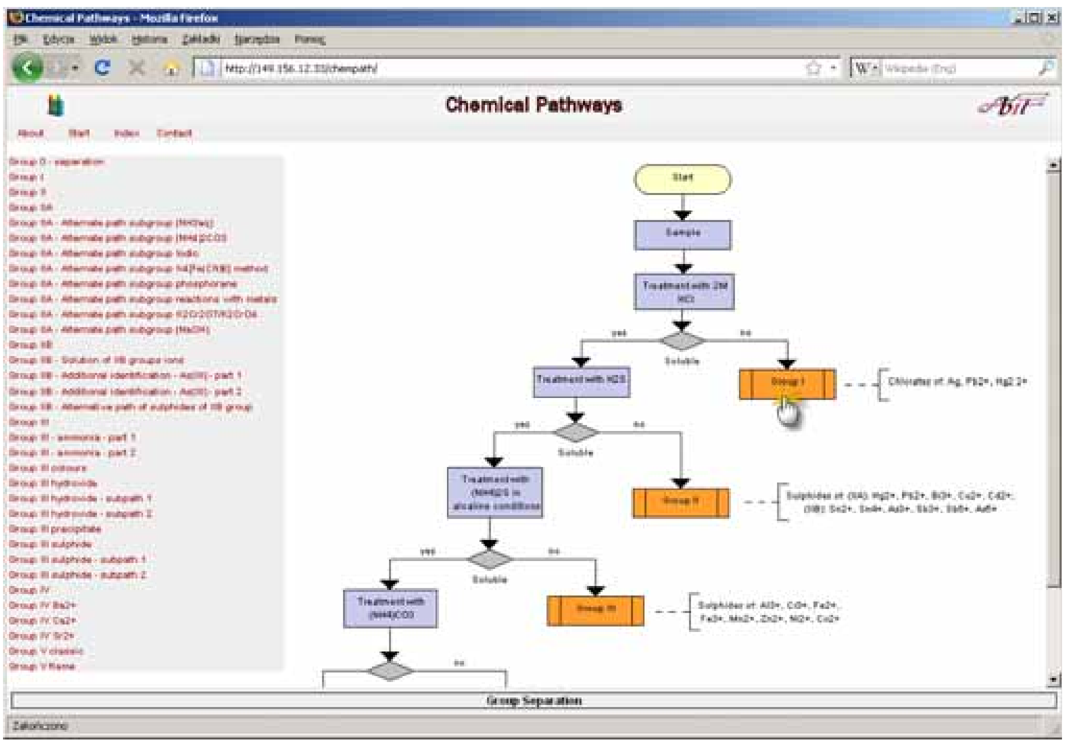


Fig. 5 Chemical Pathways on-line

E-learning

References

1. Danzer K., Analytical Chemistry: Theoretical and Metrological Fundamentals, Springer 2006.
2. Reizer A., Ćwiczenia z podstaw chemii i analizy jakościowej Wydawnictwo Uniwersytetu Jagiellońskiego, 1996.
3. Grunwald T., Corsbie-Massay C., Guidelines for Cognitively Efficient Multimedia Learning Tools: Educational Strategies, Cognitive Load, and Interface, Acad Med. 2006; 81: 213-223.
4. Kononowicz A. A., Sałapa K., Building clinical pathways by postgraduate students as a method of improving knowledge about the patient's journey through a hospital, AMEE 2008, Prague, Czech Republic.
5. Kononowicz A. A., BIT Pathways – a tool for teaching and learning clinical pathways [in preparation].
6. Smothers V. & Azan B., MedBiquitous Virtual Patient Specifications and Description Document v.0.48, Technical report, MedBiquitous Consortium, 2008.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 127-131

STATISTICAL PATHWAYS – A METHOD OF VISUALIZATION STATISTICAL RULES

Kinga Salapa, Andrzej Stanisz

Department of Bioinformatics and Telemedicine,
Jagiellonian University, Faculty of Medicine
Lazarza 16, 31-530 Krakow, Poland

Abstract: The aim of this article is the application of flow charts in teaching statistics. It contains three exemplary diagrams concerning the most common tests such as independent one-sample, two-sample t-test and one-way analysis of variance. They present particular steps in process of selection the most relevant test. Hypothesis testing is a powerful tool in science because of the potential to explain causality. Unfortunately students have difficulties in recognition the correct test. Such diagrams could facilitate the understanding and studying statistical rules. All flowcharts presented in this paper have been prepared using the authoring tool called BIT Pathways.

Introduction

Clinical pathways are more and more populate in medicine. They are present since 80th XX century [1]. The main purpose of creating them is to determine sequence of activities in treatment of patients with the same diagnose. They also include information about medical staff responsible for each activity [2] [3]. Flow diagrams are used for visualization them. That graphical method is only concentrated on the main tasks should be done. Therefore such a model is clear, readable and easy to understand both for medical staff and for patients. The flow diagram is basically adopted from technical science [11]. Nowadays, it is applied in almost all discipline, e.g. economy [16], informatics [14], management [12], education [15], meteorology [13], chemistry [4] [6], etc, both in theory and in practice.

The aim of this article is to indicate that flow diagrams can be very useful teaching aid. A good example as proof of that statement can be statistical tests. It is often said that statistics rules are very complicated and hard to understand. This paper concentrates on procedure's visualization for the most common tests, i.e.:

- independent one-sample test,
- independent two-sample test,
- one-way analysis of variance (one-way ANOVA).

Nowadays, there are many statistical programs (*e.g. SPSS, STATISTICA, BMDP, SAS*) on the market. The entire analysis lifecycle from gathering and preparing data, analyzing them to reporting the results is supported by that comprehensive set of tools. However, that kind of software cannot choose the most suitable test and to validate all necessary assumptions for it, that's way basic statistical knowledge should be known by researchers.

Background

The aim of statistical hypothesis testing is scientific acceptance (or rejection) of an assumption concerning occurrence of a particular phenomenon in nature. It [9] grew out of quality control, in which the whole batches of manufactured items are accepted or rejected based on testing relatively small samples. All hypothesis tests [1] [5] [10] are conducted in the same way. Firstly a researcher propounds a hypothesis to be tested, then formulates an analysis plan and analyzes sample data according to it, and finally accepts or rejects the hypothesis based on results of the analysis.

An initial hypothesis (null hypothesis, H_0) might predict, for example, that the population mean is equal to a specified value, (*e.g. a systolic blood pressure is equal to 120 mmHg*). There are three different mutually exclusive ways to create an alternative hypothesis (H_1). The decision which one of them should be chosen depends on scientists, although the most common is that option in which alternative hypothesis totally denies the null hypothesis. Formal notation should look as follows **[1] [5] [10]**:

$$H_0 : \mu = \mu_0$$
$$H_1 : \mu \neq \mu_0 \; or \; H_1 : \mu > \mu_0 \; or \; H_1 : \mu < \mu_0$$

where:
μ – unknown population mean of a variable
μ_0 – hypothetical population mean of a variable (fixed by scientist)

In order to confirm or disprove the exemplary null hypothesis **independent one-sample test** should be applied. The procedure of the identification of the best statistic test is stepwise. It makes that flowcharts are very good way to present such algorithm (Figure 1) and help to make the decision which statistic test is the most relevant.

Many studies require comparing the population means between two groups. Then, the appropriate statistic method is **two-sample t-test**, and hypotheses should be formulated as follows [1] [5] [10]:

$$H_0 : \mu_1 = \mu_2$$
$$H_1 : \mu_1 \neq \mu_2 \; or \; H_1 : \mu_1 > \mu_2 \; or \; H_1 : \mu_1 < \mu_2$$

where:
μ_1 – unknown population mean of a variable in the first group
μ_2 – unknown population mean of a variable in the second group

The algorithm presented in figure 2 is more sophisticated than the previous one. It is caused by the fact that the selecting procedure is more complicated in two-sample tests than in one-sample tests. It should be marked that two-sample t-test can be used when the groups are **independent** (*e.g. blood pressure of patients who were given a drug vs. a control group who received a placebo*) or **dependent** (*e.g. blood pressure of patients "before" vs. "after" they received a drug*). That paper is only focused on independent variables.

The generalization of independent two-sample t-test is **one-way ANOVA**. It can be used to testify differences between two or more independent groups. However, typically it is used to compare means between at least three groups. It is cased by the fact that in the case of two groups one-way ANOVA and independent two-sample t-test lead to the same results.

Formal notation for that test is located in the box below [1] [5] [10]. Note that it requires the appearance of at least one pair with unequal the population means in order to disprove the null hypothesis.

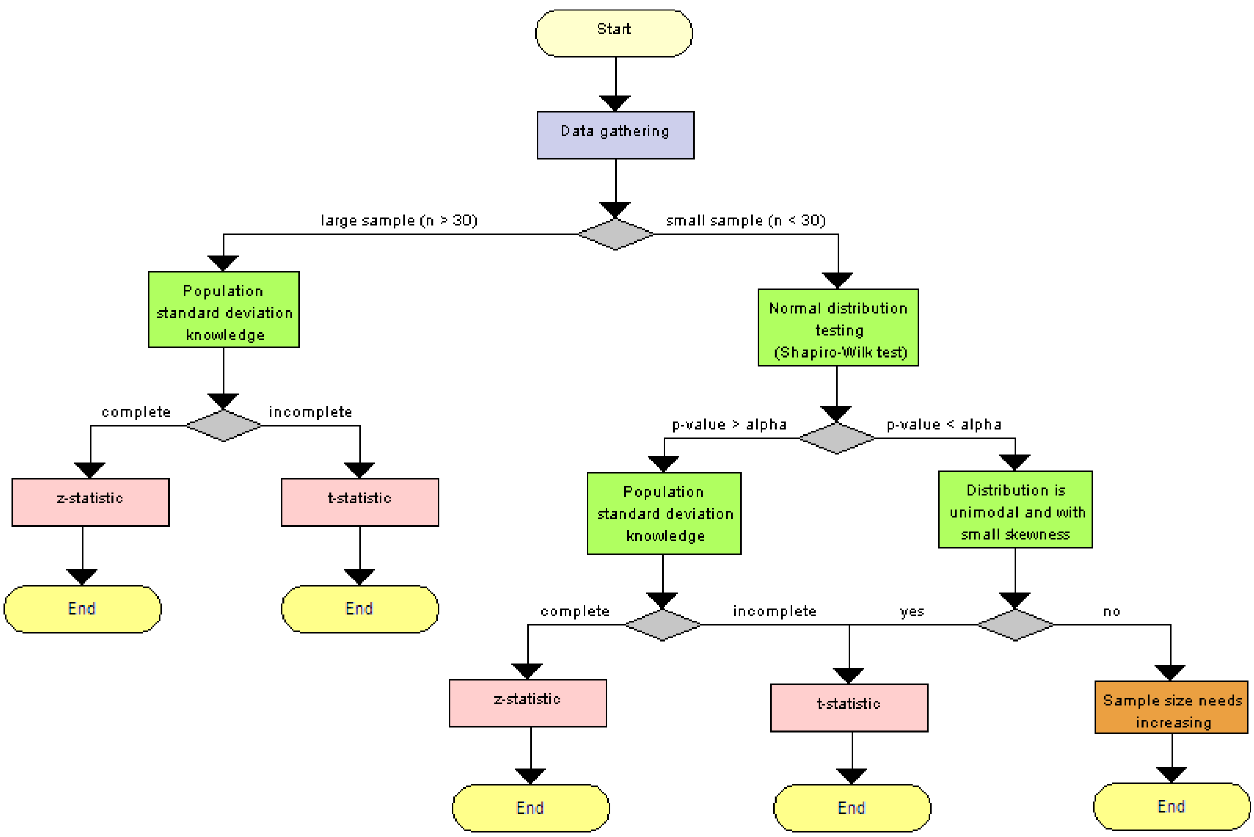


Figure 1. The procedure of one-sample t-test application

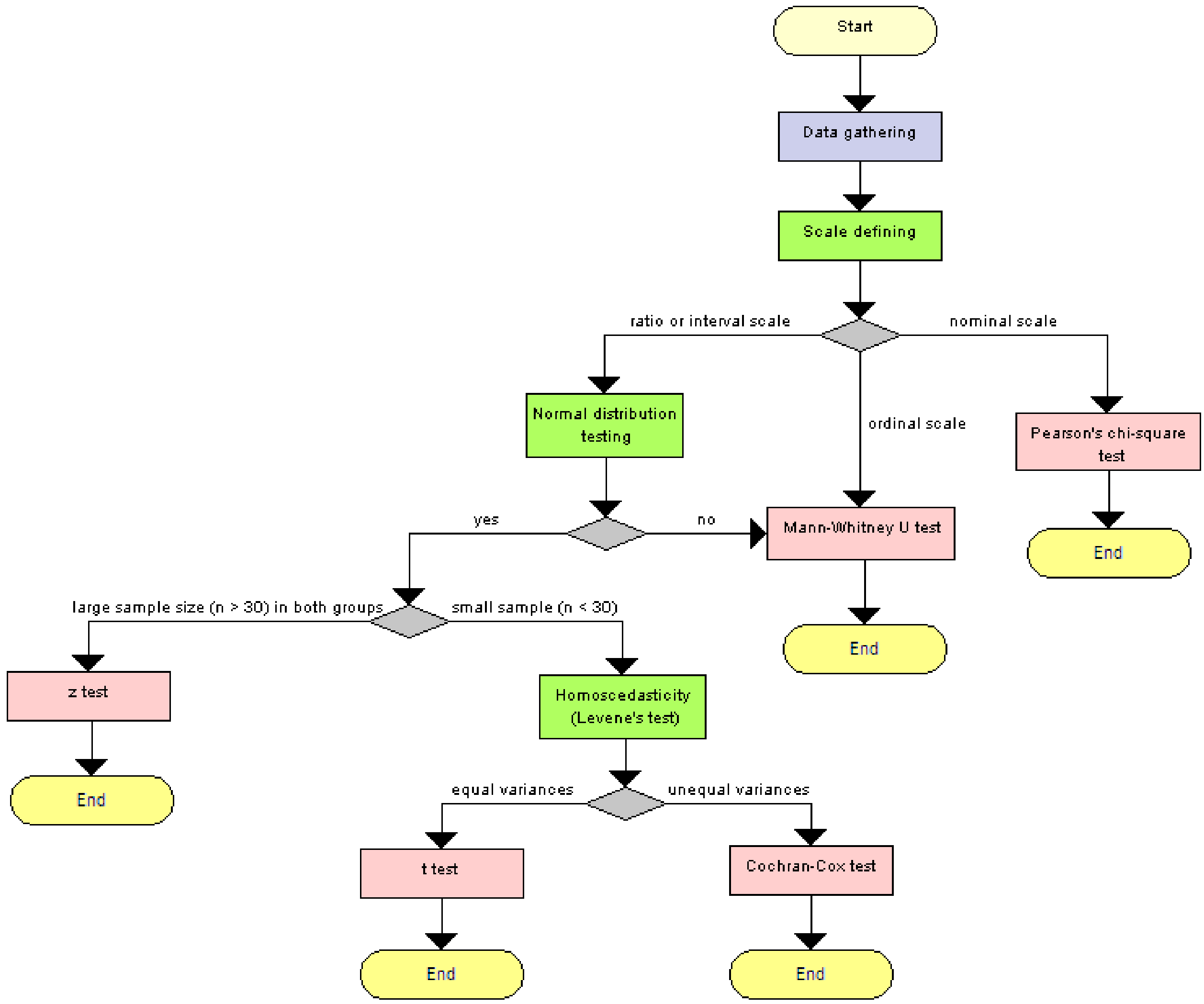


Figure 2. The flowchart of the applicability of independent two-sample t-test

$$H_0 : \mu_1 = \mu_2 = \ldots = \mu_n$$
$$H_1 : \exists\ \mu_i \neq \mu_j \quad i \neq j$$

where:
μ_1, μ_2, …, μ_n – unknown population mean in the first/second/…/nth group

According to the figure 2 and 3 it can be noticed that both one-way ANOVA and independent two-sample t-test are characterized by the same assumptions to validate. It can be a good confirmation that one-way ANOVA is the generalization of independent two-sample t-test.

Material and methods

All statistical pathways presented in this paper have been prepared using the BIT Pathways editor. It was created by Andrzej Kononowicz in Telemedicine and Bioinformatics Department as a tool to prepare clinical pathways [6] [7]. However, nowadays it is used for making pathways in many others science disciplines.

There is a wide range of companies offering software to create flowcharts on the market (*e.g. Edraw Flowchart, SmartDraw, FlowBreeze RRFlow, etc.*), but only a few of them has such facilities like BIT Pathways. Normally using commerce software it is possible to create flowchart, but it is not possible to add diverse attributes (*e.g. text, numerical values, mathematic formula*) to its elements. Moreover it is possible to set a specific colour to a group of elements in BIT Pathways.

All that attributes have been applied in the statistical pathways presenting in that paper. First of all the following colour rules have been employed: elements concerning all preliminary activities are blue, elements representing assumptions – green, those defining a final test that should be done – pink. Orange colour have been assigned to information elements, and elements such START and END are in yellow colour. Furthermore, a short description with mathematical formula have been put in an element if necessary (Figure 4).

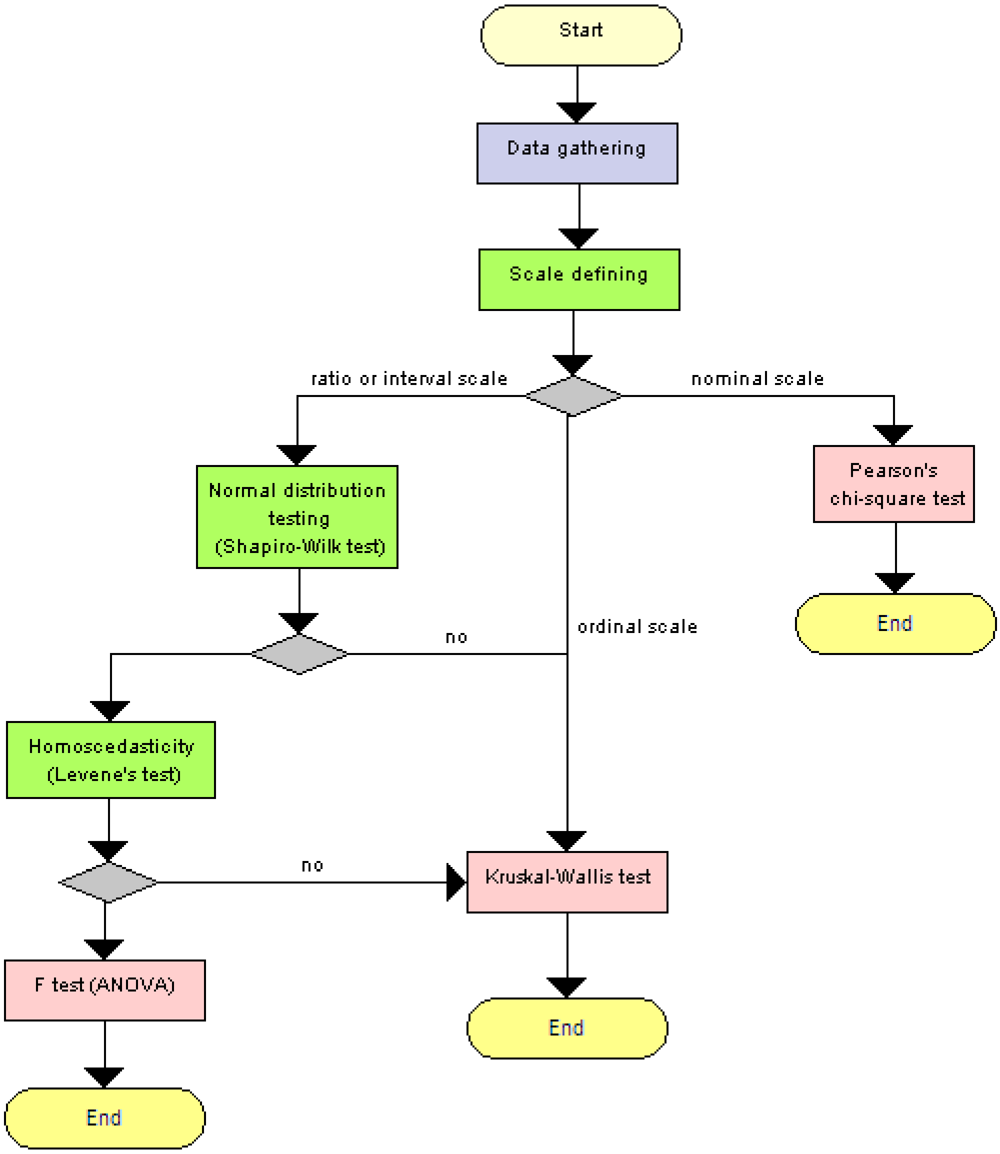


Figure 3. The flowchart of the applicability of one-way analysis of variance

Results

All represented in this paper statistical pathways are available on-line (http://149.156.12.33/statpath). Authors plan to enlarge the set of pathways systematically in the future. The main reason is possibility to use it to educational aims for medicine strudent.

The application of flow diagrams to the most relevant test identification seems to be very good way to improve understanding of statistical rules. After gathering data and making decisions what kind of hypotheses will be testified the correct test can be found by means of statistical pathways. Moving from the top of schemes to the bottom and checking all necessary assumptions there is no possibility to use the improper test and draw incorrect conclusions.

Note that according to the algorithm presented in the Figure 2 and 3 it is very important to distinguish variable scale: nominal, ordinal, ratio or interval. It very often determines the relevant test. For example, in the cases when variable scale is ordinal (or at least one of an assumptions of independent two-sample t-test/one-way analysis of variance is not fulfilled) nonparametric test like Mann-Whitney test/Kruskal-Wallis test should be used. On the other hand if variable scale is nominal the Pearson's chi-squared test (also known as chi-square goodness-of-fit or chi-square test for independence) should be applied. Then the null hypothesis concerns independent of two variables.

Conclusions

At present time hypothesis testing plays very important role in science. The results received based on it are a strong proof in scientist considerations. Statistical software is a very useful tool that helps making all calculations. The researcher shall be aware of the statistical rules. The guided step-by-step methodology (as it is in the case of pathways applicability) makes the hypothesis testing easier and helps the medical doctors and

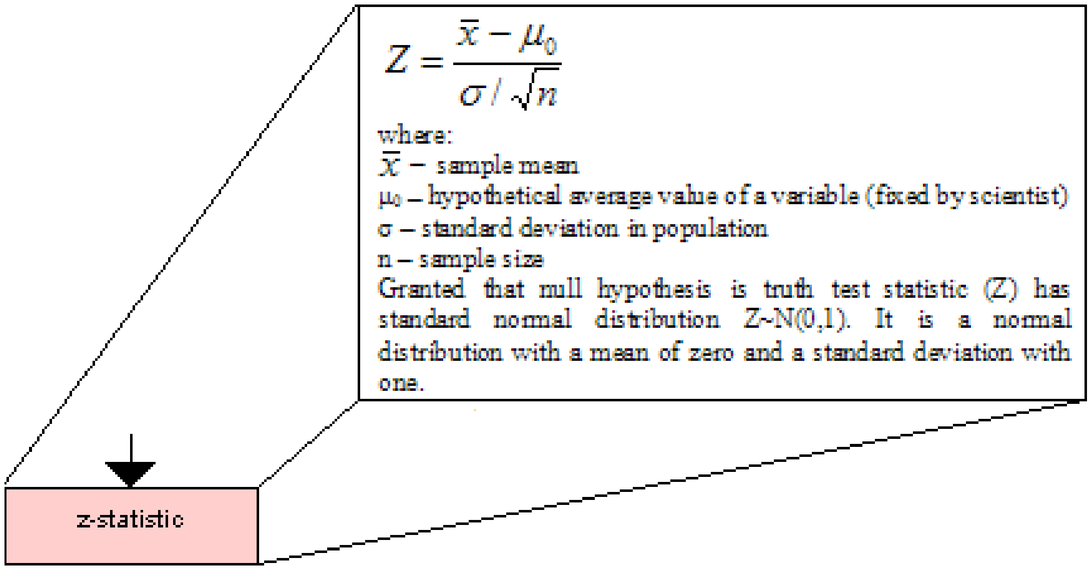


Figure 4. The exemplary description of mathematical explanation for z-statistic available in the background (form of Help service)

students to remember and understand the statistical procedure. The statistical procedures presented in the form of pathways seem to be the perfect tool for e-learning techniques in medicine.

Preparing the statistical pathways using BIT Pathways prove the flexibility of this application. This is particular importance for all disciplines which are not of clinical character.

References

1. Altman D. G., Practical statistics for medical research, Chapman & Hall/CRC, London 1999.
2. Bleser L. D.; Depreitere R.; Waele K. D.; Vanhaecht K.; Vlayen J. & Sermeus W., Defining pathways, J Nurs Manag 14(7), 553-563, 2006.
3. Bradshaw M. J., Clinical pathways: a tool to evaluate clinical learning, J Soc Pediatr Nurs 4(1), 37-40, 1999
4. Broniatowska E., Chemical pathways – application to the molecular point groups, Bio-Algorithms and Med-Systems
5. Jóźwiak J., Podgórski J., Statystyka od podstaw, PWE, Warszawa 1995.
6. Kononowicz A. A., Roterman I., Chemical pathways – visualisation of classical analytical procedures in chemistry by the use of flow charts, Bio-Algorithms and Med-Systems.
7. Kononowicz A. A., Salapa K., Building clinical pathways by postgraduate students as a method of improving knowledge about the patient's journey through a hospital, AMEE 2008, Prague, Czech Republic.
8. Kononowicz A. A., BIT Pathways – a tool for teaching and learning clinical pathways [in preparation].
9. Marshall G., A Dictionary of Sociology, 1998.
10. Stanisz A., Przystępny kurs statystyki z zastosowaniem STATISTICA PL na przykładach z medycyny, StatSoft, Kraków 2006.
11. Tho, Clinical Pathways – A practical step towards outcomes measurement reengineering the service delivery process.
12. www.fs.fed.us, Draft Adaptive Management Information Flow Chart.
13. www.meteo.se, MM5 Modeling System Flow Chart.
14. www.oracle.com, Overview of the Upgrade Process, Oracle® Application Server Upgrade and Compatibility Guide 10g (10.1.4.0.1) for UNIX Part Number B28188-01.
15. www.physics.wisc.edu, Undergrad course flow chart, the Univeristy of Wisconsin Madison, Department of Physics.
16. www.tc.gc.ca, The Regulatory Solution by Pierre-Laurent Samson, Civil Aviation Safety Inspector, Regulatory Affairs, Policy and Regulatory Services, Civil Aviation, Transport Canada.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 133-134

"EUROPEAN GAMES ACADEMY (EGA) IN CRACOW"

Paweł Węgrzyn

Faculty of Physics, Astronomy and Applied Computer Science
Jagiellonian University
Reymonta 4, 30-059 Kraków

Video games are nowadays an important part of people's lives. Most of the population in developed countries are gamers from time to time, and video games are affecting various activities (see recent reports [1-3]) . Several most novel video games have reached such a high levels of excellence that should be considered art masterpieces. The importance of video games both in the economy and in the culture implies an increased demand for knowledge, skills and training about games. Since the beginning of XXI century, many universities and colleges have been started offering courses on video game analysis, development and design.

The Jagellonian University in Cracow has teamed up with the University of Mining and Metallurgy in Cracow to create the European Games Academy (EGA) in collaboration with other partners including video game industry companies. It started in 2008 being the first organization in Poland to provide high level education in computer and video game production. The EGA has established a close cooperation with the European Games Centre (EGC). The mission of the EGC is to understand video game industry requirements in Poland and look at possible cluster cooperations.

The production of video games is a fast developing industry also in Poland, and this branch is already regarded in the world with some acclaimed titles. But the game industry needs more suitably skilled people to continue the growth and keep a world-class level. The aim of the EGA is to educate students in various video game skills and to expose them to career opportunities in video game industry.

The first initiative of the EGA is to address post diploma studies in Krakow. The entrance requirement is a first graduate diploma or equivalent degree. The EGA offers six independent post diploma courses for 111 students (see for details ega.org.pl):

- Video Game Producing (15 students)
- Video Game Mechanics (15 students)
- Video Game Programming (45 students)
- 3D Modeling in Video Games (12 students)
- 3D Animation in Video Games (12 students)
- Sound in Video Games (12 students)

Each course lasts two years. All six courses include lectures and trainings on the introduction to the process of video game development, game design, gameplay, game analysis and evaluation.

Video Game Producing include teaching of interaction design, making and editing of films, screenwriting, video game documentation, marketing, poetics and rhetoric, narrative theory and hypertext, social psychology, aesthetics and psychology of perception, introduction to game studies.

Video Game Mechanics include teaching of interaction design, making and editing of films, screenwriting, video game documentation, preparing of technical documentation, script languages, artificial intelligence and level design.

Video Game Programming include teaching of game physics, game engine, graphics engine, High Dynamic Range technology, preparing of technical documentation, particle systems, artificial intelligence, introduction to shaders, physical engine, web programming, introduction to computer animation, hardware platforms and multicore processors.

3D Modeling in Video Games include teaching of concept graphics with aesthetics, creating of storyboards, introduction to computer graphics software, F/X in graphics, modeling of characters, modeling of neighborhood, creation and correction of textures.

3D Animation in Video Games include teaching of concept graphics with aesthetics, creating of storyboards, introduction to computer graphics software, F/X in graphics, making and editing of films, preparing objects for 3D animation, traditional and novel 3D animation techniques.

Sound in Video Games include teaching of basics of film making, acoustic and sound perception, sound recording, composition and video game soundtrack, digital signal processing, sound edition, computer programs for sound processing, sound interfaces.

The EGA courses are dealing with different platforms for video games, that range from online and offline computers and consoles to mobile phones and handheld devices. Video game development is a cross disciplinary field. The lecturers are experts in programming, cinematography, art, music and more. People who are interested in learning about games must come from a wide variety of academic backgrounds and should be supported by designers and developers from industry. The EGA is cooperating closely with industry to ensure that appropriate skills and knowledge are covered in the courses. Visiting lecturers from the industry are used to provide students with a practice-oriented education. This collaboration should also encourage the best students to pursue a career in the video games industry. During their time at the EGA, students create their own projects (pre-production of video games) and their portfolios can be shown later to potential customers or employers. The hope is that the EGA will be a groundbreaking for recruiting employees in the video game industry in Poland.

In future, the EGA is going to setup graduate and postgraduate studies in video game design and development. The EGA is also planning to organize activities of educating or instructing on the impact of video games industry on other industry sectors. The development of many computer innovations is stimulated by the game industry and the latest cutting-edge games, like sound cards, graphics cards, 3D graphic accelerators, CD ROM drives. On the other hand, video games can be used as a medium in programs dealing with education or as a part of therapy in a medical treatment.

In education, students love learning platforms with entertaining elements. Moreover, video games and other modern media are producing learners with a new profile of cognitive skills. As science and technology have become more visual in their intrinsic nature, schools should use modern media to support traditional ones and develops cognitive skills and visual intelligence [4]. Video games offer new kind of collaboration between a teacher and students [5], for instance there are new game concepts which can be used in lectures in higher education to promote stronger student participation [6]. The teacher runs a game on his portable computer, while the students interact with the game using their own mobile phones. There are also tested systems of interactions between students, that are discussing addressed problems in real time with the other players [7]. The review on the adoption of video games for learning in science, technology, engineering, and math (STEM) disciplines is given in [8]. Generating interactive game courses would be hard for people that are not computer experts. Therefore special tools are proposed and will be likely developed in future to help content providers to create their educational games nicely and easily without specialized computer knowledge [9]. Comparative studies on the learning effects of games versus traditional media have been carried out among science college students [10]. Using video games is educationally beneficial, however too frequent playing may be destructive [11].

A new method for medical students to learn how to perform an effective home visit was developed in geriatrics education using an instructional video game [12]. Students are to learn the principles of a home visit using a video game. Video game experience (VGE) has been also used as a training to shorten time to achieve proficiency in surgical skills [13]. Interactive games-based approach has been developed for teaching in the surgical residency program [14]. A prospective game-based educational program in clinical neurophysiology in a neurology residency was put forward in [16].

Video games can be used also for therapy and rehabilitation, in gyms and other settings to promote physical activity and for the greater involvement in interacting of health care providers [17,18].

References

1. "Video Gamers in Europe – 2008", raport by Nielsen Games for the Interactive Software Federation of Europe (2008), http://www.isfe-eu.org/.
2. T. Byron, "Safer Children in a Digital World: The Report of the Byron Review", March 28 (2008), http://www.dfes.gov.uk/byronreview/.
3. A. Cragg et al., BBFC Video Games Report (2006), http://www.bbfc.co.uk/.
4. P. M. Greenfield et al., "Technology and Informal Education: What Is Taught, What Is Learned", Science 323, 69 (2009).
5. A. A. Anghern et al., "Designing collaborative learning and innovation systems for educational professionals", Lecture Notes in Computer Science 5288 LNAI, 167 (2008).
6. A. I. Wang et al., "An evaluation of a mobile game concept for lectures", Software Engineering Education Conference Proceedings, art. no. 4556966, 197 (2008).
7. J. Craighead, "Distributed, game-based, intelligent tutoring systems – The next step in computer based training?", 2008 International Symposium on Collaborative Technologies and Systems, CTS'08, art. no. 4543938, pp. 247-256 (2008).
8. J. M. Mayo, "Video games: A route to large-scale STEM education?", Science 323 (5910), 79 (2009).
9. H. B. Chang et al., "Interactive video game platform for game-based learning", Lecture Notes in Computer Science 5145 LNCS, 232 (2008).
10. L. W. Wong et al., "Serious video game effectiveness", ACM International Conference Proceeding Series 203, 49 (2007).
11. B. Ip et al., "Gaming frequency and academic performance", Australian Journal of Educational Technology 24 (4), 355 (2008).
12. G. Duque et al., "Learning while having fun: The use of video gaming to teach geriatric house calls to medical students", Journal of the American Geriatrics Society 56 (7), 1328 (2008).
13. M. D. Shane et al., „Should surgical novices trade their retractors for joysticks? Videogame experience decreases the time needed to acquire surgical skills", Surgical Endoscopy 22 (5), 1294 (2008).
14. S. Meterissian et al., "Games as teaching tools in a surgical residency", Medical Teacher 29 (9-10), e258 (2007).
15. L. Schuh et al., "Learning clinical neurophysiology: Gaming is better than lectures", Journal of Clinical Neurophysiology 25 (3), 167 (2008).
16. D. J. Skiba, "Games for health", Nursing Education Perspectives 29 (4), 230 (2008).
17. P. M. Kato et al., "A video game improves behavioral outcomes in adolescents and young adults with cancer: a randomized trial.", Pediatrics 122 (2), e305 (2008).

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 135

CLINICAL PLACEMENTS IN PHARMACY: DEVELOPMENT OF AN ON-LINE "VIRTUAL" LEARNING MODULE TO ORIENTATE STUDENTS TO CLINICAL PRACTICE

Beata Bajorek[1], Marianna Koulias[2], Marina Lobastov[2], Jim Woulfe[1], Greg Ryan[1]

[1]*Faculty of Pharmacy, The University of Sydney NSW, Australia*
[2]*Sydney eLearning, The University of Sydney NSW, Australia*

contact author: Beata Bajorek, beatab@pharm.usyd.edu.au

Aim: To develop, implement, and evaluate an on-learning module "virtually" depicting the clinical practice setting ('ePlacement') that would maintain and/or supplement experiential learning within pharmacy programs.

Method: The ePlacement was designed as a web-based learning module, depicting aspects of pharmacy practice across the continuum of care using mixed media and other resources, and incorporating specific student activities. Development of the module involved collaboration between academics and designers to conceptualise the module, confirm content, obtain/provide feedback, modify module as required, produce/retrieve resources (e.g., video clips, images, sound recordings, narrations, etc), and develop and analyse evaluation surveys.

Results: Student feedback was elicited in a 3-part survey (Jan-March 2008) comprising Likert Scale responses and open-ended questions to gauge: student expectations of module, immediate impressions following its completion, and final opinions after completing a 'live' clinical placement. Overall, most students "Agreed" or "Strongly Agreed" that the module provided a broader insight into practice, presented new information and resources (86.6%), and helped them better prepare for clinical placements (66.6%) through better visualization of the practice environment.

Conclusion: An alternate learning mode to help orientate students to pharmacy practice settings has been successfully developed and implemented, resulting in students being more prepared for 'live' clinical placements and more confident and able integrate into the clinical practice site. This module may help decrease the time spent orientating to 'live' placements, and alleviate the challenges of placement site shortages.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 137-141

MALE PORTRAIT HEAD

Dorota Gorzelany[1], Jerzy Walocha[2], Anna Wojas-Pelc[3], Władysław Lejman[4], Ryszard Gryglewski[4], Wiesław Pyrczak[5], Irena Roterman[5]

[1] National Museum in Cracow, inv. XI-831, Property of The Princes' Czartoryski Foundation Sw. Jana 19, 31-017 Krakow, Poland
[2] Department of Anatomy – Collegium Medicum – Jagiellonian University, Kopernika 12, 31-034 Krakow, Poland
[3] Dermatology Clinic University Hospital, Kopernika 19, 31-501 Krakow, Poland
[4] Department of History of Medicine – Collegium Medicum – Jagiellonian University, Kopernika 7, 31-034 Krakow, Poland
[5] Department of Bioinformatics and Telemedicine, Collegium Medicum – Jagiellonian University, Lazarza 16, 31-530 Krakow, Poland

Abstract:The roman sculpture of the portrait character dated 50-30 BC. is the object of the contemporary medical diagnostics. The face of the quite old man represents some symptoms which may be due to different disease. The specialists representing surgery, dermatology and anatomy suggest some medical recognition of possible diseases on the basis of the visual characteristics of the face solely.

Streszczenie: Rzymska klasyczna rzeźba o charakterze portretu datowana na okres 50-30 p.n.e. jest obiektem współczesnej diagnozy medycznej. Twarz starszego mężczyzny nosi symptomy pewnych procesów chorobowych. Specjaliści reprezentujący chirurgię, dermatologię i anatomię stawiają swoje hipotezy o charakterze diagnozy bazując jedynie na wizualnym oglądzie zmian chorobowych w obrębie twarzy.

Historical background

Amongst the Roman sculptures being displayed in the Ancient Art Gallery of the Princes' Czartoryski Museum there is a male head of 24 cm height, made in marble of yellowish colour. The naturalistic way of representation very precisely renders the physiognomic features of man's face and let us date this portrait to the Late Republic period, circa 50-30 BC (Fig. 1).

The portrait represents an unknown Roman in his mature age. The skin of his face is rendered naturalistically and seems to be flabby, there are deep wrinkles on his forehead, his cheeks are sunken. Deep set and slightly swollen eyes have clearly modelled lids. The folds of skin run from the nose to the corners of tightly closed and asymmetrically dropped mouth.

On his left temple some wisps of hair are visible [1, 2, 3].

Modern reconstruction is the nose, the central part of the upper lip and the outer fragment of his left brow. Some destruction of the sculpture surface caused with the humidity to which the sculpture might have been exposed for longer time is visible on the right side of the face, near to the eyebrow ridge, temple and cheek bone.

The head was cut of a funeral stela which made its back part flatten. Originally it was made in high relief, not in sculpture in–the–round, what explains the contrast between carefully carved face and superficially worked skull. Also destructions visible on the surface over the right ear and on the left part of the top of the skull may be due to some accidental and unsuitable sculptor's move while carving in the deeper and less accessible part of the stela. Irregular elaboration of the ears – the right is elaborated very schematically – may have been caused with originally placing the head on a stela.

Stelae used to be set into a tomb wall and they served a commemorative function. They are of rectangular shape and most part of their surface was a niche, filled with frontal busts of the deceased made in high relief. Represented were often manumissioned slaves showing in this way their new higher social status.

Opinion given by the specialist of anatomy

The observation of the face shows evident lowering of the left angle of the mouth (Fig. 2).

Together with a „scar" seen at the border of the right parietal/frontal region, which overlies cortical motor centers (Fig. 3), a diagnosis of the facial palsy may be established. The facial palsy in this case is probable a result of the compression of cortical centers which control the lower facial motor nucleus.

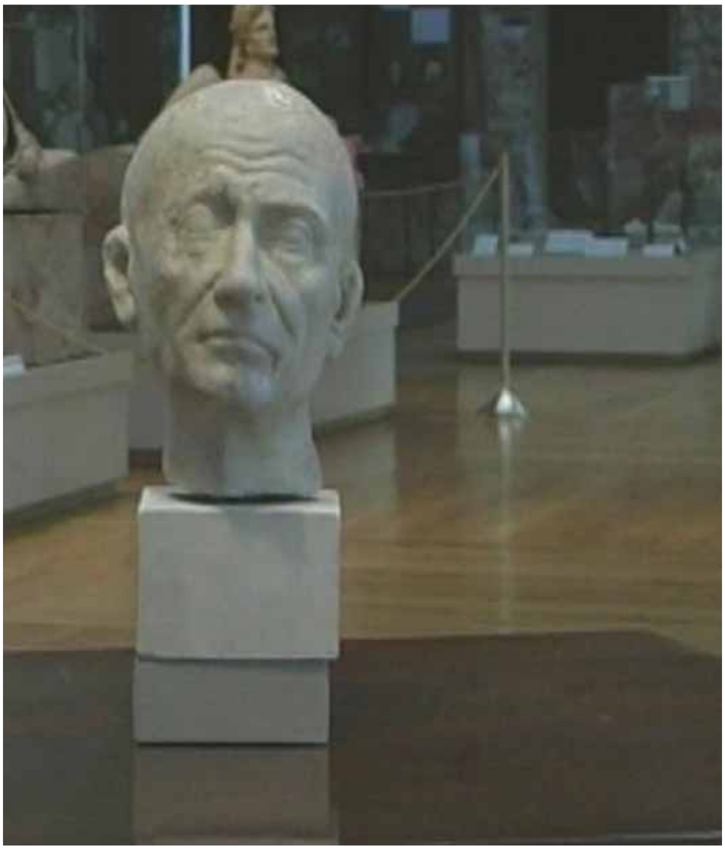


Fig. 1. The sculpture in the collection of roman art in the National Museum in Cracow, inv. XI-831, Property of The Princes' Czartoryski Foundation, Krakow St Jan Street 19.

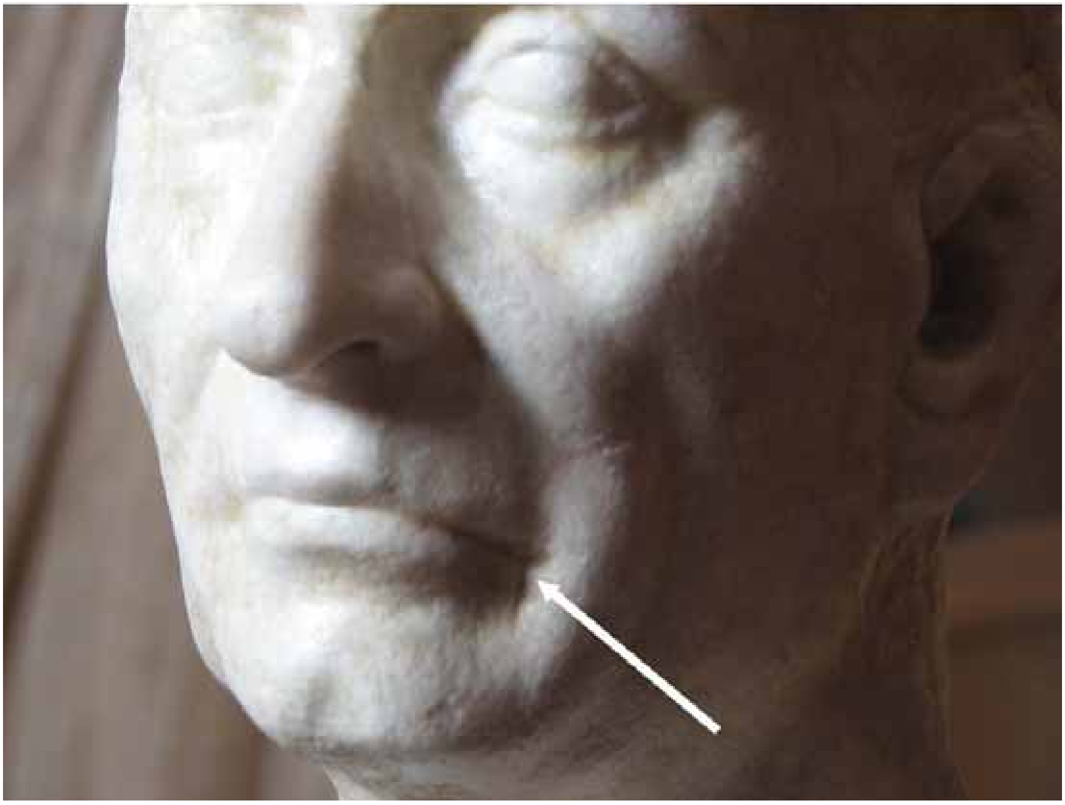


Fig. 2. Lowering of the left angle of the mouth observed by the specialist in anatomy.

Because of unilateral input which is running toward lower facial nucleus, the left-sided lower muscles of facial expression are paralyzed. You can see also a significant flattening of the grooves on the right half of the face, giving an impression of the facial asymmetry, first of all caused by loosening of the muscles of the lower cheek region – which may simulate a swelling of submandibular region, but is also quite characteristic of Bell's (facial) palsy. Irregularity in the right superciliary arch may be a result of direct trauma, as well as a result of local infection.

The dermatological recognition

According to the contemporary medical knowledge only the facial part of the sculpture is original and the other head structures were prepared later on during the renovation process. It is probable, that this man suffered from severe necrotic shingles. On the medial 1/3 of the eyebrow there is an area of depression – a scar (probably) after ulceration in the course of necrotic shingles (which is within the dermatone of the first branch of trigeminal innervation). On the right side of the face there is a mouth angle decline that may be connected with the facial nerve involvement. Transient or permanent facial nerve palsy may be the consequence of that process.

Recognition given by the specialist in surgery

The most probable diagnosis from the surgical point of view is Carcinoma cutis (probabiliter spinocellulare) regionis arcus superciliaris, temporalis et zygomatici ad dextram. Metastates ad lymphonodos submandibulares lateris dextri.

Diagnosis: Skin cancer (presumably sqamous cell type) of right supercilliary arch, temporal and zygomatic region. Ipsilateral submandibular lymph nodes metastases (seen in Fig. 5 and Fig. 6).

Conclusions

The medical diagnostics of the object treated as the artistic expression in paintings and sculpture based solely on the visual analysis is the very exciting hobby requiring the collaboration of the history of art and different medical specializations. This time the evidently pathological symptoms on the face of an unknown Roman in his mature age are the objects of the medical interpretations. The Reader may easily recognize some discrepancies and lack of the common diagnosis. The text may be of educational character for current students of medicine showing that the lack of modern techniques makes the diagnosis nonunivocal.

This could be an interesting experiment when based on their anatomical and clinical knowledge, the students after careful observation of the sculpture, should probably be able to

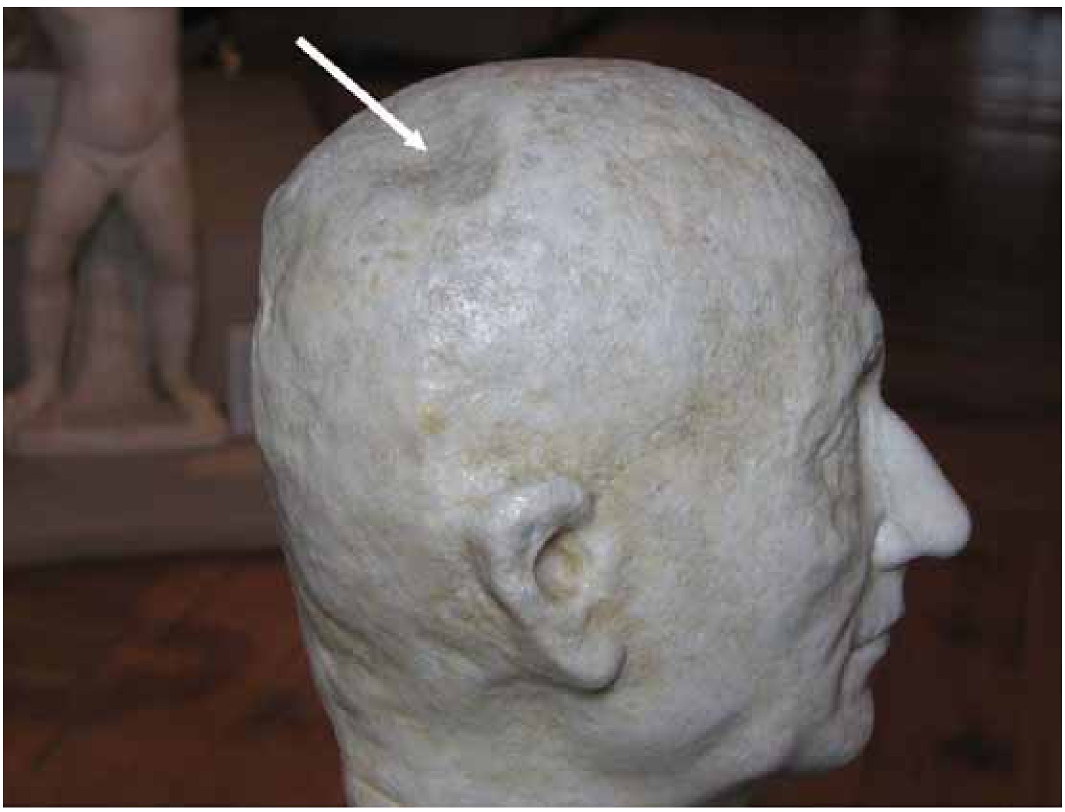


Fig. 3. „Scar" seen at the border of the right parietal/frontal region

Fig. 4. The right side of the patient's face with disease related pathological deformations.

Fig. 5. Ipsilateral submandibular lymph nodes metastases

Fig. 6. Ipsilateral submandibular lymph nodes metastases.

construct their own diagnosis and later they would compare it with opinions of different specialists.

This example proves that the diagnosis limited to visual analysis is significantly too limited leading to quite different final decisions. Although this examples reveals the very comfortable situation of medicine nowadays keeping in its hand the powerful tools (like radiological, biochemical, etc analysis) making possible the understanding the mechanisms of processes on the molecular level.

It seems, that in front of nonunivocal diagnoses, other specialists like dentists and/or neurologists should be asked for their decisions. Important information which should be taken in consideration is that the status observed on the sculpture is the result of uncured disease. Such advanced pathological status is not observed nowadays, particularly if it is the results of tooth's disease with no medical intervention. The diseases in their advanced status are not presented to students during their medical educations. This is why the example under consideration is difficult for medical recognition.

Acknowledgements

Authors are very grateful to the Head of National Museum and Czartoryski Collection making the sculpture available for operator producing the movie and photos. Many thanks to Mr Mateusz Bobek who produced the educational material of multimedia character.

[1] B. Schweitzer, Die Bildniskunst der römischen Republik, Leipzig/Weimar 1948.
[2] A. Sadurska, Corpus Signorum Imperii Romani. Pologne, Vol. I, Les portraits romains dans les collections polonaises, Warszawa 1972, no. 1, p. 13.
[3] L. Giuliani, Bildnis und Botschaft, Frankfurt a. M. 1986.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 143-146

LEONARDO DA VINCI: "THE LADY WITH AN ERMINE" – INTERPRETATION OF THE PORTRAIT

KRYSTYNA MOCZULSKA

– custodian-emeritus in the Prince Czartoryski Museum, St. Jan Street 19, 31-017 Kraków

The most famous and the most precious picture in the Polish collections in the Prince Czartoryski Museum in Kraków is the portrait of a young woman holding a tiny animal described as "The Lady with an Ermine" (or "The Lady with a Weasel"). The artist is Leonardo da Vinci (Fig. 1)[1].

Fig. 1. Lady with an Ermine by Leonardo da Vinci

The picture is worthwhile some medical interpretation because of the content included in it and the circumstances of its painting. The portrayed by Leonardo da Vinci young lady is Cecily Gallerani, the mistress of Duke Lodovico Sforza, called il Moro (1452-1508), the Ruler of Milan. There is no doubt that being the patron of the artist he ordered Leonardo to paint this portrait. The living in Milan family of Cecily did not belong to *nobilis*. Her father, having not established contacts with the court, died in the year 1480, orphaning six sons and two daughters. Cecily was seven years old at that time. Three years later the girl was married "*pro verba*" to the youth fourteen years older than she was. This young man belonged to the family of the similar social status to Cecily's. It was established in the contract that the marriage would take place when Cecily was twelve years old, but the dowry would be paid in instalments. However, the marriage did not take place either from the reason of the family insolvency or from other causes because the contract was dissolved in the year 1487. The successive document concerning Cecily comes from the year 1489 and points to her relationship with Duke Lodovico Sforza. She was then sixteen years old and he, being then thirty-seven years old, was married "*pro verba*" by a contract written still in the year 1489 to Beatrice d'Este (born in 1475), daughter of the Duke of Ferrari. The wedding ceremony was planned for the year 1490. However, when in the early part of the year 1490 Lodovico sent some jewellery to his future wife, he did not declare the term of the wedding.

It was the reason why the relationships between the courts of these two countries became tense. Especially, when in one of the letters of November 1490 the ambassador in Milan informed his ruler, the Duke of d'Este, about the reason of this dealy. He told the Duke that Lodovico was reluctant to the arrival of Princess Beatrice at the Sforza's court because his beloved Cecily was not only "*bella come un fiore*", but also "gravida". However, the wedding ceremonies of Beatrice and Lodovico took place on the 16th January 1491 and the situation of "the beautiful as a flower" and pregnant Cecily in the Castello Sforzesco, where she was still living, was becoming more and more difficult, especially that Beatrice quickly discovered

Cecily's relationship with her husband. And thus, one month after his wedding, the Duke presented Cecily with a landed property and a house. And after giving birth to his son, on the 3rd May 1491, Cecily received a successive estate. The boy was named Cezare. One year later nineteen-year-old Cecily was married to Earl Lodovico Carminati de Brambilla, called Bergamino, and she started to live with her husband and son in the palace Carmagnola in Milan. This palace was a gift of Lodovico il Moro for his son.

In the portrait Leonardo showed "the beloved and resembling Venus" Cecily with a tiny animal in her hand, described as an ermine or a weasel and – what is stressed by all the scholars – in the way not included in the convention of the portraits of those days. From the psychological point of view the animal which occupies the foreground of the picture is as important as the model herself.

The ties connecting Cecily and the tiny animal are both unusual and mysterious; they are double ties: formal and psychical. Both images are shown in half-length. There is a striking harmony in the arrangement of their heads, their structure and expression, in the eyes concealing tension, looking intensely in the distance. Exposed in such a way, this tiny animal seems to be the key to recognize the painter's idea contained in the picture.

Since the Middle Ages ermines have been symbols of purity and innocence owing to the whiteness of their fur (winter attire) and they have been known from the descriptions telling about their fondness of cleanliness (they prefer to be killed than to get dirty). Thus, according to some investigators, Cecily would present the personification of this virtue. In the year 1488 Duke Lodovico received from Ferdinand I of Naples "The Order of the Ermine". The attributed to it designation Ermellino (ermine) can be found in the court poetry. Would then the tiny animal be an allusion to the intimate relationships of both these people?

Attention has also been paid to the identity of the shortening of the surname Gallerani with galee – in Greek a weasel and also in metaphor – a girl. In the circle of court erudite humanists, among whom Cecily was staying, such associations of ideas play on words and charades were a favourite form of pastime?

In my opinion this play on words Gallerani – galee could be for an artist a starting point concerning the numerous symbolic contents which he coded in this unconventional portrait.

However, his direct inspiration was the well-known myth from the Ovid's Metamorphoses. It tells about the dramatic circumstances of the birth of Hercules, the illegitimate son of Zeus. When – by the order of Hera – during the birth of the future hero prevented the goddess of births, the young servant Galantis craftily misled the goddess and helped her lady, who was exhausted by the very long-lasting birthpain, in delivery. The angry goddess out of revange changed the young woman-servant into a weasel (Galantis into galee).

What would then be the meaning linking this myth with the portrait?

For Cecily expecting the birth of her child, whose father was the Ruler of Milan, the wedding of Lodovico with Beatrice d'Este meant a great change in her life. It could cause various threats and complications, especially if the expected descendant were a son, whose coming into the world was to precede the birth of the children from the legal marriage.

Leonardo carried out innumerable observations on the processes of nature and studies of various character, among others, anatomical ones, including women's anatomy and embryology, which were additionally testified by means of pictures. And as it results from his notes placed in the so-called Manuscript H – a kind of *bestiarium*, he also knew the symbolic representation of ermines and the possibilities with which the weasels were gifted by Nature.

The animals from the weasel's family were the cause of a lot of superstitions and they were to help in various pains. The medicines prepared from them were used as a strong medium against poisons, for liver pains, rheumatism, epilepsy and easier childbirth. Especially when weasels ate rue they became so strong that each of them could kill a snake. They were even able to cope with basilisks. Their magical and medical properties were the subject of many writers in antiquity, among others Pliny in his Natural History in the books devoted to medicine and magic, "which crept in under the mask of the most sacred medicine". Also in the Middle Ages in various so-called Hortus sanitatis it was often repeated what had already been known earlier. The fact "that weasels can break the arrows of death" was known in Poland too. Doctor Nicolaus (who lived in Poland in the 13th century and studied in Montpellier) wrote about it, among others, in his medical book *Antipocras*.

Fig. 2. Parmigiano *Antea* (around 1536) Napoli Galleria Nazionale

It is known that when Leonardo was painting he did not imitate the nature directly, but he created it making a reliable picture. The artist painted the tiny animal in such a way that it caused a diversity of opinions concerning its name. The animals from the weasel's family are smaller than ermines, they have a somewhat different frame of their head, a shorter snout, thick neck and short little paws covered with hair in such a way that their musculature is invisible.

The painter showed the varied in size tiny animal, gentle but watchful, with a slightly elongated snout, with well seen tense muscles of one little paw in the foreground and the delicacy of touch of the second one.

It can be read as a conscious artistic intention to show the most beautiful Gallerani and the galee which is gifted by Nature with the most perfect features.

The belief in the natural and extraordinary power of weasels, which is to facilitate the childbirth, going back to antiquity, survived in the folk customs, e.g. in the Balkans, still in the 19th century. Would not the pieces of fur from the animals of the weasel's family worn by pregnant women be a proof of such a belief in Italy? These pieces of fur were either worn on the hand or fastened to the waist. They were fashionable especially in the 16th century, but the causes of wearing them were undoubtedly different. In some portraits of women wearing such pieces of fur their pregnancy can be clearly seen and additionally stressed by the gestures of their hands. In such a way was presented Antea in the portrait by Parmigianin from about the year 1536 (Fig. 2) or Livia da Porto Thiene painted by Veronese around the year 1551 (Fig. 3).

And Beatrice d'Este, the wife of Duce Lodovico il Moro, was presented in the same manner on the sarcophagus in Certosa di Pavia (Fig. 4). She has a piece of fur placed on her crossed hands on her waist, and one can see Beatrice's fingers on the head of the tiny weasel animal lying on her abdomen. She died during the childbirth on the 3rd January 1497.

Leonardo da Vinci, an observer and investigator of the natural properties of plants and animals (however opposed to killing them) had to be convinced that only a living animal and not its fur can be a link in the mysterious power of Nature, that what was defined as natural magic or practical piece of work of natural science. In this context, according to his vision of Nature, as it can be believed, in the drawing of Hercules, Leonardo changed Hercules's attribute – the lion's skin – for a quietly lying alive animal (Fig. 5).

And it becomes clear that only an alive galee held on Cecily's left hand, near her heart, focused on its rhythm, as if itself was a prefiguration of the child, can protect him in the most effective way. The ray of light, falling from the side, models Cecily's face, her breasts, her right hand as well as the head and the front part of the tiny animal, to come gradually into shade, the strongest on the right side of Cecily. In the lower part of the picture there is some shade hiding discretely her real state (pregnancy).

The way to express the mystery is the alive tiny animal which provokes the imagination to reflect on this what has been hidden. The tiny animal has got two natures, it is to personify both the virtue and strength. Due to its curing and magic abilities, its very effective help, its vital forces with which it has been gifted by Nature, it is to lead to the expected aim. Particularly, as being the symbol of both parents it becomes at the same time the symbol of their child. Thus the galee, the liv-

Fig. 3. Paolo Veronese *Livia da Porto Thiene with her daughter* (around 1551), Baltimore, The Walters Art Gallery

Fig. 4. Cristoforo Solari, Sarcophagus of Beatrice d'Est (died 1497) La Certosa

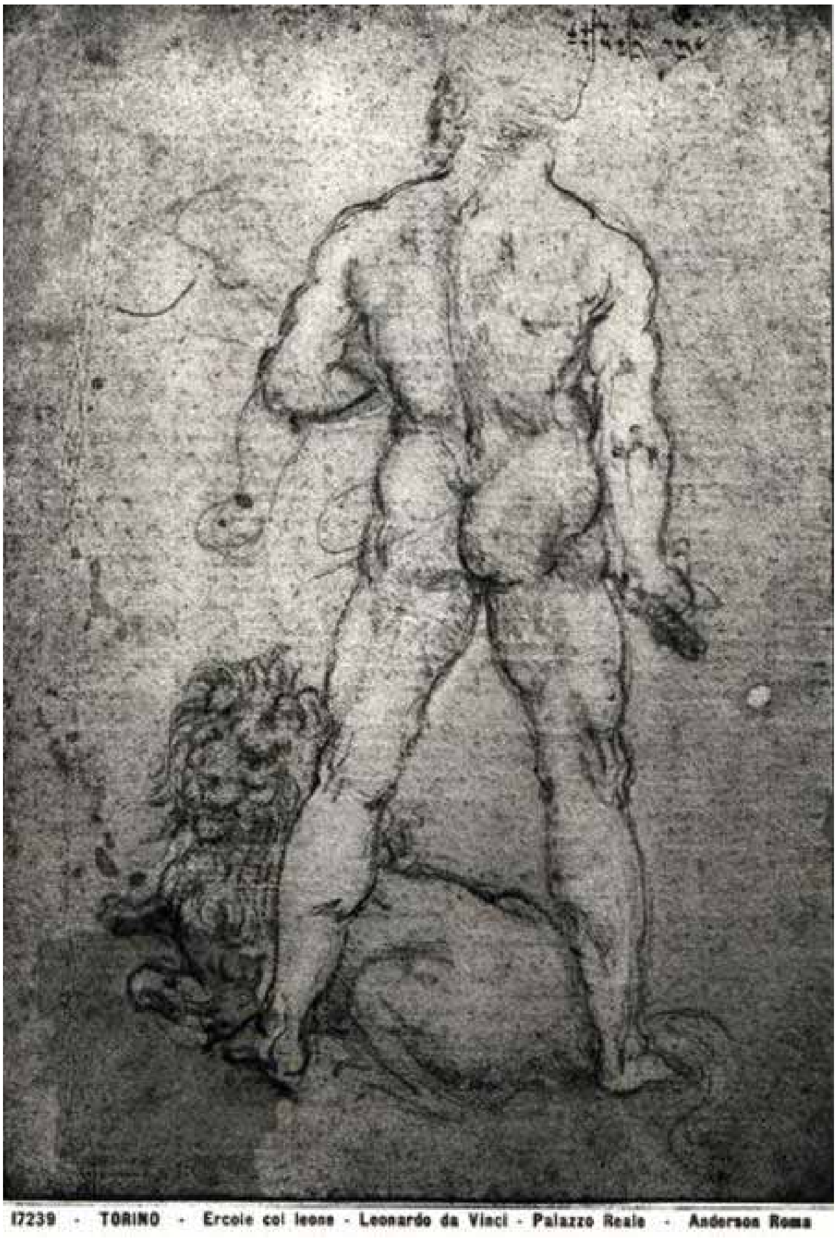


Fig. 5. Leonardo da Vinci (?) *Hercules* – Biblioteca Reale di Torino

ing symbol joining three existences (according to the number theory originated by Pitagoras – *omne trinum perfectum*) has received the most perfect features of its species.

The picture, without any doubts was thought to be a gift of Lodovico for Cecily, would have been meant to memorize their relationship when Cecily was "bella come un fiore" and "gravida" at the end of the year 1490 and at the beginning of the year 1491.

Notes:

1 The summary of the article: Krystyna Moczulska, Najpiękniejsza Gallerani i najdoskonalsza galee w obrazie Leonarda da Vinci, (The most beautiful Gallerani and the most perfect galee in the picture of Leonardo da Vinci), Folia Historiae Artium, Seria Nowa I, 1995, pp. 55-86. The picture was bought in Italy around the year 1800 by Prince Jerzy Czartoryski and presented to his mother Izabela Czartoryska to her collection of art and souvenirs at Puławy. In the year 1831 after the defeat of the November Uprising the portrait was taken to Paris, and there it was kept in the residence of the Czartoryski family at the Hôtel Lambert till the year 1878. Since that time it has been kept in Kraków except the periods of the First and Second World Wars (seized by the Nazis in 1939 and then regained). The original grey-blue background was covered by black paint in the 19th century.

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 147-152

THE XV CENTURY PATIENTS (AS PRESENTED ON WIT STWOSZ ALTAR) DIAGNOZED

Irena Roterman

Department of Bioinformatics and Telemedicine – Collegium Medcium Jagiellonian University, Lazarza 16, 31-530 Krakow, Poland

The art of sculpture in the form of polyptych (13 m high, 11 m wide), and it would probably be more proper to say pentaptych, dating the XV century (the notary's entry from the year 1533, found at the back of the altar) placed in Saint Mary's Church in Kraków (Fig. 1), makes a splendid document of the time – the period of its origin.

The middle part of the altar is filled with the scene of "The Holy Virgin (Our Lady) Falling Asleep amongst the Apostles". The figures of this part are over and above natural dimensions. This scene apart from the presentation of the figures is deprived of any additional decorations.

Two pairs of doors (in which one pair is two-sided) are covered with rectangular caissons, in which each one represents a scene from the lives of Jesus Christ and His Mother (Fig. 2). These scenes are presented in the form of bas-reliefs with the rich background showing landscapes, interiors of chambers or objects not specially connected with the same act makes up the illustrated subject (Fig. 3).

Wit Stwosz proved to be not only the master in the domain of sculpture, but also a great psychologist and documentalist. The appearance of the face of each of the presented figures is extremely suggestive, characterizing the individuality who takes part in the given event. Only the faces of Jesus and Mary are idealized, although the joy, pain or suffering is expressed very suggestively with the help of other measures than in the case of people participating in the presented event. Old, tired faces ploughed with wrinkles, hands and legs, showing the hard lives and toil of each of those people are reproduced with special truthfulness.

The faithfulness of portraying the figures streches to medical troubles. It appears that some people carry symptoms of diseases which on the basis of the visual analysis can be accurately diagnosed. Most probably the men who were sitting for the Artist were attacked by them.

From the scene of "Falling Asleep of the Holy Virgin" one can observe the characteristic anatomic changes connected with old age. And so the face of the Apostle St. Peter has got a typical of the old age wart near the region of his nose. According to the detailed medical diagnosis it is *verruca sernilis*

Fig. 1. The Saint Mary church in Cracow – the altar is localized in the main nava of this church.

Fig. 2. The altar in the opened form. The two wings, when closed uncover the second pair of wings

Fig. 3. The presentation of the altar in the closed form. The second pair of wings covered by sculptures ordered in segments.

(Fig. 4). The arrangement of wrinkles on the face of the person correlates with the presence of *verruca* proving great fidelity in reproduction of reality – in this case the compact reproduction of people in advanced age.

The most abundant in various dermatological diseases are the people participating in the following scenes: 1. Capturing Jesus Christ; 2. Descent into the Hell; 3. Resurrection.

The people taking place in these scenes are the most abundant in various dermatological diseases. The manner of their presentation is so truthful that even today an accurate diagnosis can be easily made.

In the scene of "Capturing Jesus Christ" (Fig. 5) among twelve figures three men with typical symptoms blemishing skin sufferings, perfectly expressed in wood, can be found. The soldier, grasping Christ's hair with both his hands, has in the vicinity of his right malar bone (zygoma bone, yoke bone, jugal bone) the most precisely sculptured hollow in the bottom of which a roundish verruca rise can be seen. This outgrowth is without any doubt skin cancer (basalioma epithelioma, ulcus rodens) (Fig. 6). This verruca is accompanying by another verruca without any hollow located on the right side of the nose. This symptom is very characteristic as accompanying tumor charges.

This type of tumor was formerly defined as rodent ulcer. Such phenomenon concerns mainly people in their prime (being a little more than forty years old). The described soldier was about forty years old.

The second figure afflicted with the skin illness is a servant, standing close to the above-mentioned soldier (Fig. 7) The skin

Fig. 4. The St Peter with the *verruca sernilis* on his nose.

Fig. 5. The scene of "Capturing Jesus Christ" – fragment of the central wings in their closed form (left upper – see Fig. 3)

Fig. 6. The skin carcinoma recognized on the right cheek.

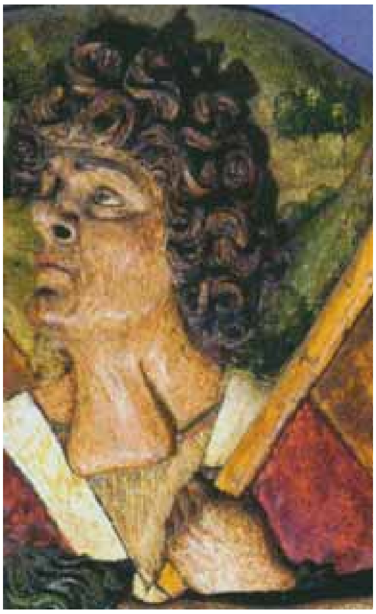


Fig. 7. The person with *fibroma pendulum.*

trouble being presented by the sculptor is the so-called *fibroma pendulum*. Soft fibromata are tumors which are quite often met. Such fibromata can have both a soft or a hard form and they can adopt various dimensions and shapes. A fibroma weighing 15 kg is well-known.

In the scene of "Capturing Jesus Christ" a person is present with extremely truthfully reproduced complex of disease symptoms. This figure, most probably a Pharasee, is endowed with a very large, wide, square cranium (skull) without any hair, with a proturberant forehead and distinctly protruding frontal tumors. Eyes - with visible *exophtalmus* and convergent *strasbismus* (strasbismus convergens) - are placed in deeply fixed eye-sockets (orbits) with protruding bone edges (ends, verges, brinks) (Fig. 8).

The photographs from the collection of the Dermatology (Dermatological) Clinic of the Jagiellonian University in Kraków are shown (presented) for comparison reasons

The eyebrows are marked, they are narrow, whereas the eyes are deprived of eyelashes. The lower lip is narrowed and it is dropped most probably because of the lack of constant bony base. Additionally, the right eye bears traits of the corea or iris suffered disease. The right pupil is considerably paler in comparison with (in relation to) the left one. The object being an interest of a dermatologist can also be the nose which became sunk as a result of disintegration (degradation) processes of the bone and gristle (cartilage, copula) parts and in mucous membrane. All these symptoms suggest the so-called congenital or acquired syphilis. Leprosy is also not excluded

Fig. 8. The faces revealing the symptoms of *Lues congenila*

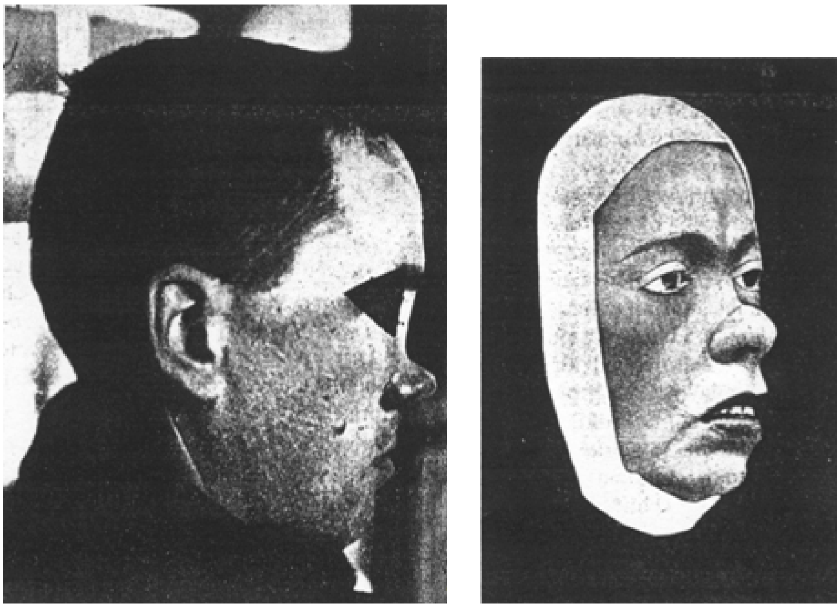


Fig. 9. The faces of two patients from Dermatological Clinic with recognized *Lues congenita* (taken from the archival documentation).

as well as long-lasting parulent and gangrenous processes. The participation in the shock (trauma) injury is possible too.

Distinctly (clearly, markedly) deformed nose and a similar structure of the cranium can be seen with the person taking part in the debate in the scene ”Christ among Scholars”. The head of the person is hidden in a hood, therefore the evaluation of the shape of his cranium is impossible. It prevents us of formulating an accurate diagnosis, although a passed suffering from syphilis cannot be excluded (conceivable) (Fig. 9).

Fig. 10. The soldiers nose with *acne rosacea*.

The figure of the watching (it would be better to say ”sleeping”) soldier in the scene of ”Resurrection” (Fig. 10) can also be an object of analysis. His face is covered with his hands. In the exposed (revealed, disclosed) part of it one can see considerable callosities, the tincture of the skin is in the blue-red hue, the thickening of the nose end is covered with red wavy (serpentine, anguine, meandrous) veinlets. Here the rosette acne (*acne rosacea*) is reproduced. This suffering leads to a considering skin thickening causing the nose disfiguration (*rhinophyma*) what can be visible with the discussed person.

In the scene of ”Descent of Christ into the Hell” the Satan is also an interesting figure. His face bears the traits of skin tuberculosis, the so-called lupus (noli-me-tangere) (*lupus vulgaris vorax*). Nodulous knobs (perturbances) and ulcarations on the thickened and deformed nose and on both cheeks are a good evidence of it. The upper lip of the ill person was most probably destroyed in consequence of the decay of tissues. An oblong ulceration with ragged verges in the place of the upper lip can testify it. Owing to the destruction of the lip, the jaw and the teeth are exposed (uncovered) and deprived of gums. The teeth show devastation of enamel. It seems that the lower canine (laniary) teeth, huge, large round eyes and horns on the forehead are the work of fantasy of the Artist, making this face rather bestial than human (Fig. 11). However, on this face the effects of toberculous process in the form of an opening (orifice) in the frontal bone can be seen. One can also detect the effects of syphilis in the later stage (phase), or perululent inflammation of medulla ossium or even leprosy similar to *lupus vulgaris vorax* – in the form of nodulous exarithema (rash), infiltrations and verrucous rises (outgrowths) (lepra tuberculoides Jadassohn).

Fig. 11. The devil – the artistic vision presented according to *Lupus vulgaris vorax.*

The accurate reproduction of all the anatomical details of the vein system in the region of the low extremities proves enormous clear-sightedness and sense of observation of the Artist. This surveillance may also suggest the maintenance of faithfulness in reproducing morbid (sickness) changes with the figures presented in the scenes of Christ and His Mother's lives.

Sickness states especially in the range of skin changes are not observed today because of (owing to) the advanced treatment excluding the admission **to** such far gone states. Nevertheless, the faithfulness of the presented reality as well as the masterly skill of WIT STWOSZ permits us today, after a lapse of five centuries from the time of finishing the Author's masterpiece, to investigate the health characteristic**(s)** of the society in the XV century.

To mention the former analysis done in the past one shall make references to [1, 2, 3]. The Authors of these publications recognized the diseases according to their knowledge, which did not change much since then.

Fortunately to the Author of this paper, all "patients" died more than 70 years ago. Thus the privacy law regulations do not limit our freedom to use their faces for medical studies.

References

[1] Walter F., Wit Stwosz – Rzeźbiarz chorób skórnych. Szczegóły dermatologiczne ołtarza Mariackiego, Wydawnictwo Krakowskiego Towarzystwa Miłośników Historji Medycyny, Kraków 1933, pp. 3-31.

[2] Szydłowski T., O Wita Stwosza ołtarzu Marjackim i jego pierwotnym wyglądzie, Kraków 1920.

[3] Talko-Hryniewicz J., Typy antropologiczne w ołtarzu Mariackim, Kraków 1932.

[4] Bujak A., Czyżewski K., Wit Stwosz – Ołtarz Mariacki, Biały Kruk, Kraków 2007.

Acknowledgements

Copyrights for all colour figures belong to "Biały Kruk". Many thanks to the Editor "Biały Kruk" of the album entitled "Wit Stwosz – Ołtarz Mariacki" for permission to reproduce the colour pictures of Adam Bujak [4].

Anna Zaremba-Smietańska – Department of Bioinformatics and Telemedicine – Jagiellonian University – Collegium Medicum made the editorial work (scanning pictures and formatting the text).

BIO-ALGORITHMS AND MED-SYSTEMS
JOURNAL EDITED BY MEDICAL COLLEGE – JAGIELLONIAN UNIVERSITY
Vol. 5, No. 9, 2009, pp. 153-155

EGYPTIAN MUMMIES – PERFECT VIRTUAL PATIENTS

Andrzej Urbanik[1], Robert Chrzan[1], Wadim Wojciechowski[1], Piotr Czubak[2], Hanna Szymańska[3], Krzysztof Barbaj[3]

[1] Radiology Department – Collegium Medicum Jagiellonian University, Krakow, Poland
[2] Institute of Forensic Research, Krakow, Poland
[3] Archeological Museum, Krakow, Poland

The special patients, who were diagnosed in Radiology Department, were the Egyptians living in Ancient Egypt about 3 000 years ago (Fig. 1). The mummie belong to the largest Polish collection of Egyptian mummies in Krakow (Archeological Museum) Wroclaw and Warsaw.

Seven mummies were submitted to radiological examination. The standard X-ray films were made and digitalized.

The CT examinations were performed with following parameters: collimation 1.3 mm, pitch 1.5, increment 30%.

Visual data from each examination was processed resulting in images of axial and sagittal projections, multiplanar reconstructions (MPR), curved multiplanar reconstructions (cMPR), 3D reconstructions and visual endoscopy (Fig. 2 and Fig. 3).

Linear measurements and X-ray attenuation values of the particular elements of heads were performed. One of the mummies was unwrapped. The radiologist taking part in the examination had the opportunity to compare the CT images with the real status.

Fig. 2. The computer-aided visualization tools applied for mummies analysis.

Fig. 1. One of the mummies under consideration.

Fringe

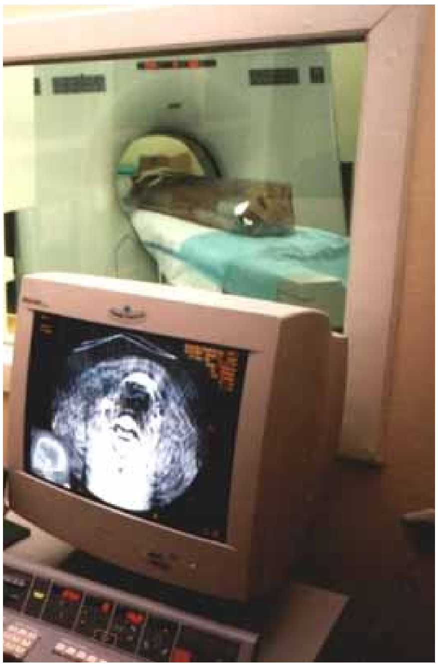


Fig. 3. CT technique applied for mummies analysis.

CT visual endoscopy allows assessment of the destruction of bones structure and localization of resin in the body.

The traces of the excerebration were found in many of the mummies under the study. The most popular through the nose technique was applied damaging a little bit the nasal cavity seen in CT examination (Fig. 4).

Traumatic changes have been recognized, like damages in calvaria parietal region and damages of the calvarian bones. The malocclussion, carietic changes, paradontosis, attrition of mastication surfaces. All these observations prove the low level of dentition (Fig. 6).

Computed tomography is the powerful tool allowing examination of Egyptian mummies – patients living more than 2 thousand years ago. The most useful is the 3D and CT virtual endoscopy. It makes possible recreation of the visual form of “patients” face without the unwrapping of the mummy under consideration. This is the perfect example of “virtual patient”.

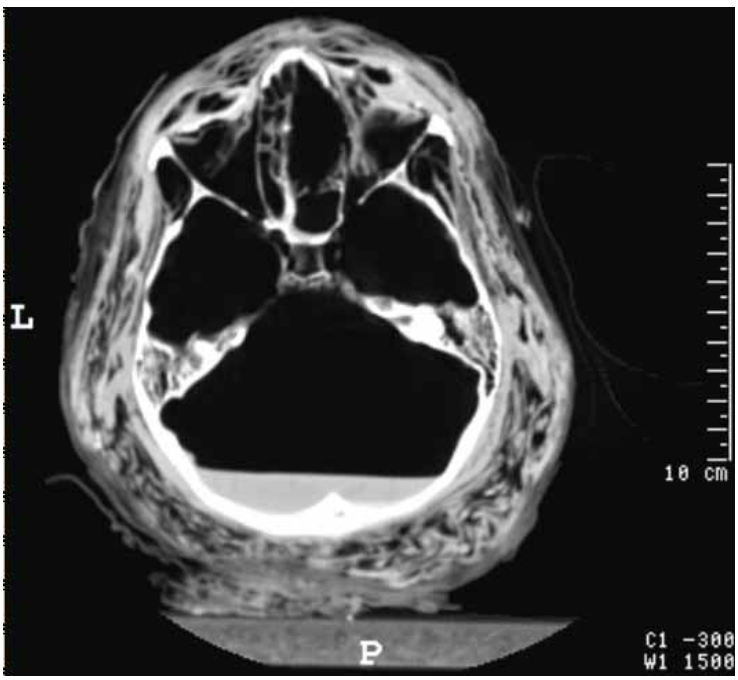


Fig. 4. Nasal cavity damaged (on the right)

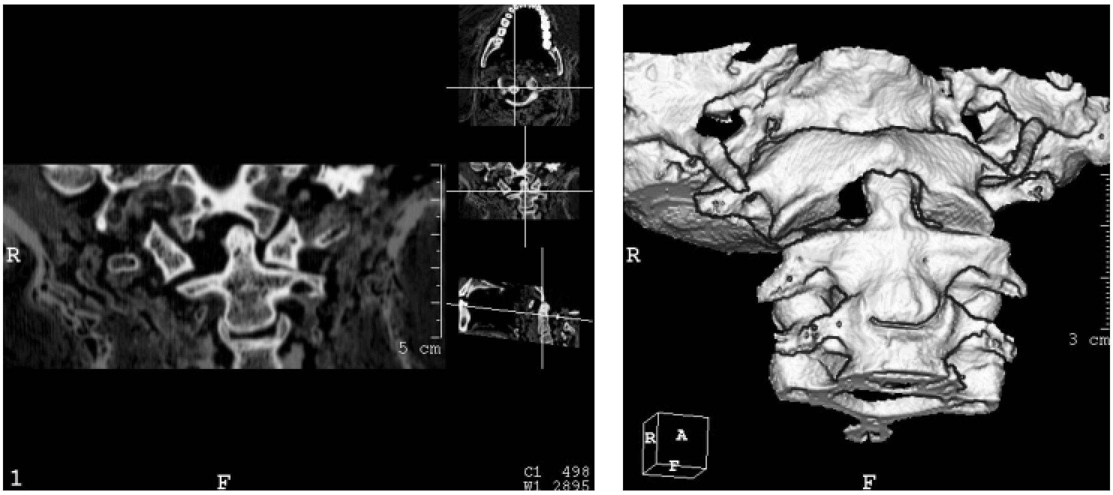


Fig. 5. Breakdown of the axis of the cervical vertebrae.

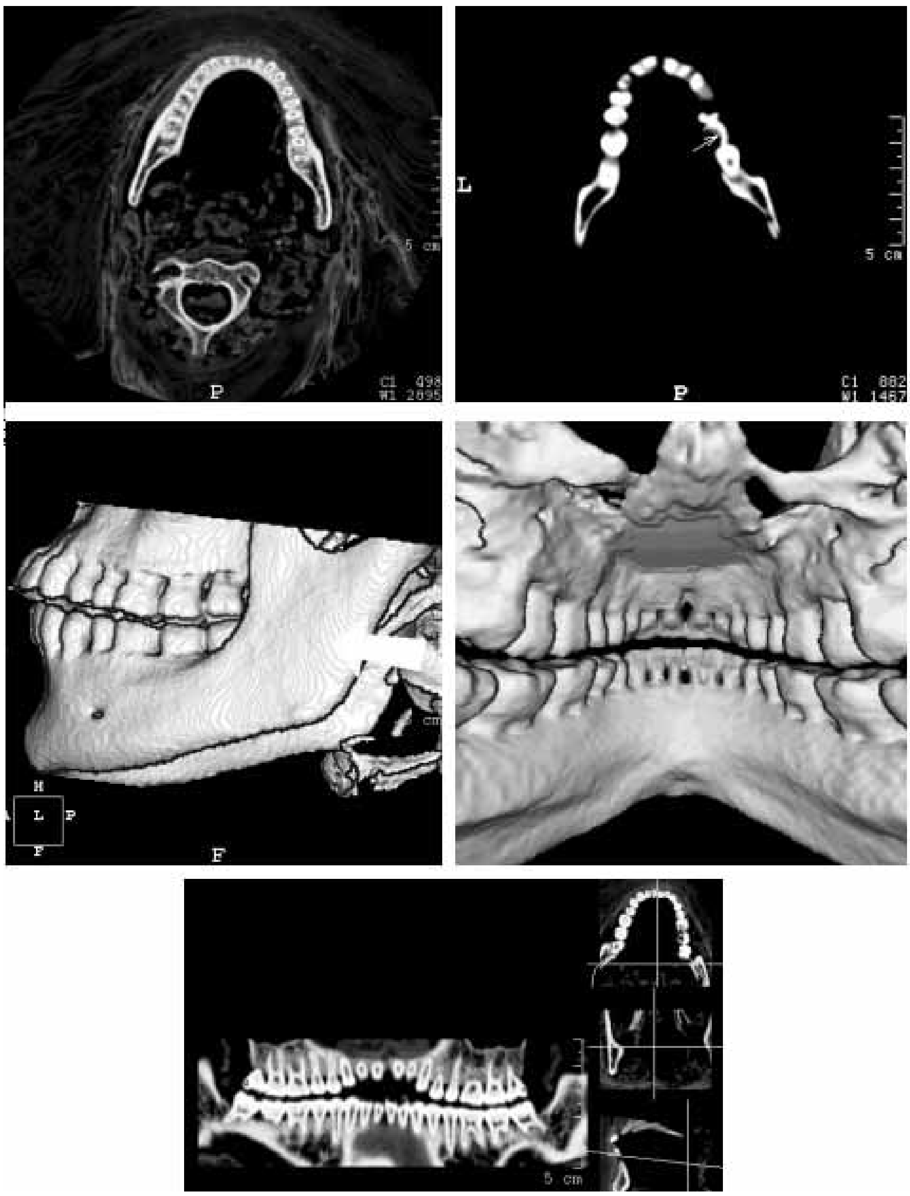


Fig. 6. Different dental damages.

INSTRUCTION FOR AUTHORS

1. The original and one Photostat copy of the manuscript should be mailed to: Managing Editor Zdzislaw Wisniowski. Authors are strongly urged to submit a CD or floppies 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 ma 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-Alghoritms 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. PREFFERED 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 copywrighted 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 <u>www.bams.cm-uj.krakow.pl</u> 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

www.akademicka.pl

ISSN 1895-9091