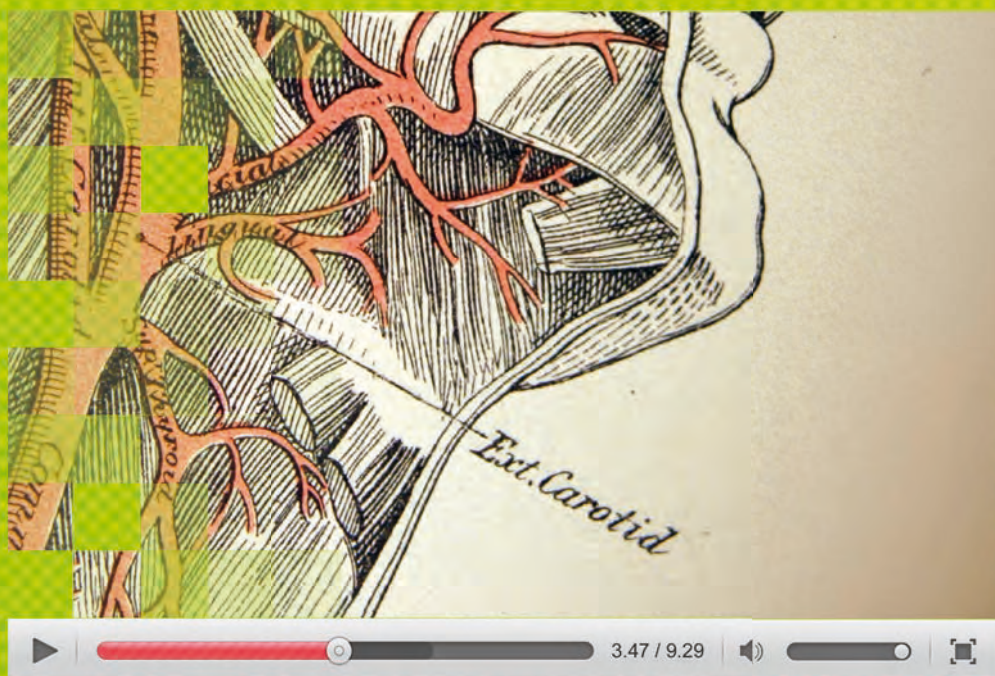


# MEFANET report 04

## Efficient multimedia teaching tools in medical education



Editors:

Daniel Schwarz

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Stanislav Štípek

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# PREFACE

Dear colleagues and students,

we really appreciate that you have been interested in follow-up volume of MEFANET REPORT 04: proceedings, which have been looking back at the 4<sup>th</sup> year of the MEFANET conference. This conventional conference focused on e-learning and medical informatics and their application into a medical curriculum. Similarly to previous conferences, the MEFANET 2010 conference provided an opportunity for Czech and Slovak teachers and students to discuss their experiences from various medical fields of interest. The historical milestone was represented by the foreign speakers' participation. These well-known specialists appeared in person on the MEFANET conference for the first time. They have introduced the virtual patient technology, which is used to describe interactive computer-based simulations in health care education area.

Apart from general aspects of electronic support of education the conference was also focused on the impact of a specific topic of medicine. The fourth year of the MEFANET conference was dedicated to e-learning in morphological fields of medicine. The keynote motto was "E-learning in pre-and post-graduate study of human anatomy, histology and embryology".

All contributions published in the proceedings illustrate the variability of using modern information and communication tools and sophisticated ideas that improve and enrich teaching methods and techniques – for example virtual patient, casuistic trainings, advanced simulation, various web-based educational environments, e-learning courses and assessment tools. The MEFANET report 04 is divided into four thematic sections:

- A: Casuistic training and clinical reasoning
- B: Simulations and advanced multimedia learning tools
- C: E-learning and on-line assessment
- D: Information systems and educational portals

We hope that you will find lots of interesting and inspiring topics in the proceedings and would like to invite you as a passive or active participant for the MEFANET 2011 conference, which will be held in November 2011 in Brno.

Daniel Schwarz    Martin Komenda    Ladislav Dušek    Stanislav Štípek    Vladimír Mihál







# MEFANET 2010: VIRTUAL OR REAL MEDICINE? E-LEARNING IN MORPHOLOGICAL FIELDS OF MEDICINE

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## Abstract

Everything started in June 2007, when six Czech medical faculties agreed on cooperation in the field of electronic teaching support and e-learning. The cooperation was based on more or less voluntary basis and all introductory activities were arising exclusively from passion of several enthusiasts. Now let us move approximately three and half years ahead into November 2010. The project MEFANET (MEDical FACulties NETwork) now involves eleven Czech and Slovak medical faculties and representatives of all members are getting together in the Brno hotel Voroněž to attend the fourth year of the MEFANET annual conference. The whole project is under the official auspices of an agreement signed by deans of all faculties and supported by the European Social Fund in the Czech Republic. This short statement explicitly illustrates the way the MEFANET network has been growing up and acquiring importance and reputation. Nevertheless, let us shift from austere data to the traditional conference, which took place, as usually, in excellent atmosphere and brought lots of interesting topics and contributions.

.....

## Conference opening

The conference was opened by prof. Jaroslav Štěrba, Ph.D., vice-dean of the MU's Faculty of Medicine. Summary of the more

than 3-year MEFANET existence, its present, and plans for the future were scope of the contributions by assoc. prof. Ladislav Dušek and Daniel Schwarz, Ph.D., members of the



Chairmen of the Plenary session I. From left: prof. Vladimír Mihál, prof. Uno Fors, prof. Terry Poulton, prof. Jaroslav Štěrba, and assoc. prof. Ladislav Dušek.



Videoconference lecture by prof. Martin Haag.

MEFANET Coordination Council representing Faculty of Medicine, MU. Both of them focused, among others, on problems associated with guarantee of quality of published electronic work, which goes hand in hand with overall improvement of the shared content quality. In the near future the MEFANET publications reviewed by independent expert will be clearly marked, which will certainly be a significant motivation for further improvement of the portal content. Expert guarantors of individual sections will be responsible for the selection of reviewers.

## Virtual patients are coming into the Czech Republic

Recent progress of the MEFANET education network was also demonstrated by fact that the introductory plenary session included lectures by two invited guests from abroad – prof. Uno Fors from Karolinska Institutet in Stockholm and prof. Terry Poulton from St. George's University in London. The third contribution from abroad followed on the 2<sup>nd</sup> day of the conference by means of a videoconference contribution by prof. Mar-

tin Haag from University of Heidelberg. All invited guests are recognized experts in the field of medical education by modern information and communication technologies.

Common topic of all three lectures was so called virtual patient. As the term indicates, virtual patient is interactive computer simulation of a patient, which is based on real cases and is used mainly in education of medical students, physicians, and other health care professionals. The virtual patient is in its basic form an electronic clinical case with defined symptoms, parameters, and medical history. The user (in the role of a physician) investigates other details, indicates examinations and tests and on the basis of obtained information determines diagnosis and subsequent treatment procedure. The virtual patients may have a number of forms, from simple structured text files to sophisticated “videogames”, in which the patient communicates with the user, changes mood etc.

Although it is obvious that reality cannot be fully replaced by simulation, the virtual platform brings a number of advances in medical education. They consist in equal and easy access of students to various diseases that often cannot be met in case of real patients.



Workshop on electronic examination of students with practical demonstrations.

This is also connected with improving health care and, therefore, generally shorter duration of hospitalization. And last but not least, comfort and calm for real patients must be mentioned as well. The virtual patient teaches future physicians to decide and come to final diagnosis the most effective way. In the Czech Republic the virtual patients are at the very beginning; the more important milestone may the MEFANET 2010 and visit of top experts be for the future. We can assume that we will meet virtual patients at the Czech and Slovak medical faculties soon.

## **E-learning in morphological fields of medicine**

Further rich topic discussed during the MEFANET 2010 conference was the use of electronic forms of education in morphological fields of medicine, particularly in anatomy, pathology, or histology. Lecturers presented wide range of educational publications that help students familiarize with the human body – from photo atlases over multimedia textbooks to virtual microscopes and preparations. Some faculties establish

specialized multimedia classrooms with an equipment suitable for teaching with the virtual preparations. The lecturers also emphasized advantages arising from the possibility to communicate with all students at the same time and significant decrease of costs associated with necessary renewal and maintenance of samples and microscopes. On the other hand, it would be very daring to say that this form of teaching may fully replace real sample and real biological material. It is, however, a valuable tool for basic education of a higher number of students.

## **From theory directly to practice**

The MEFANET conference programme included as usually not only theoretic lectures, but also several specialized workshops. The first of them was focused on electronic examination of students. Problems of quality of students' preparing and its testing during the education process by means of ICT have been permanently discussed among both teachers and students. That is why this seminar was held during the MEFANET 2010 conference. Its programme included practi-



Coordination Council meeting.

cal demonstration of various examination systems and introduction to theoretical background, which is the key point for creation of a reliable evaluation material. Concept of the test, methodology for creation of various tasks, and analysis of the real course examination agenda were discussed in details. Risk areas and the most frequent pitfalls in electronic examination were emphasized as well, together with benefits for all involved parties (students, teachers, institutions etc.).

A multi-member team from the 1<sup>st</sup> Faculty of Medicine, Charles University in Prague led by Martin Vejražka, MD, Ph.D., prepared 2-hour live symposium dedicated to the WikiSkripta project, which allows medical students for active participation in the preparation of electronic education texts. The workshop audience could try WikiSkripta online in practice, whereas the team members were available for help and advice, showed individual functions of the system, solved problems and answered numerous questions.

The MEFANET network is narrowly connected with operation of ten local portals in individual medical faculties, whose educational content is exported to the central gate <http://portal.mefanet.cz/>. A number of new functions are related to the release of the new portal platform version 1.8. The most important one is undoubtedly

implementation of the 4-D evaluation of the published work quality. Since the whole administrator agenda is relatively complicated, a workshop was organized for editors and administrators, who are responsible for operation of the portal within the frame of their faculties. The participants got familiarized with properties and technical details of the new solution for improvement of education materials quality, new form of platform documentation and services and benefits of the academic identity federation eduID.cz.

## MEFANET Coordination Council

Traditional meeting of the MEFANET Coordination Council took place at the end of the conference in a pleasant and friendly atmosphere. Assoc. prof. Ladislav Dušek, Ph.D., was elected as new and old head of the Council. After interesting discussion and suggestions for the future the 2-day conference MEFANET 2010 was officially closed.

## VIRTUAL PATIENTS IN MEDICAL EDUCATION: THE EXPERTS' VIEW

For the first time the foreign lecturers appeared at the MEFANET conference in person. Three world's top experts, who have been participated in a number of projects and other activities related to the topic of Virtual patient for years, accepted our invitation: Uno Fors, Terry Poulton and Martin Hagg. While Martin Haag gave his lecture through videoconference from the Heilbronn University in Germany, other two guests arrived at Brno personally. All of them described different kinds of virtual environment for learning, training and assessment in medical education.



**Uno Fors** is Professor at the Department of Learning, Informatics, Management and Ethics, Karolinska Institutet, Sweden. His research interests include the development of and research into interactive computer systems that simulate the interaction between the patient and the healthcare professional. This field of research, often merging with medicine, pedagogy and medical informatics, is often referred to as virtual patients (VP). Virtual patient cases are mainly used in training, where students can learn things that they cannot try out on real patients. Uno Fors spoke about Virtual patients and other virtual environments in educational area.

### Abstract:

Various types of computer-based simulated patient cases have been developed and introduced in medical and healthcare education during the last 10–15 years. Most of these have been aiming for learning and training various skills and have been used in preclinical, clinical and graduate education. Today, the common term for these kinds of learning systems is Virtual Patients, or VP for short. Virtual Patient applications have been found to best suit learning and training Clinical Reasoning, which can be described as clinical problem solving or clinical decision making. But such cases can also be used for self-evaluation, assessment and also for other tasks.

There are a number of Virtual Patient systems available, but most of them have common features like interactive illness history taking, physical examination, lab/imaging tests, diagnosis and therapy suggestions. Most systems also have a feedback section where the user automatically may receive information about his/her performance and which tasks that were performed good/less good. A number of these systems exist in different languages and have been implemented in various courses around the world. Many VP systems have been focused on only specific medical areas and course set-ups like surgery, radiology or preclinical physiology, but there are also more generic ones, by means of which the teacher or course director can create and edit his/her own cases. Further on, VPs can be used for not only medical education, but also in nursing, dentistry, physiotherapy and similar programs.

Today, there are many scientific studies published describing increased motivation and engagement of students as well as of comparisons with more traditional learning materials when using VPs. However, few studies have focused on learning outcomes, the use of VPs for assessment and the use of Virtual scenarios and cases for also diagnosing and treatment of (real) patients.



Professor **Terry Poulton** is Associate Dean for e-Learning, and Head of the e-Learning Unit in the Department of Medical Education at St. George's University, London. He is Programme Director for the eViP project, the European Union-funded project to create a bank of VPs adapted for multicultural and multi-lingual use. His interests and research programmes include the embedding of interactive virtual patients (VPs) in the core curriculum as a replacement for Problem-Based Learning, the use of VPs in assessment, and the development of interactive virtual patient mannequins in virtual worlds. Terry Poulton introduced Virtual Patients as a new generation in Problem-Based Learning.

### Abstract:

Virtual patients are interactive computer simulations of real life clinical scenarios for the purpose of medical training education and assessment. They are ideal tools for teaching clinical decision-making.

Problem-based Learning (PBL) is a well-established process in undergraduate medicine, in which students in groups work through a patient scenario, defining the knowledge they require to understand the scenario, exploring diagnoses and subsequent management, and generating learning objectives as they progress. However, as the case unfolds, no matter what the students may reason, or management strategies they select, the case is paper-based, can only unfold in one direction, and is inflexible.

To create a more interactive, decision-making model of our PBL course delivery the eLearning Unit, at St George's replaced the paper-based with interactive online VPs. As these cases develop, at key points in the case students are presented with options, take decisions, and then explore the consequences of their actions. This process was very successful, and virtual patients have now replaced paper cases at the core of our medical curriculum. In addition, formative assessment VPs were created to provide additional self-directed learning opportunities as companions each week to the relevant PBL cases. eLU also trialled the use of VPs in Virtual Worlds.



**Martin Haag** is Associate Dean and Professor at the Faculty of Informatics, Heilbronn University, Germany. His research is focused on software engineering and use of digital media in medical education, including virtual patients and electronical testing. The topic of Martin Haag's lecture was Virtual Patients for Education, Assessment and Research.

### Abstract:

Nowadays, virtual patients are becoming increasingly essential for high-quality medical education since there are not enough actual patients available for educational and training purposes. The lack of patients is caused by several reasons: Some diseases are seasonal, patients with severe diseases cannot serve as educational subjects for a large number of medical students and the average stay time of patients in hospitals has decreased over the last years. However, development and curricular integration of virtual patients is challenging and time consuming. This lecture gives an overview on relevant aspects of development and usage of virtual patients for education, assessment and research. It also shows the current state of development as well as perspectives and future challenges.

***What brought you to the idea of working with VPs?***

**Uno:** I was introduced to the idea of developing multimedia based VPs in 1989 by my former chairman, Dr. Rolf Bergin who had started pioneering work in the area as early as 1970.

**Terry:** Basically I was interested in scenario-based learning, I came across interactive virtual patients in 2005, realised they could support problem based learning in entirely new ways that could offer practice in clinical decision-making, and it followed from there. I began to build an e-learning unit and five years later, thanks to a lot of grants, it became the largest elearning group in medicine that we are aware of.

**Martin:** I was the first employee at the laboratory of computer-based training in medicine (nowadays “Center for Virtual Patients”) at Heidelberg University in 1995 and was looking for an appropriate subject for my Ph.D. thesis in Medical Informatics. At this time the World Wide Web comes up and so I decided to develop a software for creation of Virtual Patients which can be run on every web browser, which was an unique feature in 1995. With an easy to use authoring system medical teachers should be able to create highly interactive virtual patients without the need of any Informatics knowledge. Controlled vocabularies should reduce the effort of authoring and allow semi-automatic translation of Virtual Patients in other languages.

***You are one of the world-renowned experts, could you shortly introduce and describe your present activities in the VPs area?***

**Uno:** I work with more than 10 different VP-related projects right now. Three main focus areas are interesting for me: 1. Learning outcomes of VPs; 2. VPs for assessment; 3. VP-like environments for

diagnosing and treatment of (real) patients.

**Terry:** Broadly, we are working on the transformation of the curriculum with virtual patients, and that has meant exploring how we can supplement or replace different learning styles with interactive patient scenarios, whether tutorials, seminars, lectures and assessments. The interactive, decision-making nature of the virtual patients is a very good supplement to learning in many different medical disciplines: from clinical science to clinical skills, from law to ethical behaviour. We are running workshops in these new approaches from December 2011 onwards. We are looking to the future with our research in more immersive, 3-dimensional environments, which exploit game-like technologies.

**Martin:** At the moment we are working for example on formative assessment with Virtual Patients. We want to give medical students and medical teachers much more feedback on their work with Virtual Patients. We also work on the optimization of our controlled vocabularies in our Virtual Patient System CAMPUS. We have seen over the last years, that there are partly very different requirements for the vocabularies in the medical specialties and in different countries. Because “assessment drives learning” we also work on the continuous improvement of our tool for summative assessment in medicine using key feature problems. At the moment we also did some tests to use low-priced tablet computers for assessment of medical students outside of computer pools.

***There are many different definitions of VP, could you define in one sentence this modern learning object?***

**Uno:** A computer-based virtual representation of a patient used for learning and/or assessment, where the user can freely perform physical examinations, ask about the illness history and order lab/imaging tests.

**Terry:** An interactive computer simulation of real-life clinical scenarios for the purpose of medical and healthcare training, education, or assessment.

**Martin:** Virtual Patients represent a “specific type of computer program that simulates real-life clinical scenarios; learners emulate the roles of health care providers to obtain a medical history, conduct a physical exam, and make diagnostic and therapeutic decisions”. This is in my opinion a very good definition from AAMC Institute for Improving Medical Education. So it’s not necessary to create my own definition :-)

**Could you shortly highlight general objectives of integration VPs into medical curriculum?**

**Uno:** Hmm, not an easy question, it depends what you really mean here... But my idea is that to be of value, VPs must actively be integrated into the curriculum, meaning that there should be time allocated for use of the VPs and also sessions where the students can discuss their findings and get feedback from their teachers.

**Terry:** Broadly to improve the student learning experience, by providing a more authentic, immersive, problem solving approach to the medical curriculum, which simultaneously supports all knowledge areas with the curriculum, supports cognitive learning, and provides training in clinical problem-solving.

**Martin:** The general objective is to improve differential diagnostic skills of medical students. Medical students should train the successful diagnosis and treatment of Virtual Patients and the active usage of medical knowledge. Students

can supervise Virtual Patients from admission to discharge and practice decision making without any risk of real patients. So Virtual Patients are a valuable complement for the real patient encounter, because there are not always enough patients available for educational purposes.

**What is the students’ and teachers’ feedback?**

**Uno:** Most students I have met (today many hundreds) are very positive to VPs. Teachers are most often also positive, but some teachers think that they need much technical assistance when creating VP cases and that it takes too much time.

**Terry:** In many ways an extraordinarily good response, and encouraging for this who believe that both students, and experienced teachers, will recognize a ‘good thing’ when they see it. Students found the VP experience authentic, and immersive. They believe it improves their decision-making, and that the greatest learning comes from the consequences of poor decisions.

**In which fields and specializations are VPs the most widespread?**

**Uno:** Oh, I really do not know. But I think that Internal medicine is a very common field. There are also many VP cases in pediatrics. However, there are interesting cases in medical ethics, genetic counseling and other very specialized areas as well.

**Terry:** Pediatrics and mental health for opposite reasons! Paediatrics requires rapid, accurate management, and trainees cannot see a wide enough number of cases in their short attachments. For mental health the opposite reasons – to speed up the time of a mental health patient

**Martin:** Probably pediatricians and internal specialists are the most active



groups in my perception. But of course there are many other medical specialities where Virtual Patients were developed and used. You find a referatory with 340 Virtual Patients at <http://www.virtualpatients.eu/referatory/>. This referatory was the result of a project cofounded by the European Union and shows the impressive range of Virtual Patients.

***Have you ever met with active students' participation in VPs development?***

**Uno:** Yes indeed. However, sometimes different teacher groups ask for different (contradictory) features that cannot be implemented in the same VP-system. My own system, Web-SP that is in use in many different universities worldwide and which exists in many different languages, had never been so successful, if not teachers from different place had given us feedback and asked for new features.

**Terry:** Yes, and it can be effective, but interactive VPs- in which the scenario will take different paths, according the decisions the student takes- these require clinical understanding and experience, and so the student will require a lot of guidance to produce an authentic case

**Martin:** In Heidelberg students participate in different projects at VP development. Especially my colleague Sören Huwendiek MD, Ph.D., who is in cooperation with me the head of the Center for Virtual Patients has had a lot of very positive experience over the last years.

***What do you think about users' comments and requested updates? Do you apply these stimulations into improvement process and further development?***

**Uno:** Yes indeed. However, sometimes different teacher groups ask for different (contradictory) features that cannot be implemented in the same VP-system. My own system,

Web-SP that is in use in many different universities worldwide and which exists in many different languages, had never been so successful, if not teachers from different place had given us feedback and asked for new features.

**Terry:** They are essential. These branching VPs are complex to construct, it is easy to introduce inconsistencies or to provide options which are either not realistic or are too 'obvious'. Through sheer numbers, students provide a large and effective review force. Cases need regular review and the students can provide that.

**Martin:** Of course. We always encourage our users to give us feedback and suggestions for improvements, because we want to improve our Virtual Patients continuously. In our new Virtual Patient Player we even have a feedback button, which is always visible. So our users can give the CAMPUS developers direct feedback while working with a Virtual Patient. This is quite comfortable and users like this new feature.

***What are your future objectives related to VPs progress?***

**Uno:** Ohh, many ideas comes up here. I think that even more research is needed in terms of when and how to best implement and use VPs in different types of courses. And also new types of VP-systems need to be developed, facilitating development of cases of different kinds and for different needs.

**Terry:** The digital avatar! Soon, VPs will 'meet' simulation, and many people are looking forward to the idea of the digital human as a tool, not just for education, but for informing clinical practice. We are working with the European Virtual Physiological Human Network of Excellence' in this direction. I think the best description of our ultimate objective belongs to a colleague

‘We want to create a digital model of you – you when healthy, you when sick. We will use this to keep you healthy and to treat you when sick. We will do the same for your friends and family, for your parents as they age and your children as they grow.’ — Seamus MacSuibhne ([seamus.macsuibhne@ucd.ie](mailto:seamus.macsuibhne@ucd.ie)).

**Martin:** I hope that we will have enough evidence in some years about the best Virtual Patient design for different learning objectives and best curricular integration so that we can optimize the Virtual Patients and curricular integration.

Interviewed by Martin Komenda

**A**

**CASUISTIC TRAINING  
AND CLINICAL  
REASONING**



**mefanet**



## 03

# A CASUISTIC MODEL OF EVIDENCE-BASED ANSWERS TO CLINICAL QUESTIONS USING BLENDED LEARNING: AN OVERVIEW

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## Abstract

The aim of the paper is to describe a theoretical background of casuistry and its practical implications for evidence-based medicine training. The use of a blended learning concept rather than pure e-learning is discussed, and a proposal is made how to develop an effective case-based learning environment in medical education.

## Keywords

casuistry, evidence-based medicine, blended learning

## Introduction

Learning through experience<sup>[5]</sup> is an important approach employed by humans to comprehend new problems. Medical practice management is facing a challenge of knowledge discovery from the growing volume of information. Recently, there has been a hot debate about the role of casuistry<sup>[3]</sup> in the context of evidence-based solutions. Case-based reasoning (CBR)<sup>[14]</sup> matches the natural reasoning model similar to that used by physicians: “I have seen a patient like this”, and provides recollection of past cases relevant to the present case. A general CBR life cycle consists of four steps: (a) retrieve the most similar case or cases; (b) reuse the information and knowledge in that case; (c) revise the proposed solution; and (d) retain the experience for future problem solving.

Current medical students, often referred to as millennials, have grown up with computers and expect learning materials to be available electronically. It is a rapidly expanding field with systems evolving from simple computer storage of learning materials to sophisticated web-based multimedia interactive modules. In medical education, a portion of face-to-face approach seems indispensable which has led to introduction of a blended learning

design<sup>[14,29]</sup>, i.e. development of online modules combined with didactic lectures. These learning opportunities encourage dynamic interplay between learners and teachers with e-learning and may help to obviate some of the potential pitfalls of purely online instruction.

Case stories of real patients supplemented with evidence-based literature reviews may serve a valuable resource to develop hyper-medial learning objects<sup>[18]</sup>. Educational principles must be given priority and include: relevance, reliability, validity of content, clarity of delivery, effective use of time and appropriate assessment.

## Fundamentals of Case-Based Reasoning (CBR)

In 1996, R. Schank, one of the influential contributors to artificial intelligence and cognitive psychology, wrote<sup>[22]</sup>:

“Learning from experiences is the fundamental process of case-based reasoning. Taking case-based reasoning seriously as a cognitive model implies that experiences play a fundamental role in human learning as well. This has important effects on what and how to teach. Learning by doing works because it teaches implicitly rather than explicitly.

Things that are learned implicitly need only be experienced in the proper way at the proper time. In order to make classrooms into learning-by-doing experiences we need to allow students to be in situations that are germane to their interests.”

Ten years later, deMantaras Lopez and colleagues<sup>[3]</sup> confirmed that CBR was a procedure encompassing the significance of prior experience during future problem solving. New problems can be tackled by reusing, and if possible, modifying the solutions to similar problems that had been solved in the past. It became applicable in a wide range of disciplines and domains, including medicine. Case-based reasoning gave rise to case-based teaching that is generally considered a superior instructional methodology contrary to lectures, because it motivates learners' critical thinking skills. Even though much is known about the role played by facilitators in case-based teaching, there are still numerous controversies on the impact of the format and structure of cases on teaching and learning<sup>[11]</sup>.

## **Case-based Teaching and Evidence-Based Medicine (EBM)**

In the context of EBM, Tonelli<sup>[26]</sup> provoked a hot debate in 2006 about integrating “real” evidence into practice as a substitute for evidence-based approaches.

He introduced EBM struggling with other kinds of medical knowledge, such as (a) empirical evidence, (b) experiential evidence, (c) pathophysiologic rationale, (d) patient goals and values, and (e) system features. He emphasized that none of the topics had a priority over others, and the relative importance of a topic would depend upon the circumstances of the particular case. The skilled clinician must weigh these potentially conflicting evidentiary and non-evidentiary aspects for action to employ both practical and theoretical reasoning and to make the best choice for a respective patient. His paper was followed by numerous thought-provoking comments<sup>[2, 4, 8, 12, 13, 16, 19, 20, 25, 28]</sup> that are worth reading.

Other authors<sup>[10, 14, 17]</sup> have demonstrated that case-based activities can be enhanced

by evidence-based re-designing e-resources for undergraduate medical education in favour of blended learning to improve their understanding of the theories and to develop their skills in clinical problem solving. It has been also confirmed that case based learning can be used to promote deeper attitudes to instruction and reduced reliance on surface approaches in medical students.

## **Blended Learning: Definitions and Implications for Evidence-Based Practice**

Blended learning has been defined as the combination of face-to-face and electronic learning opportunities while reducing classroom contact hours<sup>[6]</sup>.

Inherent in blended learning is a fundamental redesign of the instructional model, shifting from lecture to student-centred instruction, increasing all forms of interaction and incorporating formative and summative assessment<sup>[6, 27]</sup>.

Blended learning = combined and integrated use of e-learning and face-to-face (F2F) learning activities to develop a community of learning<sup>[23]</sup>.

Blended learning complements face-to-face classes with eLearning modules<sup>[29]</sup>.

It is possible to bring the advantages of face-to-face classes and online courses together. Further advantages are the higher flexibility and reduced costs in comparison to traditional classes<sup>[7, 9]</sup>.

It supports a wide range of learning models, such as situated, associative, systemic, simulative and constructivist learning which help to improve the quality of medical education<sup>[24]</sup>.

Combining face-to-face learning opportunities, especially those that encourage a dynamic interplay between learner and teacher, with e-learning may help to obviate some of the potential pitfalls of purely online instruction<sup>[1]</sup>.

The revised results of a meta-analysis, performed by U.S. Department of Education<sup>[15]</sup> focused on evaluation of evidence-based practices in online learning, can be summarized as follows:

- Instruction combining online and face-to-face elements had a larger advantage relative to purely face-to-face instruction than did purely online instruction.
- The mean effect size in studies comparing blended with face-to-face instruction was  $+0.35$ ,  $p < .001$ ;
- This effect size is larger than that for studies comparing purely online and purely face-to-face conditions.
- The observed advantage for blended learning conditions may not be rooted in the media used per se, thus reflecting differences in content, pedagogy and learning time.
- Contrasting blends of online and face-to-face instruction with conventional face-to-face classes, blended instruction has been more effective, providing a rationale for the effort required to design and implement blended approaches.
- Despite strong research designs used by the studies in the meta-analysis (i.e. experimental or controlled quasi-experimental), many of the studies suffered from weaknesses:
  - small sample sizes;
  - failure to report retention rates for students in the conditions being contrasted;
  - bias stemming from the authors' dual roles as experimenters and instructors.

This meta-analysis is a challenge for performing future experimental studies to increase validity of the results.

## **A Triad for Developers of Case-Based Learning Environment in Medicine: A Proposal**

Select attractive, authentic clinical problems to place students in medias res and motivate them to take responsibility for learning through decision making.

Encourage learners to tackle the clinical problem in a way consistent with professional practices and methodologies (eg. include search skills training and journal clubs as educational interventions).

Offer students as much support and guidance as possible (apply mentorship), but promote creative approaches (eg. critical thinking), far from fragmented, surface solutions based on memorizing mere facts.

## **Take Home Message**

In spite of technological advances in the digital era (e-learning), medical education should retain its traditional humanistic feature (case-based teaching/learning) and peer-guided format (affective, pedagogic, organizational support). While students find, filter, and focus, their teachers must be ready to act as guides, facilitators and mentors.

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# METHODOICAL GUIDANCE OF STUDENTS DURING MULTIMEDIAL ALGORITHM CREATION FOR THE PORTAL AKUTNE.CZ

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## Abstract

I would like to summarize the findings from the supervision of three students of the Medical Faculty of Masaryk University in Brno in the course of development of algorithms for an interactive multimedia educational portal AKUTNE.CZ.

E-learning and publishing portal AKUTNE.CZ [ISSN 1803-179x] is focused on e-learning of acute medicine topics. Its aim is to introduce in an attractive way (interactive algorithms, video, lectures, discussions, etc.) the issues of acute medicine at the pre- and post-graduate level. Students of the faculty of medicine are involved in the development of portal site and materials. In 2009, I was asked to supervise the semester works of three students dealing with first aid topics (near-drowning, traffic accidents and hypothermia). We decided to transform these topics into interactive algorithms for the portal AKUTNE.CZ. Each algorithm consists of a set of questions with right and wrong answers. The questions are arranged in order to create didactic instruction on how to proceed in a given situation. The opportunity to present their work publicly makes the students think twice about its content and thoroughly study the issue. The formulation of the questions for the algorithm helps the students to see the broader perspective of the problem and distinguish priorities. The preparation of right and wrong answers teaches precise wording of given assertions and helps to rebut some of the long spread myths (they are classified as wrong answers). Each algorithm includes a description of situation in which the students have to consider which information are essential for readers and which of the circumstances are important to mention. Development of algorithms is the first experience with publishing activities for the students. The placement on the web portal allows for further editing and expansion of the topic (e.g. adding a professional first aid to general first-aid). Shared internet environment is less time consuming than personal consultation and provides greater flexibility.

## Keywords

algorithm, akutne.cz, education, acute medicine

## Introduction

E-learning portal AKUTNE.CZ [ISSN 1803-179X] was established in 2007 and it is targeted on interactive teaching of acute medicine. You can find a link to interactive algorithms in the section “education” on the portal AKUTNE.CZ, there are also links to tests, multimedial education tools etc. Interactive algorithms are made up of medical students and their supervisor oversees the accuracy of chapters from the ranks of

teachers and experts. Even the creation of the algorithm is a teaching method because the student is required to thoroughly study issue, to formulate questions and answers, and also find the point of the problem and clear solution. Making the algorithm is often the first opportunity of publication activity.

## Methodology

Three students were asked to make the algorithm for teaching portal AKUTNE.CZ



Fig. 1

as a semester work. They picked up the theme that were attractive to them (water rescue, hypothermia, traffic accident), themselves. I have defined the range of the algorithm (number of steps and answers) and skills (first aid). I asked students to create good and bad answers to which I wished to include a common error I've encountered in practice. I offered them possibility of electronic and personal consultation. We analysed the algorithm situations at the first meeting. The first step of algorithm is necessary to introduce readers the circumstances of the accident, definition of available means, number of involved, known values of the patient etc. Then the students create questions and answers as remind the decision-making algorithm in a real situation. The students already had experience of providing first aid, therefore the creation of questions and answers was easy for them. My job was to correct their work. Because the system allows to upload algorithms without publishing them on the web site and access is possible from any PC, we were able to consult the algorithms online, so we saved a lot of time.

## Results

Algorithms consist of a set of questions offering answers. Questions are asked to simulate a sequence of decisions in a given situation, and answers often include the traditions and superstitions. Choose the correct answer to advance to the next question, wrong answer

means a return to the question or termination of the algorithm, if the mean response given a fatal mistake. The resulting algorithm is presented on the portal AKUTNE.CZ in the form of flash applications. Situation is described to a investigator (circumstances, the number of injuries, the available tools, ...) and the timer is started (Fig. 1)

### How the students evaluate their work on interactive algorithms for AKUTNE.CZ?

Andrej Černý, author of the algorithm, Water Rescue I and II:

*"Creating algorithms for the portal AKUTNE.CZ offers the opportunity to realize and help the others in education. I personally decided to do this work, because I have knowledge of medicine, experience in water rescue and basic overview of emergency medicine and would be a pity not to transfer such information on. Currently, there are only few lay people who can help in such situations. I'm convinced that algorithms AKUTNE.CZ can help in these respects."*

Markéta Brandová, author of the algorithm Hypothermia:

*"The theme of hypothermia and frostbite, I chose because I often go to the mountains and a few people from my neighborhood have their own experience with frostbite. It is possible that I will meet this situation too, I hope that this information will be use-*

*ful to the public. I think my algorithm complements a series of algorithms dedicated to first aid. We tried not only to describe the correct procedure, but also mention frequently heard point out errors. Such as the friction of frostbite, too hot baths, etc. The information I gathered from the literature, first aid and emergency medical care, there is some evidence, however, diverged sometimes disagreed. Therefore I find necessary consultations, advice and repairs from Lenka Baláková, M.D. Work on this algorithm helped me to realize the causes of frostbite and hypothermia, to clarify the*

*mechanisms of damage in the body, and improper first-aid to fix the correct procedure in these situations.”*

## Conclusion

Due to an electronic form of algorithms we are able to extend the topic, update or develop as a follow-up algorithms. Attendance of portal AKUTNE.CZ in 2009 exceeded the limit of 4000 unique IP addresses per month, so I hope that the knowledge of first aid will improve.

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Interactive algorithms are available at [www.akutne.cz](http://www.akutne.cz)

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**B**

**SIMULATIONS  
AND ADVANCED  
MULTIMEDIA  
LEARNING TOOLS**



**mefanet**



## 05

# NEW TRENDS IN UNDERGRADUATE EDUCATION OF HUMAN ANATOMY

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## Abstract

Seeing that the imagination is one of the most difficult aspects in education of anatomy, our anatomy lectures are improved by presentation of 3D virtual models and animations prepared according to the requirements of the teacher. The virtual materials can be easily transformed into the 2D pictures so these outputs are used in our new computerized classroom. Education of anatomy was also improved by installation of cameras in dissector rooms.

## Keywords

3D virtual models, computerized classroom, lectures, education

## Introduction

In the last years, the modern tools intended to support educational process offers possibilities that allow teachers to present their subjects in an effective and more demonstrative way. The students have to be allowed to learn and utilize new things in as understandable way as possible. The main goal and the result of education process in human anatomy should be to offer for students of medical faculty the detailed study of human body, its organs and their topographical relation. Our department has been also focusing on innovative teaching processes with substantial attention on anatomy lectures, and has already transferred the load of education on information and communication technologies. Because the imagination is a very important aspect in education of anatomy, the simulations and virtualization methods can be used to revive education. 3D virtual models serve students to imagine the anatomical structures like in the real body and to achieve as high precision as they need.

## Realisation

Following new trends in methods of anatomy teaching, it is necessary to pay more attention to quality, depth and effectiveness of medical education. The computer based learning and interactive software applications are the available enhancements in learning methodology. Also our anatomy

department focused on innovative technologies in teaching process and education using information and communication technologies. The anatomy teachers search after applying new methods that use computer software focusing on the topography and function of the organs. Very important is to offer a real look of human body as it is. Teaching of anatomy requires demonstrative aids and tools that allow students to see and understand background of particular organs or functional systems. Such equipment should offer a better way to classify their structure and functions, to reveal deeper details and other related connections. Everything must be classified in better form than is a book or standard printed graphics. Other disadvantage of convenient approach is that some details are almost unimaginable and for beginning medical students incomprehensible. Absence of post-mortem materials and only two dimensional pictures open the space for simulation systems that eliminate here mentioned disadvantages<sup>[1, 2]</sup>. Development of multimedia educational tools is one of our educational priorities.

Our lectures are significantly improved by implementation of 3D virtual models and animations prepared according to the requirements of the teacher. Visual perception equipped with the comments of teachers brings a big didactic benefit. Software 3D anatomy offers animations, allows for



Figure 1: 3D virtual model of human body increases the quality of lecture

creation of various sequences of animations according to individual requirements, contains a lot of macroscopic images, synopsis of basic anatomical structures; visualization of organ sections, facilitates understanding space relationships. According our expectation, this system increases the interest of students in presence forms of study and the quality of lecture content as well. 3D projection systems are based on principles of virtual reality and are presented as rooms that are equipped by projection screens. Using specialized glasses the students feel an existence of 3D space. This virtual projection system is installed in lecture room and consists of three components: large screen projection, teacher workstation and 3D camera system. Authors of 3D educational materials (movies, models etc.) prepare its content before the lecture. It is used to as computer animations prepared from 3D model of human body (Fig. 1). Except of movies it allows to add descriptions, sounds and other recorded audio comments<sup>[3, 4]</sup>. The successful implementation of virtual tools and virtual support of education bring many advantages. The direct students' response is transferred

to the teachers, and they are reflected it preparing more precise and more qualitative educational presentations. The new lectures help students facilitate to study of human body, directing them correctly to draw attention to important anatomical structures.

These virtual reality outputs can be easily converted to the forms that are applicable into the systems intended for distance education. The virtual materials can be easily transformed into the 2D pictures; broad themes are structuralized into small standalone monothematic educational parts so these outputs are used in our computerized classroom for practical self-study and knowledge assessment include short quizzes as well. The former practice room of the anatomy department was transferred into a multimedia classroom. The room is equipped with ten personal computers (Fig. 2). Designing and installation of camera system for audio-visual real-time transmission between dissector room and classroom also significantly improved the education of anatomy. This utilization of modern technologies brings into the pedagogical process new dimensions, increases its quality, and supports a professional advancement for both students and teachers.

## Conclusion

The today's tools and methods that use a variety of sophisticated applications enable interestedly and easily understand the space relationships and synopsis of anatomical structures without the necessity of memorization, increase self reliance of students on practical lessons as well as reduce the burden of the teachers. The main aim of information technologies implementation is to get increased retention of knowledge from anatomy, which is a prerequisite for the study of clinical subjects and for the future clinical practice. These changes of teaching were met unhoped-for interest of students and help them to prepare for anatomy in a better way.





Figure 2: Multimedia classroom with ten personal computers

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# COMPLEX MODEL OF INTEGRATED PHYSIOLOGICAL SYSTEMS – A THEORETICAL BASIS FOR MEDICAL TRAINING SIMULATORS

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## Abstract

For the teaching of medical decisions are of great importance of a comprehensive training simulators, including models of various physiological subsystems, but also integrating them into a comprehensive whole. Medical simulators have recently become the sought-after commercial commodity. For example, the Advanced Simulation Corporation manufactures flight simulators, since 1993 also focuses on the development of medical simulators (<http://www.advsim.com>). User interface of training simulators is not just a computer screen. It can also be computer-controlled manikin patient. Sophisticated simulators with a dummy patient for example, offer Lardeal (<http://www.laerdal.com>) and METI (<http://www.meti.com>) companies. Like the airline pilot simulator, medical simulator is controlled by an operator from a location where the teacher can control the simulated patient and choose between various scenarios simulated disease. The core of medical training simulators is a complex model of physiological regulation of the human body, connected with a hardware simulator. Its detailed structure (the system of equations and the parameter values) is usually not published and becomes a carefully protected technological know-how. There are also an open source models of integrated physiological systems. One of them is a large model of Coleman et al. called Hummod (<http://hummod.org>) implemented by almost three thousand XML files. Our implementation of this model in the Modelica language has brought a much clearer description of the simulated complex physiological relationships than XML implementation. We uncovered several mistakes in the original model, the model we have modified and expanded in particular in modelling acid-base homeostasis. Our implementation model Hummod (<http://physiome.cz/hummod>) will provide a theoretical basis for training simulators. In its implementation we will use our web simulator creation technology.

## Keywords

model, Modelica, training simulator

## 1. Schola Ludus for the 21<sup>st</sup> Century

“Tell me, I’ll forget, show me and I may remember; involve me and I’ll understand” – this ancient Chinese wisdom is also confirmed by modern learning methods, sometimes called “learning-by-doing”, where simulation plays are widely applied. Simulation plays make it possible to test the behaviour of the simulated object without any risk

– for example, try to land with a virtual airplane or, as is the case of medical simulators, treat a virtual patient or test the behaviour of individual physiological subsystems. The connection of the Internet and interactive multimedial environment with simulation models provides quite new pedagogical opportunities, particularly when it comes to explaining complex interconnected relationships, active exercising of practical skills, and verifying theoretic knowledge.

The old credo of John Amos Comenius “Schola Ludus” – i.e. “school as a play”<sup>[12]</sup> pioneered by this European pedagogue as early as in the 17<sup>th</sup> century finds its application in the incorporation of multimedial educational plays in training courses.

Simulation plays for the teaching of medicine are the core of the offer of numerous commercial companies. Besides commercial simulators, *freely available educational simulators of individual physiological subsystems* can also be found on the Internet. For example, the simulator ECGsim (<http://www.ecgsim.org>) can be used to study the formation and spreading of electric potential in heart ventricles, and to study the mechanism of ECG formation in the presence of various pathologies<sup>[75]</sup>. Pressure-circulatory curves in heart ventricles in the presence of various pathologies can be observed using the heart simulator of the Columbia University (<http://www.columbia.edu/itc/hs/medical/heartsim>)<sup>[4]</sup>. Simulators of anaesthesiological instruments of the University of Florida allow for administer-

ing anaesthesia to a virtual patient (<http://vam.anest.ufl.edu/>). Blood gas transfer and acid-base parameters are the topics of the simulator OSA (Oxygen Status Algorithm), designed both for teaching and for clinical practice<sup>[70]</sup> (<http://www.siggaard-andersen.dk>). Activities of a neuron and neural networks can be studied using the simulation programme NEURON of the Yale University (<http://www.neuron.yale.edu>)<sup>[5, 27]</sup>. The training simulator AIDA (<http://www.2aida.net/>) models a virtual diabetic patient and allows for observing the effect of dosage of various insulin types with any assigned food intake on glucose metabolism<sup>[57, 64]</sup>. The Internet-based *Atlas of Physiology and Pathophysiology* is one of the results of our efforts in this area. The Atlas has been conceived as a freely available multimedial educational aid that utilizes the visual way to explain, through the Internet and simulation models, the function of individual physiological systems, the causes and manifestations of their disorders – <http://physiome.cz/atlas><sup>[42, 43, 48]</sup>.

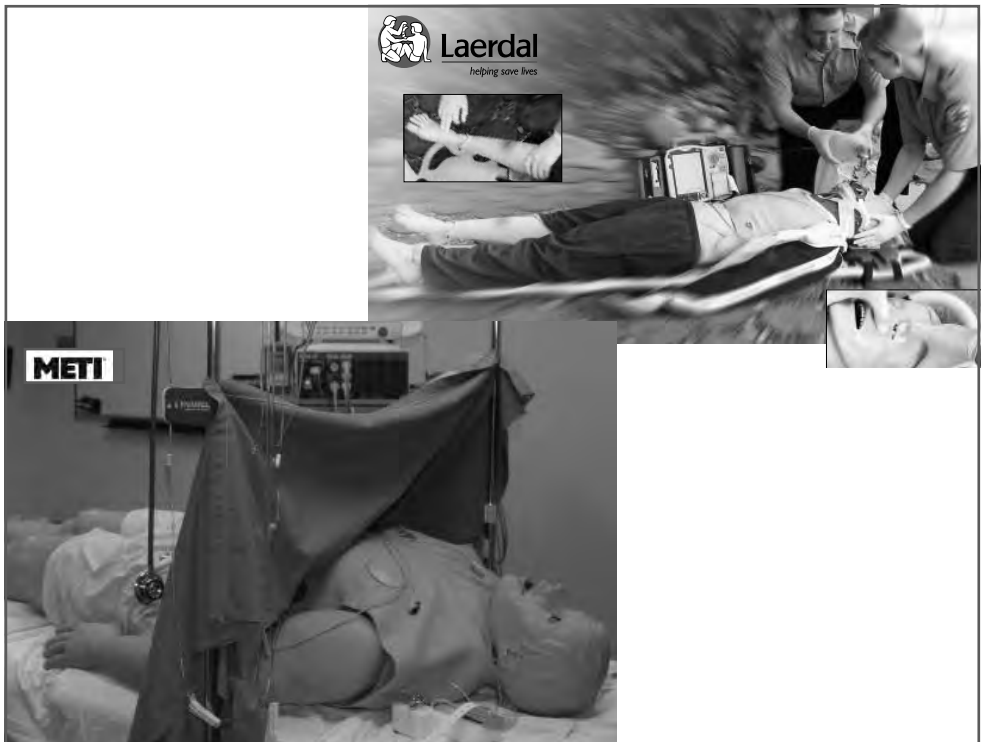


Figure 1: Patient simulators from Laerdal Company (<http://laerdal.com>) and from METI company (<http://www.meti.com>). The background of these simulators is a mathematical model. The most effective use of these simulators is mainly in the field of emergency medicine.

## 2. Medical training simulator

The interface of educational simulators need not be represented only by a computer screen (figure 1). The development of haptic scanning technology and of virtual reality imaging has brought a new class of simulators designed for training practical performance of some medical tasks (cardio-pulmonary resuscitation, catheterization, endoscopy, patient intubation, etc.) on a patient figure. However, also hardware trainers have been offered in increasing levels, designed at the same time also for training the medical decision procedure<sup>[23, 58]</sup>. For example, the Norwegian company Laerdal (<http://www.laerdal.com/>) manufactures a set of robotized simulators including the simulator SimBaby, used with a success as a medical trainer for newborn and infant care [68]. Laerdal trainers have proved to be useful not only in the training of doctors, but also in education of nurses<sup>[6]</sup>. The American company METI (<http://www.meti.com>) is another successful manufacturer whose robotized trainers provide a highly efficient (although costly) educational aid for the training of anaesthesiologists and medical care teams, particularly in the field of acute conditions medicine<sup>[16, 69]</sup>.

Similarly as air trainers, medical trainers allow for implementing a quite new way of teaching where the student may practice diagnostic and therapeutic tasks in virtual reality, associated with no risk for the patient. Similarly as airline pilot simulators, the trainer itself is controlled from within the operator site where from the teacher may control the simulated patient and choose from various scenarios of simulated diseases. All actions of students are monitored and the simulator provides grounds for later debriefing of the diagnostic and therapeutic procedure of the students<sup>[8]</sup>.

As noted by many authors in recent times in particular, teaching with a simulator imposes fairly higher demands on the teacher than classical teaching methods. However, provided that the simulator is used correctly, the pedagogical effect is very marked, especially in areas where fast and correct decision-making is very important,

for example, in acute conditions medicine and in anaesthesiology<sup>[3, 13, 29, 30, 61, 66, 78]</sup>.

Similarly as the theoretic foundation of an air simulator is based on an airplane model, medical simulators are based on a sufficiently truthful model of physiological systems in the human body. Its detailed structure (system of equations and parameter values) is usually not published for commercial trainers and becomes a carefully guarded technological know-how.

## 3. Integrative physiology

Models used as the theoretic foundation of medical trainers include *mathematical models not only of individual physiological subsystems, but also their interconnections, thus forming a more complex unit*. The field of physiological research dealing with the study of interconnected physiological subsystems of the body seeks to describe the physical reality and explain the results of experimental research, as well as “integrative physiology” seeks to create a formalized description of the interconnected physiological regulations and explain their function in a healthy human and also for conditions of various diseases.

Formalized description of the circulatory regulation in connection with other physiological subsystems was one of the first extensive mathematical descriptions of physiological functions of the interconnected subsystems of the body; this description was published in 1972 by A. C. Guyton with two other authors<sup>[19]</sup>. Right at first glance, the article went absolutely beyond the scope of the habitual form of physiological articles of that time. Its essential part was formed by an extensive diagram pasted in as an appendix, remotely resembling a drawing of some electronic device. However, instead of electronic components, the diagram showed interconnected computational blocks (multipliers, dividers, summaters, integrators, functional blocks) that symbolized mathematical operations performed with physiological variables. Instead writing a system of mathematical equations, graphic representation of mathematical relationships was used in the article. The whole diagram thus represented a formalized description of physiological relation-

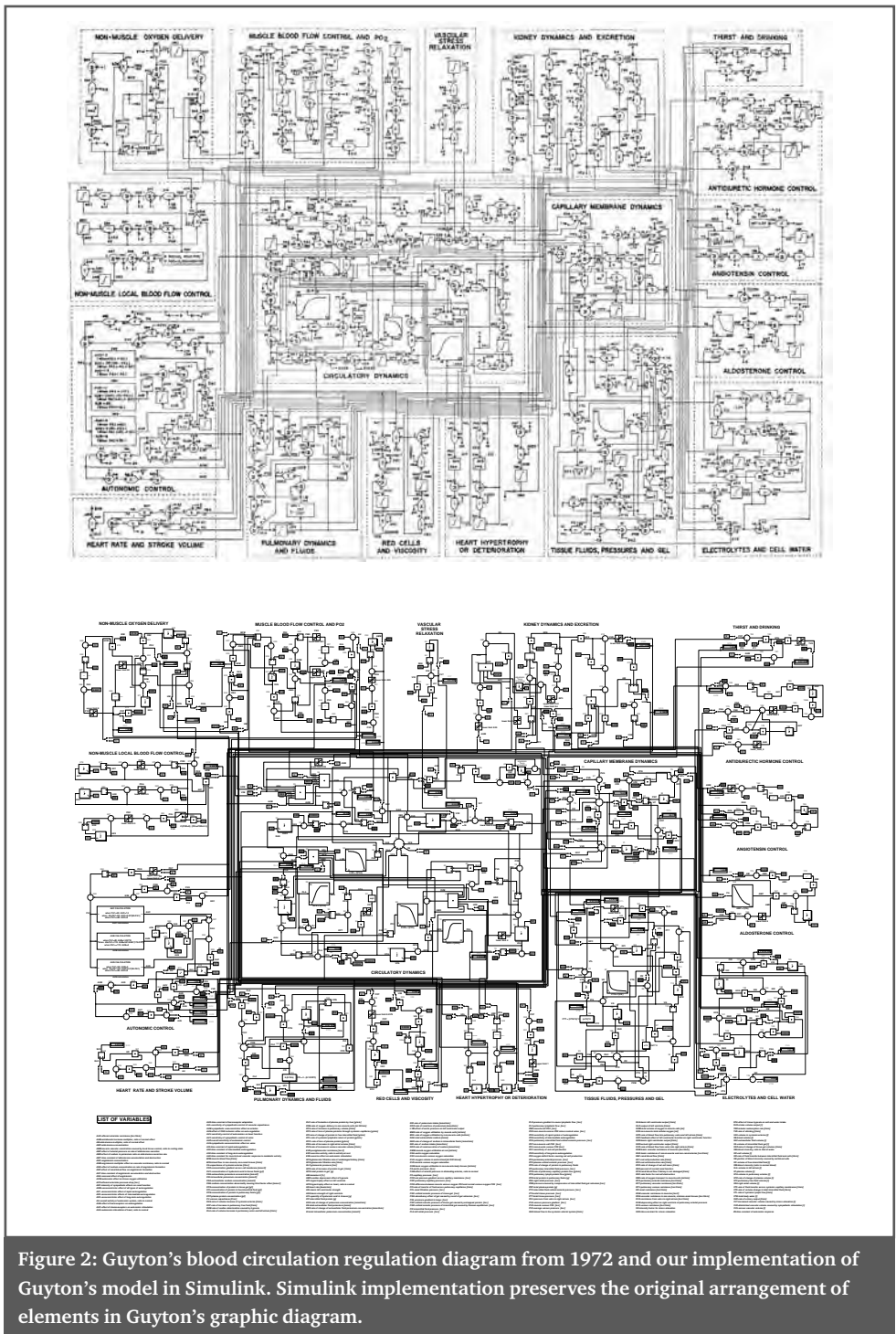


Figure 2: Guyton's blood circulation regulation diagram from 1972 and our<sup>[20]</sup> implementation of Guyton's model in Simulink. Simulink implementation preserves the original arrangement of elements in Guyton's graphic diagram.

ships using a graphically expressed mathematical model (figure 2). The authors applied this way, quite new then, of using graphically expressed mathematical symbols to describe physiological regulation of the circulatory system and its

wider physiological contexts and connections to other subsystems of the body. The comments and reasons for the formulations of the mathematical relationships were very brief. Later, in 1973 and subsequently also in 1975, monographs<sup>[20]</sup> were published

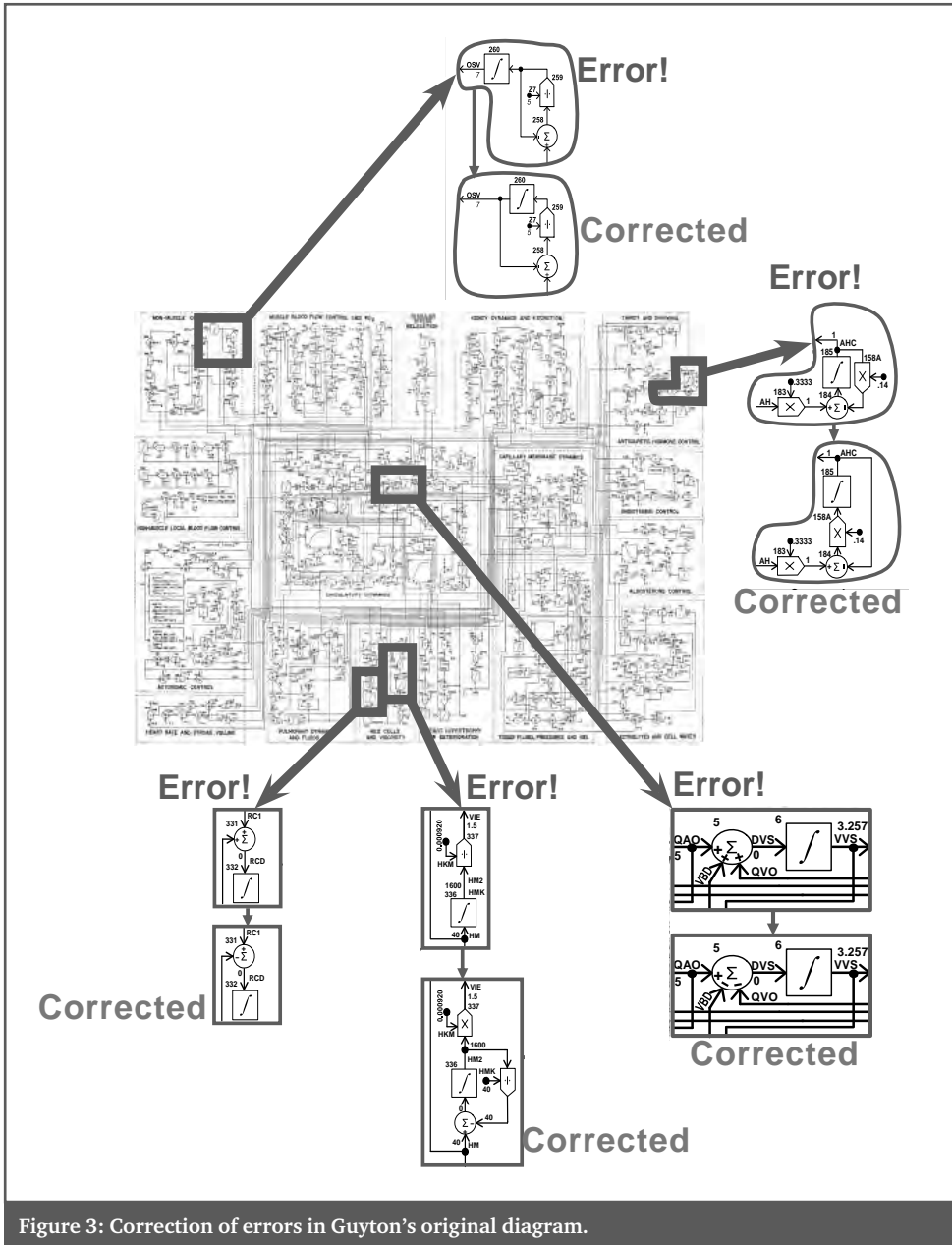


Figure 3: Correction of errors in Guyton's original diagram.

providing a more detailed explanation of a number of the approaches applied. Guyton's graphic notation of the formalized description of physiological relationships was soon adopted also by other authors – for example, Ikeda et al.<sup>[28]</sup> in Japan or the research group of Amosov in Kiev<sup>[2]</sup>. However, graphic notation of a mathematical model using a network of connected blocks was a mere image representation at that time – the Guyton's model as well as its additional modifications (similarly as mod-

els of other authors who adopted the expression notation of Guyton) were implemented in Fortran and later in C++ language. Guyton and his collaborators and students kept developing the model continuously<sup>[63, 71]</sup>. The Guyton's model was an inspiration as well as a resource for designing complicated complex models of physiological regulations used to explain causal chains of reactions in the body to various stimuli, and also to understand the development of pathological conditions. Besides others, a modified Guy-



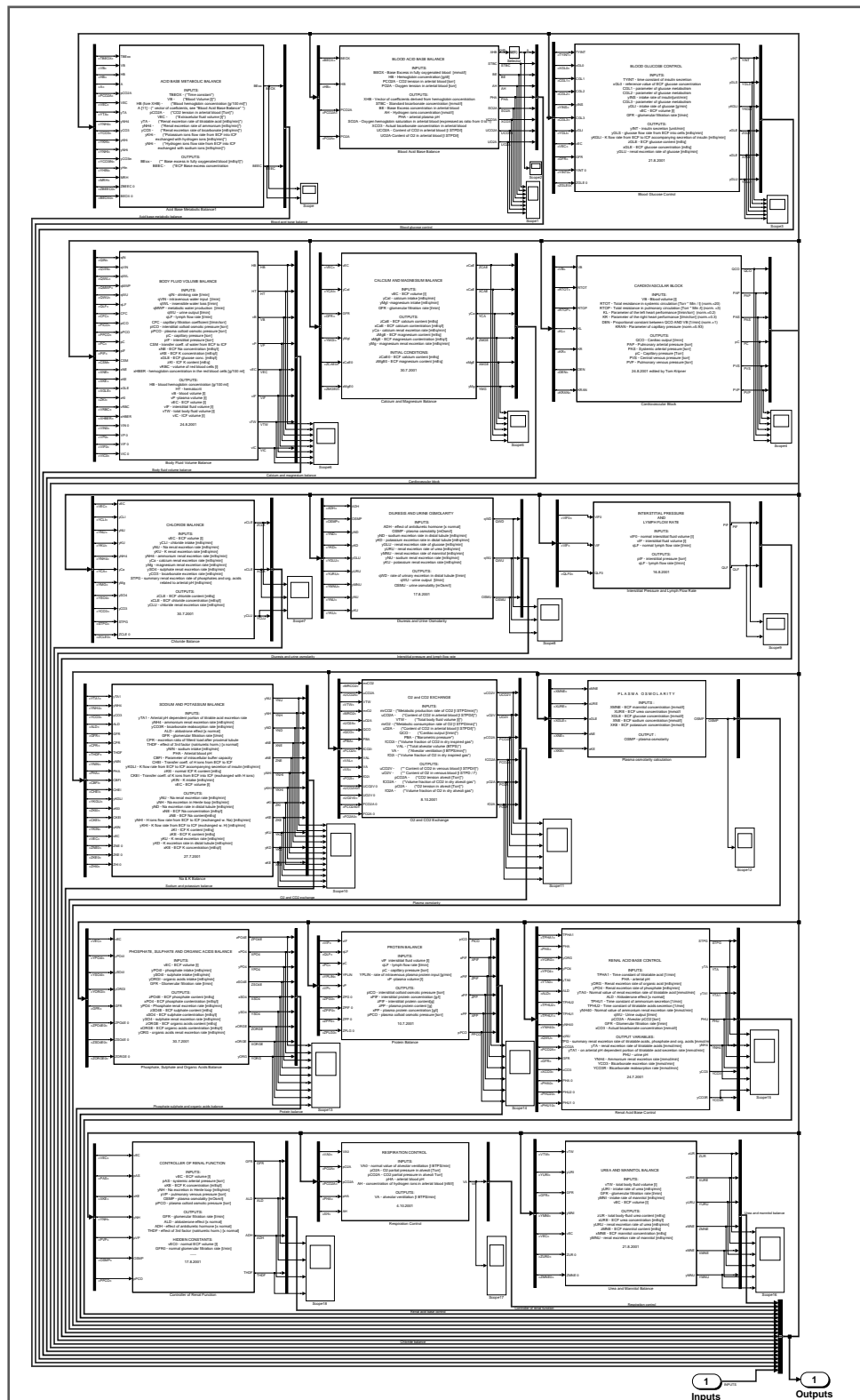


Figure 5: The internal structure of the Simulink block, which implements the simulation model of the Golem, is composed of 18 blocks of physiological subsystems and their inputs and outputs are connected through a common bus.



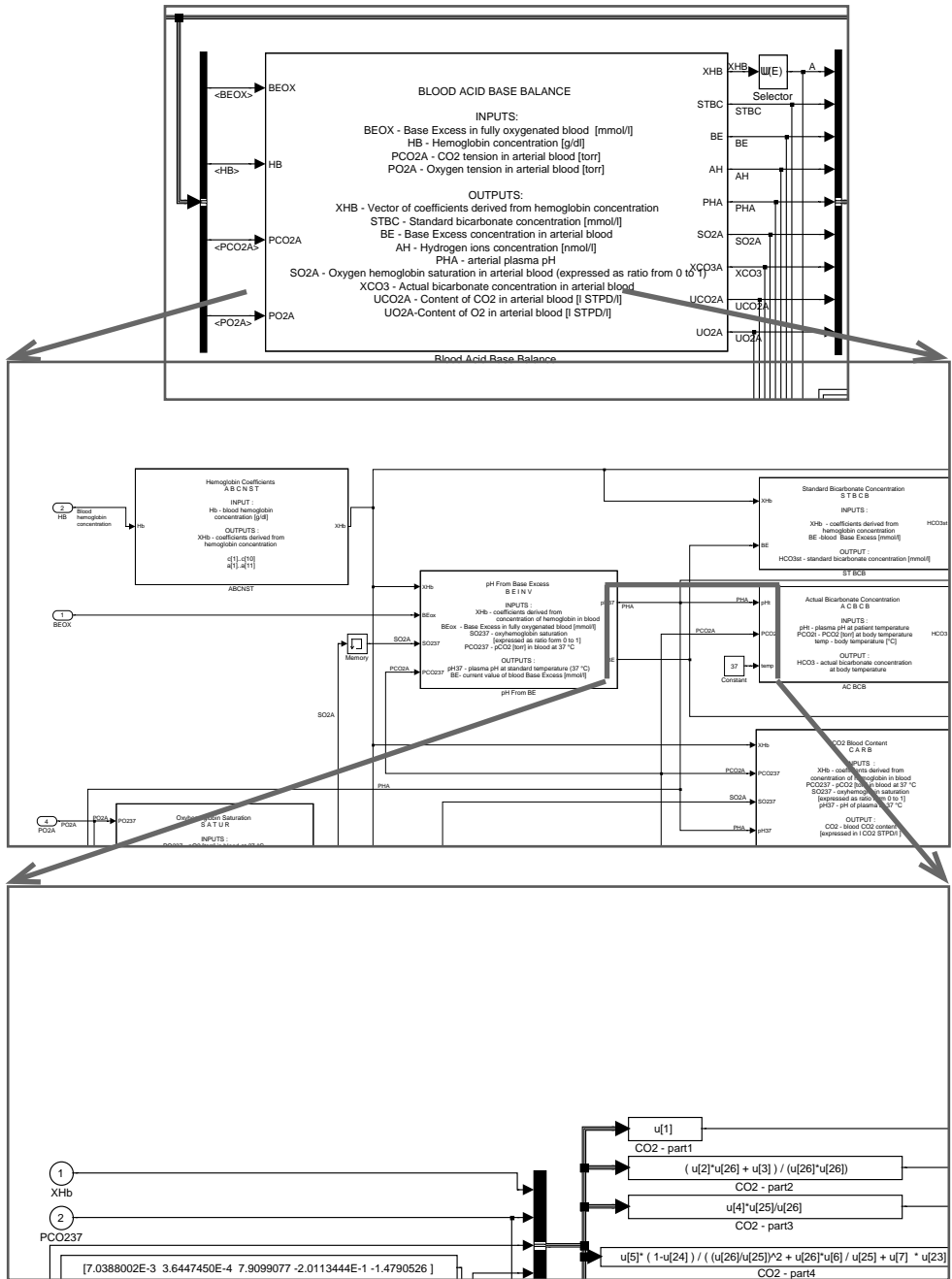


Figure 6: The whole model of the Golem simulator is created from the hierarchical, interconnected Simulink blocks. The link shows the dependencies and linkages between different physiological subsystems. Simulink computing network, representing mathematical relationships, it appears only at the lowest hierarchical level. For example, within a block BLOOD ACID BASE BALANCE one of the linked units – (block CARB), counting the total concentration of carbon dioxide in the blood, already has its own counting blocks.

principles of regulator circuits and their applications to physiological regulation<sup>[80]</sup>. The students worked with models implemented on the analogue computers MEDA

and later, as allowed by the technical equipment of the department, also on digital computer terminals.

In the 80s, we also embarked on the development of our own extensive model of mutually connected physiological regulations focused predominantly on modeling the disorders of homeostasis of the inner environment. The model of acid-base equilibrium and of blood gas transfer<sup>[31]</sup> was expanded to a complex model of the inner environment hemostasis<sup>[18, 39, 45, 46, 47]</sup>. Besides others, the created model was a part of a wider project of using mathematical models of the human body in the Soviet cosmic research<sup>[77]</sup>, similar to the American NASA project “Digital Astronauts”<sup>[79]</sup>. Some subsystems of the model found their practical applications also in calculations of some clinical-physiological functions by means of identifying the model to measured clinical data<sup>[44]</sup>.

In the middle of the 80s, we also attempted at using our complex model of the inner environment in classes. Communication with the model running on remote hardware ran through an alphanumeric terminal. Interactivity was therefore somewhat cumbersome, only numeric outputs were used, and pseudographs created from character sets replaced any graphic output. In the end, the pedagogical effect therefore did not correspond to the effort that we devoted to its implementation. We returned to the issue of educational simulators as late as in the second half of the 90s when the progress of information technologies made it possible to create educational simulators applicable in practical teaching of medicine.

## 5. Models and “simulation chips” in Simulink networks

Today, designing simulation models is facilitated by specialized software environments. Matlab/Simulink of the company Mathworks is one of them. It includes the graphic simulation language Simulink that can be used to set up a simulation model from individual components using the mouse – thus a model of a kind of software-based simulation parts that are connected to form simulation networks. Simulink blocks highly resemble elements used by Guyton for his formalized expression of the physiological

relationships. Their graphic shapes are the only difference.

Besides others, this similarity inspired us to resurrect the old classical Guyton’s diagram and transform it into a functional simulation model<sup>[32]</sup>. We tried to preserve quite the same external appearance of the Simulink model as in the original graphic diagram – the layout, placement of wires, names of variables, and even block numbers are the same (see figure 2).

However, simulation-based visualization of the old diagram was not quite easy – there are namely errors in the original picture diagram! This is not a problem for a drawn picture, but if we try to liven it up in Simulink, the model collapses immediately as a whole. For a detailed description of the errors and their corrections see<sup>[33, 49]</sup>.

It is of interest that the Guyton’s diagram as a complex picture has been reprinted many times in various publications – recently, it appeared for example in<sup>[7,22, 76]</sup>. However, no one pointed out the errors before us, and no one took the trouble to remove them (figure 3). No drawing programs existed yet at the time when this picture diagram was created – the picture was created as a complex drawing – and manual redrawing of the complex drawing was not easy. It is even possible that the model authors themselves had no special desire to correct the errors – those who took the pains to analyze the model unveiled the graphic “misprints”, while those who would only like to copy without thinking had no luck. After all, in their times the authors also distributed source codes of the programs of their model in Fortran – there was thus no need to program anything if only the model behaviour was to be tested. Our Simulink implementation of the (corrected) Guyton’s model is available for download at <http://www.physiome.cz/guyton>. Our Simulink implementation of a much more complex version of the model of Guyton et al. from later years is available on this website, as well. At the same time, very detailed description is provided of all the used mathematical relationships, together with reasons for them.

However, the Guyton’s diagram and the Simulink network designed based on the diagram are quite difficult to survey at first

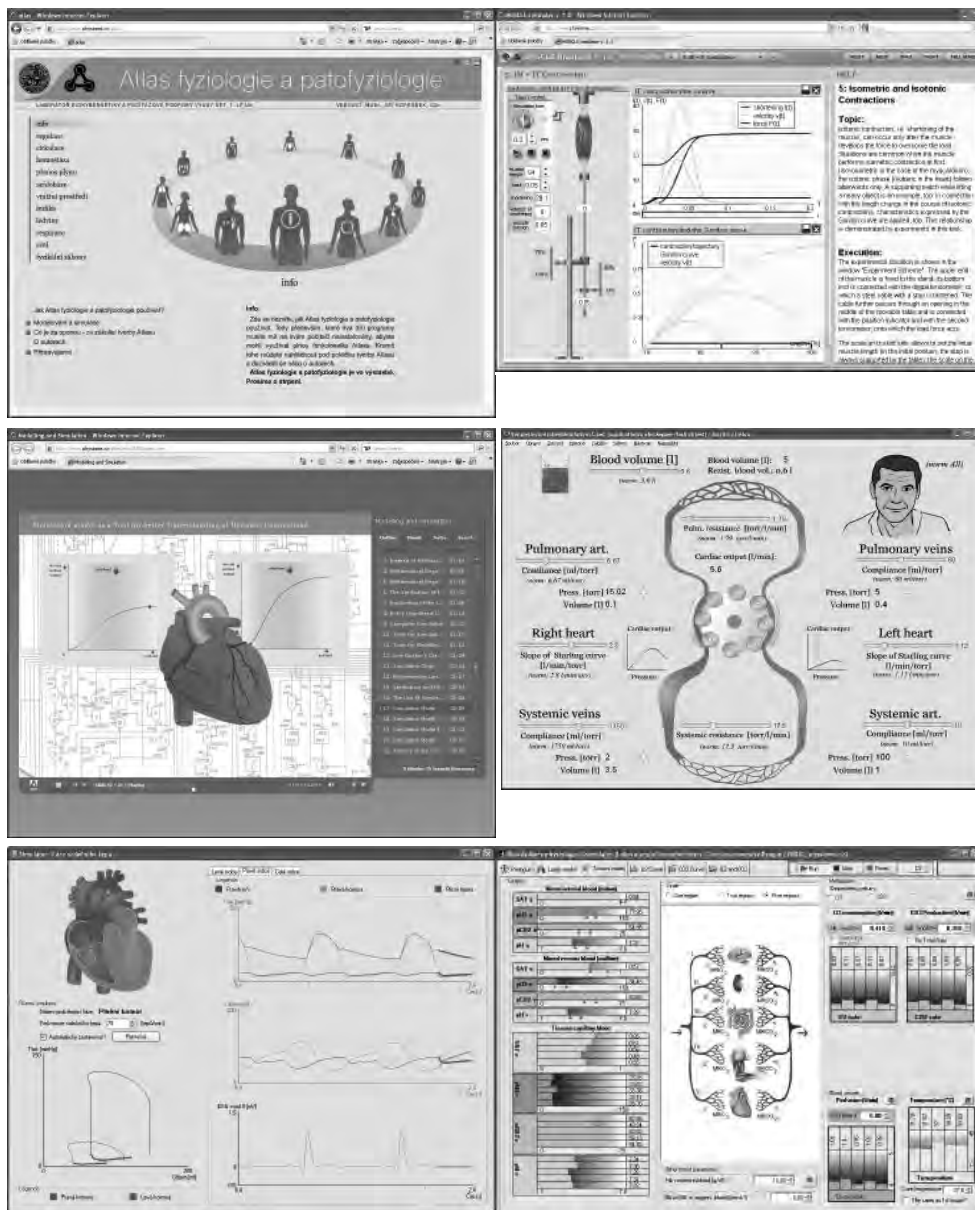


Figure 7: The Atlas of physiology and pathology combines interactive interpretations with sound, animations and interactive simulations. It has been created in Czech and (gradually) in an English version as well. It is freely available at: [www.physiome.cz/atlas](http://www.physiome.cz/atlas).

glance. In order to increase its clarity, it is advisable to hide the actual active elements of the Simulink calculation network (multipliers, dividers, integrators, summators, etc.) in individual subsystems implemented in Simulink as user blocks with appropriate inputs and outputs from the outside. The whole model then consists of interconnected blocks of individual subsystems where it can be seen clearly what variables

are used to connect individual subsystems, while the algorithm of the actual simulation computation is hidden in the Simulink network within the blocks.

The blocks can be saved in libraries as user-defined subsystems. In the process of creating models, the blocks can be taken out from the library, connected and grouped in blocks of a higher hierarchic level as the case may be. Individual Simulink subsystems rep-

resent a kind of “simulation chips” hidden from the user by the structure of the simulation network, similarly as an electronic chip hides from the user the connection of individual transistors and other electronic elements. The user may thus be concerned only with the chip behaviour, and need not worry about the inner structure and algorithm of the computation. The “simulation chips” can be used for easier testing of the model behaviour, and especially for clearer expression of mutual dependencies among variables of the modelled system. The whole complex model can be shown as interconnected simulation chips, while it follows clearly from the structure of their connections what effects are considered in the model and how.

This approach provides important advantages in cooperation of multiple specializations – particularly in borderline fields, such as modelling biomedical systems. An experimental physiologist does not have to examine in detail what mathematical relationships are hidden “inside” the simulation chip; however, he/she will understand the model structure from the connections among individual simulation chips, and can verify the chip behaviour in an appropriate simulation-based visualization environment<sup>[40]</sup>.

The Simulink blocks were used to create a **library of physiological models called Physioblibrary**, which is freely available at: <http://www.physiome.cz/simchips>. The library also includes an extensive integrated model of physiological regulations that has been used as the foundation for our **educational simulator Golem**. The model uses a hierarchic structure composed of individual nested and interconnected Simulink blocks<sup>[37]</sup> (see figures 4–6).

## 6. Golem instead of the patient

Besides the model, additional considerable programming efforts were needed to design the educational simulator **Golem**, which consisted in creating the user interface and connecting it to the verified model implemented on the background of the simulator<sup>[36]</sup>.

The simulator “Golem” designed as open source at the end of the 90s focused predominantly on the teaching of the pathophysiology of inner environment disorders<sup>[34, 35, 50–54]</sup>. It allowed for simulating especially mixed disorders of ionic, osmotic and acid-base equilibrium, disorders of blood gas transport, respiratory failure and renal failure. It also allowed for observing the effect of various infusion therapies.

The simulator has been used at our and some foreign medical faculties. It proved itself especially in the teaching of pathophysiology and clinical physiology. Thanks to the complexity of the physiological systems model on its background, the simulator could be used to demonstrate clearly ***how individual physiological subsystems are related with each other, and how these connections are manifested in individual pathophysiological conditions.***

From the pedagogical point of view, it proved to be highly advantageous to explain the physiological meaning of individual regulator circuits by means of ***disconnecting and reconnecting individual regulatory bonds.*** Upon disconnecting regulatory bonds in the simulator, ***the response of individual physiological subsystems*** on changed values of some variables ***can be observed locally***, which themselves are regulated in the body, though. We have therefore introduced in Golem the ***possibility of “disconnecting regulation”*** of some regulated physiological variables, and their “switching to local input”<sup>[38]</sup>. Disconnection of the regulatory loops made it possible to limit the simulation to an individual physiological subsystem, and to examine its behaviour independent of the complex regulatory relationships within the whole body, and thus to observe the behaviour of individual physiological regulatory relationships separately, which contributed to better understanding of the physiological relationships. However, our experience as well as the experience of other departments with the deployment of complex models in teaching show that large and complicated models provide a considerable disadvantage from the didactic point of view due to their complex control<sup>[14, 56, 48]</sup>. Large amounts of input variable require that the user acquires

a more profound understanding the very structure of the simulation model, as well as knowledge of what processes should be observed during the simulation of certain pathological conditions.

Pedagogical practical experience showed that simulation plays with simple aggregated models (enabling the user to observe only several variables) is sometimes a more suitable tool for explaining complex processes than an extensive and complicated educational simulator. It is advisable to proceed from simple to more complex things in the explanation, i.e. explain the basic principles at first using simple models, and only then pass on to more complex details and use simulation plays with more complex models.

It is suitable to use the models together with explaining their use – at best using interactive educational applications on the Internet. It is only the **connection of the lectures with a simulation play** that provides the possibility of utilizing all advantages of virtual reality to explain complex pathophysiological processes.

In order to join the potential of interactive multimedia and simulation models for the teaching of medicine, we have therefore designed the project of an Internet and computer-based *Atlas of Physiology and Pathophysiology* (<http://physiome.cz/atlas>), which combines interactive explanatory chapters and simulation plays with models of physiological systems (figure 7). The user interface resembles animated pictures of the printed Atlas of Physiology<sup>[71]</sup> or Atlas of Pathophysiology<sup>[72]</sup>. However, unlike printed illustrations, the pictures that form the user interfaces of multimedial simulators and **“live” and interactive – changes of variables of the simulation model are reflected in a change of the picture**. Thus conceived interactive illustrations can be used to implement simulation plays that help, better than a static picture or even a simple animation, to explain the dynamic relationships in physiological systems, and thus also help especially to understand the causal relationships in the development of various diseases. In the process of designing the atlases, we have stemmed from our

web-based educational simulator design technology<sup>[41]</sup>.

## 7. From Simulink to Modelica

Simulink is one of **block-oriented simulation languages** that allow for setting up computer-based models from individual blocks with defined inputs and outputs, where the blocks can be connected to form computational networks, and the computational networks can be grouped into block of a higher hierarchic level. Block-oriented simulation tools provide the advantage that they make it possible to structure the model clearly into connected, hierarchical components. The structure of a block-oriented description thus shows clearly how the values of individual variables are calculated in the model – i.e. what the computational algorithm is. The term **causal modelling** is thus used. However, the blocks cannot be connected to the network of relationships quite arbitrarily, unfortunately. Algebraic loops may not exist in the connected elements – i.e. cyclic structures where some input value introduced as an input to a computational block depends (through several intermediary elements) on the output value from this block in the same time step. The way of connecting the blocks reflects rather a **computational procedure** than the very structure of the modelled reality.

Recently, new, the so called **“acausal”** tools to create simulation models were developed. An essential innovation brought by acausal modelling tools is represented by the possibility of describing individual parts of the model directly **as a system of equations and not as an algorithm to solve the equations**. The notation of the models is thus declarative (the structure and mathematical relationships are described, not the computational algorithm) – the notation is thus acausal.

Acausal modelling tools work with connected components that represent instances of classes where equations are defined directly. The components may be connected through special acausal connectors – an acausal connection actually means

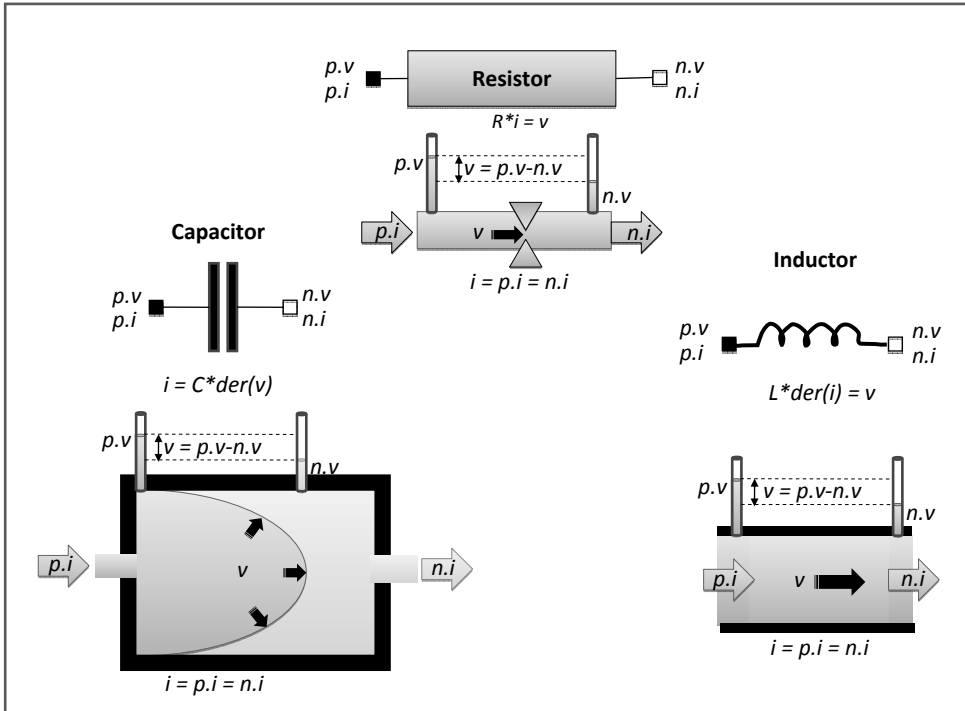


Figure 8: The hydraulic and electric elements are from different domains but have the same formal description. The analogy of voltage ( $v$ ) in the hydraulic domain is pressure, the analogy of current ( $i$ ) in the hydraulic domain is a stream of fluid (and a stream of gas in the pneumatic domain). Hydraulic resistance ( $R$ ) follows Ohm's law in the same way as electric resistance (the voltage difference is just replaced with the pressure gradient and the current is replaced with the flow rate). The hydraulic analogy of a capacitor is an elastic bag expanded by the difference in pressures inside and outside the bag. The analogy of the electric capacity of a capacitor ( $C$ ) is the compliance of the elastic bag wall. When we include inertia in a hydraulic system, the force that accelerates fluid flow is the pressure gradient. According to Newton's law, the acceleration of flow, i.e. the first derivative of flow  $\text{der}(i)$ , is proportional to the pressure gradient ( $v$ ) and inversely proportional to the weight of the selected fluid column, called inertia ( $L$ ). In the electrical domain, inertia corresponds to coil inductance. Each element from the hydraulic or electric domain has two interconnecting connectors through which electric current or medium flow ( $p.i$ ,  $n.i$ ) flows in and out; as a rule, the running flow ( $i$ ) never disappears in the element (i.e.  $i = p.i = n.i$ ). Simultaneously, voltage or pressure ( $p.v$ ,  $n.v$ ) is connected to the connectors by interconnecting into a network, and a voltage gradient or a pressure gradient ( $v$ ) builds up in the element.

that individual variables in the equations of appropriate components are connected, and their connections define the systems of equations of the model.

Elementary elements of simulated reality may take the form of a very trivial notation of relationships among quantities. For example, resistance, capacitor or coil from the electrical physical domain or their hydraulic analogies (used e.g. for the circulatory system modelling) can be named as illustrative examples (figure 8). A more complex computational system arises upon connecting such elementary elements in networks – systems of equations are obtained upon their mutual

connections. An algorithm of their numerical solution written in Simulink may not be trivial (see e.g. more complex, the so called “RLC models” of circulation or respiration implemented in our Simulink library Physioblibrary). However, there is no need to care about the way of solution in acausal simulation tools. It is the acausal tool itself that takes care of solving the obtained system of equations.

**Modelica** is a modern simulation language built directly on acausal notation of models<sup>[17, 74]</sup>. Unlike the block-oriented simulation environment Simulink, the structure of Modelica models shows much better the

physical essence of the modelled reality (an appropriate compiler then takes care of the solving algorithm of the resulting system of algebraic differential equations). Models in Modelica are, compared to those in Simulink, clearer and self-documenting. A simple example from the field of hemodynamics modelling can be used to illustrate this. In order to model the resistance of a blood vessel, we shall create a class and write the Ohm's law equation in the class. A user-defined icon may be assigned to every class – for example, graphic representation of the vessel in the given case (see Fig. 11). In order to facilitate its interconnection with the surroundings, we shall add a connector to the class, which will be used for conductance values input in the case of resistance, and at the same time, we shall define acausal connectors at both ends of the vessel.

A causal connector-based connection can be implemented using two types of quantities: One that represents flow – where the sum of flows at all connected nodes is null (because no material is accumulated at the bifurcation point of the nodes), and another whose value remains the same at all the connected nodes. The flow variable is blood flow for the component that models vascular resistance, while the nonflow variable is blood pressure. The pairs of connected flow and nonflow variables may differ for other components (such as the material flow as the flow variable, material concentration as the nonflow variable).

The so called elastic compartment (figure 9) is used often in vascular dynamics modelling. The elastic compartment concept is based on the idea that if a vessel is filled with blood, the vascular pressure is determined only by the external pressure exerted on the vessel (*ExternalPressure*) up to a certain residual volume (*VO*); afterwards, the elastic and muscular fibres in the vessel start stretching and the vascular pressure rises proportionally to the difference of the vascular volume (*Vol*) and residual volume (*VO*).

An elastic vascular compartment can be imagined as an inflatable bag with one acausal connection connector (called perhaps the *ReferencePoint*) used for connect-

ing the compartment to the surroundings. This connector provides us with two values: Flow *ReferencePoint.Flow*; Pressure *ReferencePoint.Pressure*

Three signal inputs will enter the compartment from the outside:

Basic fill *VO* – volume value from which, when achieved, external pressure will start rising during filling of the vessel, thus the external pressure of the outside surroundings exerted on the vessel *ExternalPressure*  
Compliance of the elastic compartment *Compliance* – besides others, its value depends on the tension of muscular fibres.

Two (causal) signal outputs will exit the compartment on the outside:

Information on the momentary volume of the compartment *Vol*;

Information on the pressure value within the compartment *Pressure*.

An icon used to display the elastic compartment can be designed in the programming environment, as well.

The program fragment that describes the behaviour of the elastic compartment is as follows in Modelica:

```
model VascularElasticBloodCompartment;
```

```
...
```

```
equation
```

```
  StressedVolume = max(Vol-V0,0);
```

```
  Pressure = (StressedVolume/Compliance) +
```

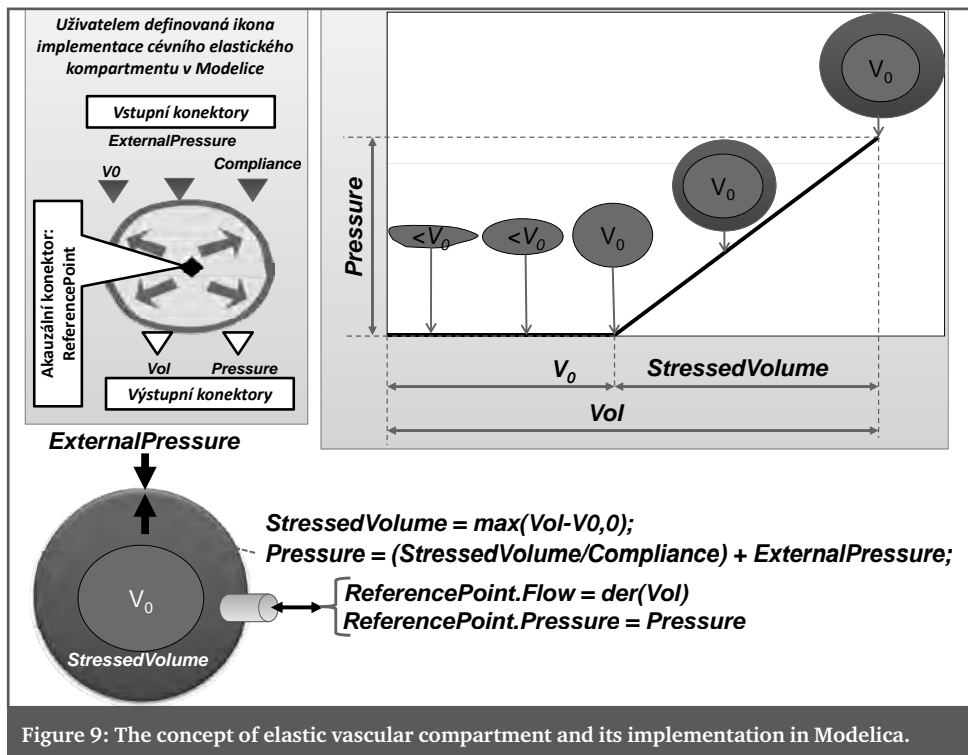
```
    ExternalPressure;
```

```
  der(Vol) = ReferencePoint.Flow;
```

```
  ReferencePoint.Pressure = Pressure;
```

```
end VascularElasticBloodCompartment;
```

The first equation declares that the value of the elastically stressed volume *StressedVolume* will be calculated as the difference between the compartment volume *Vol* and the value of its basic fill *VO* (which is the input); furthermore, the equation says that the compartment volume value can never decrease to negative values. The second equation declares the relationship between the compartment pressure *Pressure*, the stressed volume value *StressedVolume*, compliance *Compliance*, and the external pressure *ExternalPressure*. The reader should be reminded once again that these are equations and not assignments. The equation could be written in Modelica also as follows:



$\text{Pressure} - \text{ExternalPressure} =$   
 $(\text{StressedVolume} / \text{Compliance})$ ;

The third equation is a differential equation – volume derivation “ $\text{der}(Vol)$ ” is equal to the flow “Flow” coming from the connector “ReferencePoint”. The last equation connects the compartment pressure value “Pressure” with the pressure value “ReferencePoint.pressure” connected with the surroundings by means of the acausal connector.

The value “Pressure” is a signal output from the compartment at the same time – and being a signal, it can be brought to other blocks – but it is a causal output (signal) variable and its value cannot be affected by the element it is connected to. However, the situation is different in the case of connections from an acausal connector. Upon connecting an instance of the elastic compartment with other elements using an acausal connector, the four equations in the compartment become a part of the system of equations given by the appropriate connection, and variable values in the elastic compartment instance will depend on solving the thus created system of equations.

Until now, Modelica has been largely used in the industry. It facilitates modelling consid-

erably, especially that of extensive and complex systems, which also include biomedical systems, though. Therefore we have opted for Modelica as the new implementation tool for the creation of educational simulator models, thus abandoning the development of models in the block-oriented environment Simulink/Matlab.

An advantage can be demonstrated for example by the comparison of implementation of the classical Guyton’s model <sup>[19]</sup> in Simulink (figure 10) and in Modelica (figure 11).

The central part of the Guyton’s model (Circulation dynamics) represents circulation modelling of blood pumped by the right and left heart ventricle. The Simulink model represents a complex computational network, complex at first glance. The Modelica implementation provides a clear view of the essence of the modelled reality – it consists of instances of two pumps (right and left ventricles), instances of elastic compartments, and resistances of individual parts of the vascular bed, interconnected through acausal connectors (that connect the flow and pressure in individual parts of the blood stream). The acausal connector of



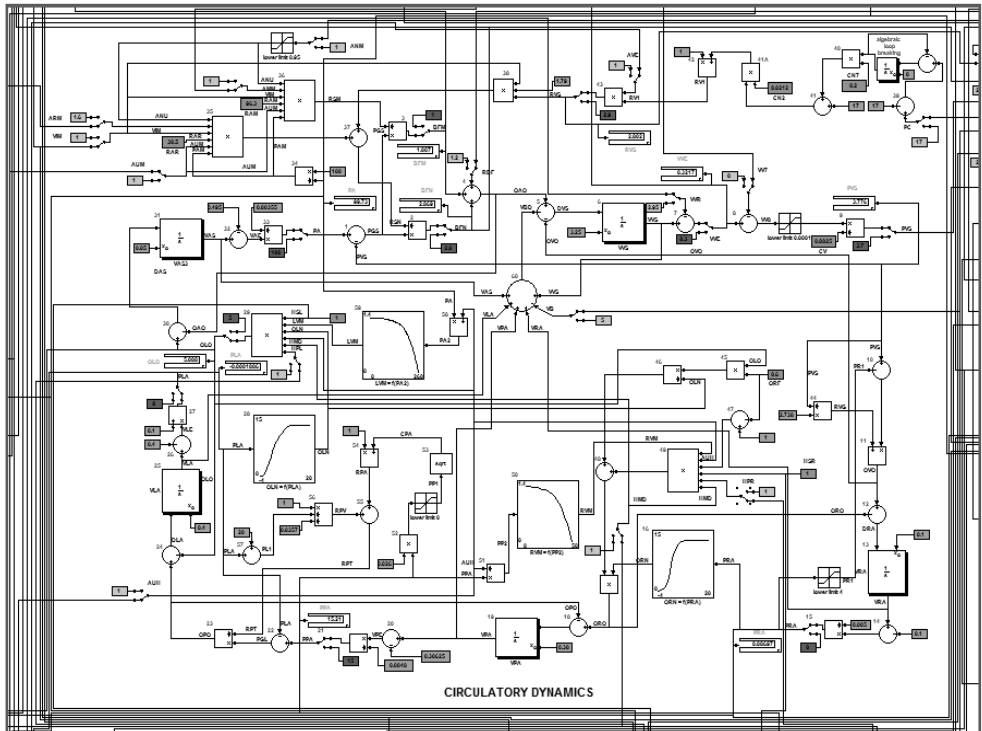


Figure 10: Circulatory dynamics – more detailed central structures of the Simulink implementation of Guyton's model, representing flows through aggregated parts of the circulatory system and the activity of the heart as a pump.

large veins is moreover connected to a controlled pump used to model blood formation or loss, infusions, and volume transfers from blood and interstitial liquid.

## 8. HumMod, Golem edition – model for the medical training simulator eGolem

Advantages of the acausal approach have been fully applied in the implementation of an extensive model of physiological regulations, which is used as the foundation of the medical training simulator *eGolem* in the process of preparation. The model structure stems predominantly from the structure of a model of American authors named *Quantitative Human Physiology (QHP)*, recently renamed to *HumMod*, [11, 24–26].

The large educational simulator *Quantitative Circulatory Physiology (QCP)* is the predecessor of this model [1], obtained upon further elaboration of the Coleman's model *Human* [9] and large models of the Guyton's working group. In order to support its use

as an educational aid in medical teaching, the authors made the model freely available from the website of the University of Mississippi (<http://physiology.umc.edu/themodelingworkshop/>). The simulator *QCP* can be downloaded and installed on a Windows computer. It includes a high number of variables (several thousand). The simulator allows for changing the values of approx. 750 parameters that modify physiological functions. The values of these parameters can be saved in an external file or read from an external file, which enables the user to prepare a number of scenarios for various scenarios of the modelled pathological conditions. The authors have prepared many of the scenarios (as input files) for educational needs, and together with appropriate comments, they made them available for free download from the respective website. The simulator proved to be useful in the teaching practice [65].

The simulator *HumMod* with its more than 4000 variables apparently represents today the most extensive integrated model of physiological regulations. The model

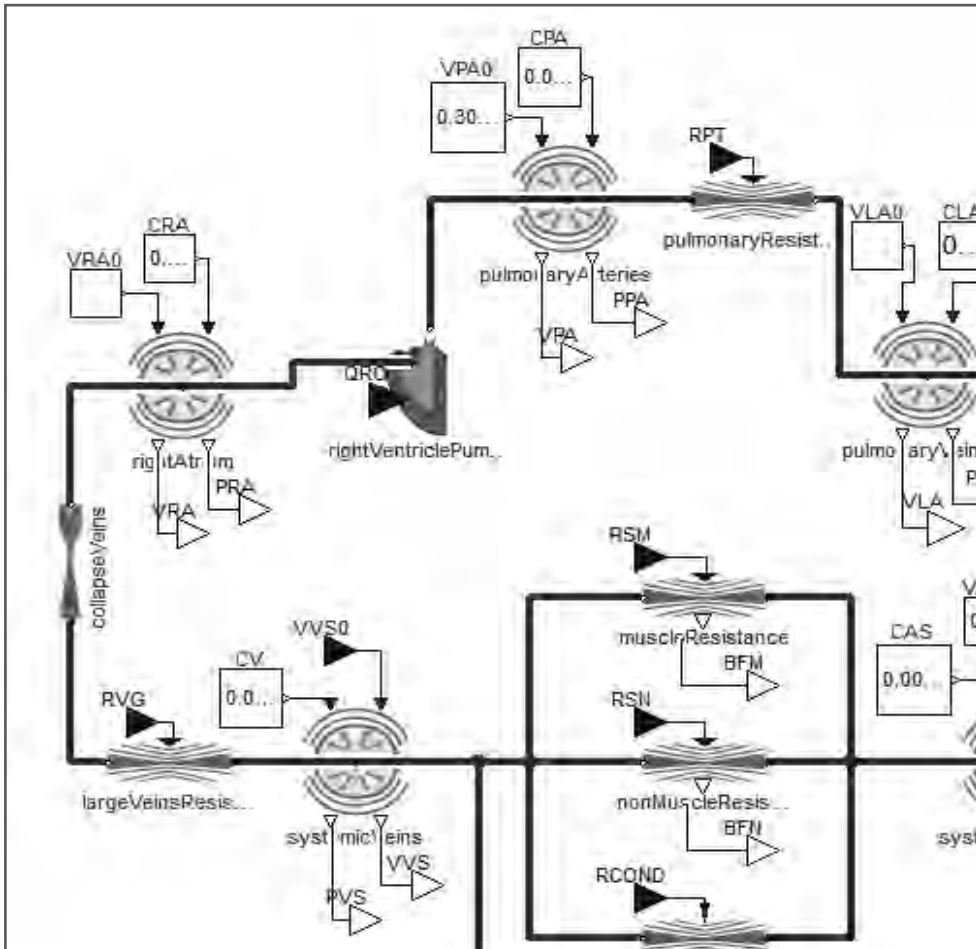


Figure 11: The same model structure as is shown in figure 10 implemented in Modelica. The structure of the model in Simulink corresponds to the structure of computational steps, while the Structure of Modelica model reflects the structure of the modeled physiological reality.

includes a menu branched abundantly, and it supports the simulation of numerous pathological conditions including the effect of any therapy.

Unlike the previous simulator QCP whose mathematical background is hidden from the user in the source code of the simulator written in C++, the simulator *QHP/Hummod* has taken a different way. Its authors decided to separate the simulator implementation and description of the model equations in order to make the model structure clear for a wider scientific community. As early as in 1985, the main architect of this model, Thomas Coleman therefore elaborated a special language for writing the model structure as well as definitions of the user interface elements of the simulator. The language is based on a modified XML

notation. The model is then written using XML files, which are compiled subsequently by a special compiler (DESolver) into executable code of the simulator.

The model *HumMod* is distributed in its source form as open source (the model and the simulator are available to the public at the website <http://hummod.org>). Its structure is written in a special XML language and incorporates 3235 files located in 1367 directories (figure 12). Thanks to this fact, the model equations and their relationships are comprehensible with difficulty, and many research teams dealing with the development of medical simulators therefore prefer to use older models of complex physiological regulations for their further expansions – for example, the models of Guyton of 1972 [19], and Ikeda’s models of

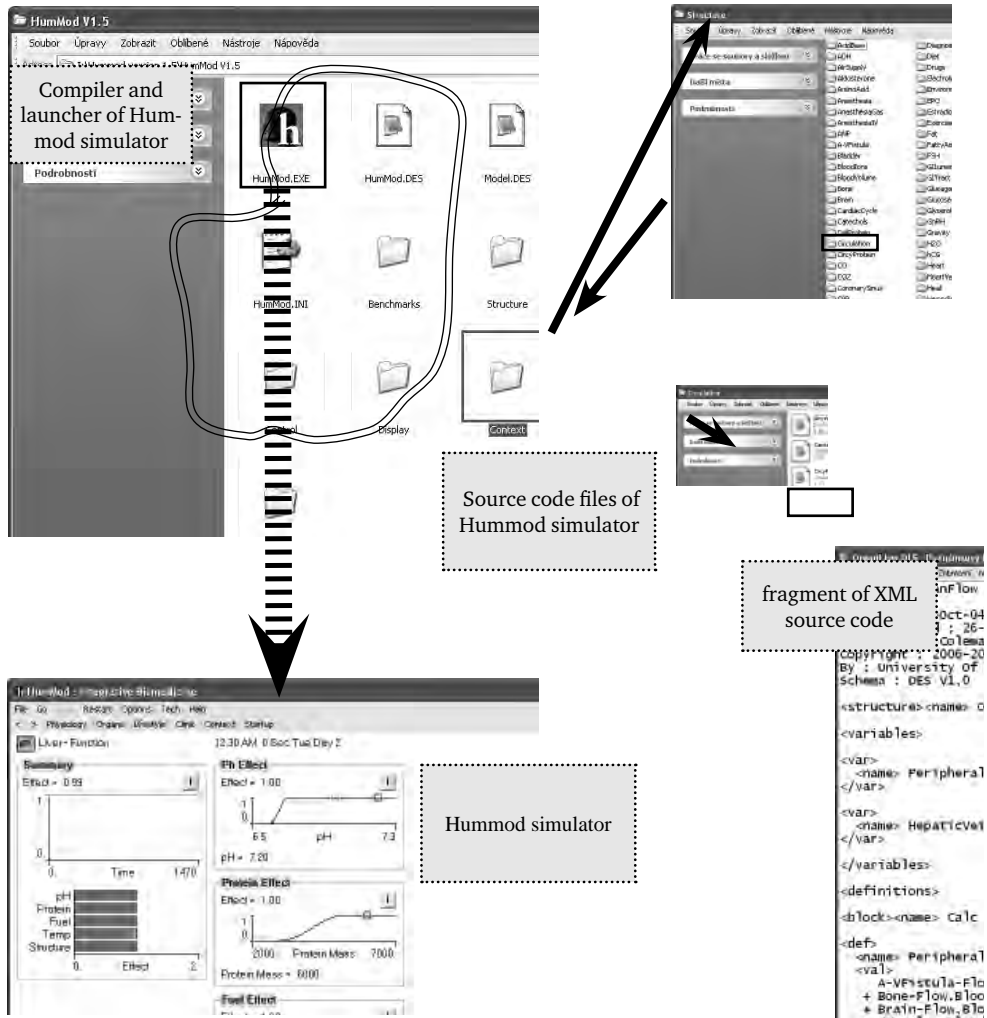


Figure 12: Simulator QHP / HumMod is designed for Windows and does not require a specific installation. Although source code the simulator and the mathematical model of its background is offered as “open source” (and the user theoretically can modify the model), the orientation of the mathematical relationships browsing thousands of interrelated XML files is extremely difficult.

1979<sup>[28]</sup>. This is the path taken, for example, by the SAPHIR (System Approach for Physiological Integration of Renal, cardiac and respiratory control) project international research team as the source texts of QHP model seemed very poorly legible and difficult to understand to the project participants<sup>[73]</sup>. Similarly, Mangourova et al.<sup>[60]</sup> recently implemented an older Guyton’s model of 1992<sup>[7]</sup> in Simulink, rather than the most recent (poorly legible for them) version of the model QHP/Hummod of the team of Guyton’s collaborators and students. We were not discouraged and have established cooperation with the American

authors. We have designed a special software tool *QHPView*<sup>[41]</sup> that creates a clear graphic representation of the mathematical relationships used, from thousands of files of source texts of the model (figure 13). Besides others, this has also been helpful in discovering some errors in the model *HumMod*.

Together with the American authors, we are of the opinion that source texts of the models that are the foundation of medical simulators should be publicly available given that they are the result of theoretic study of physiological regulations – then it is easy to find out to what extent the model cor-

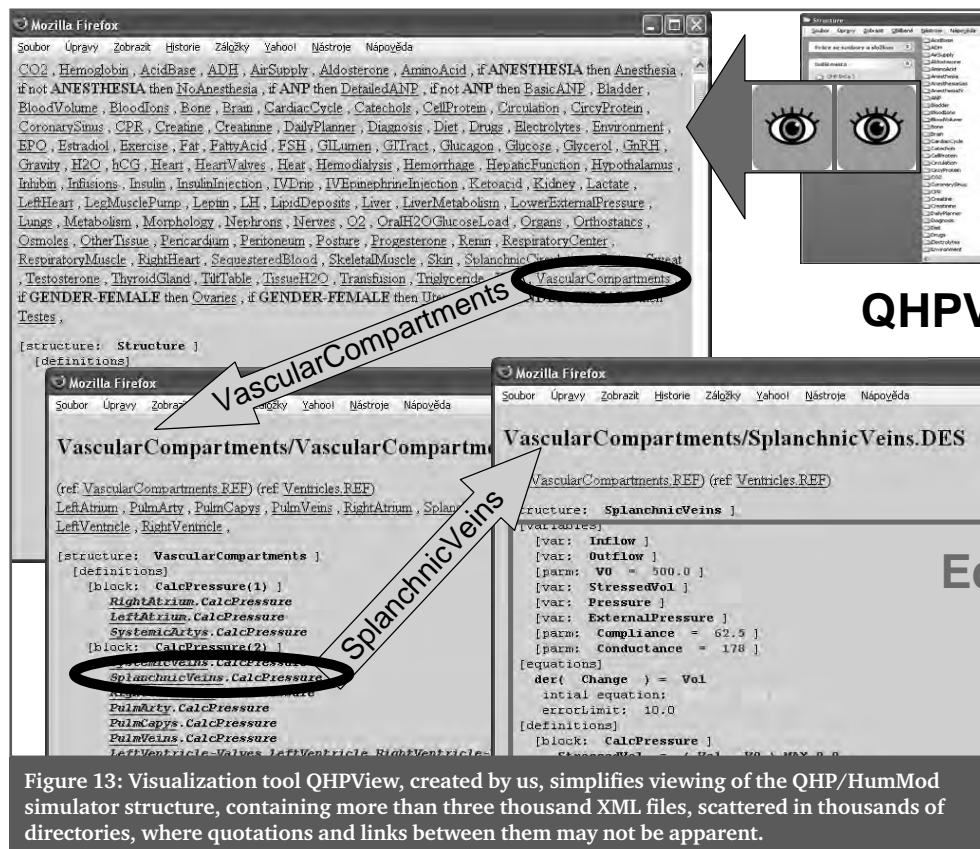


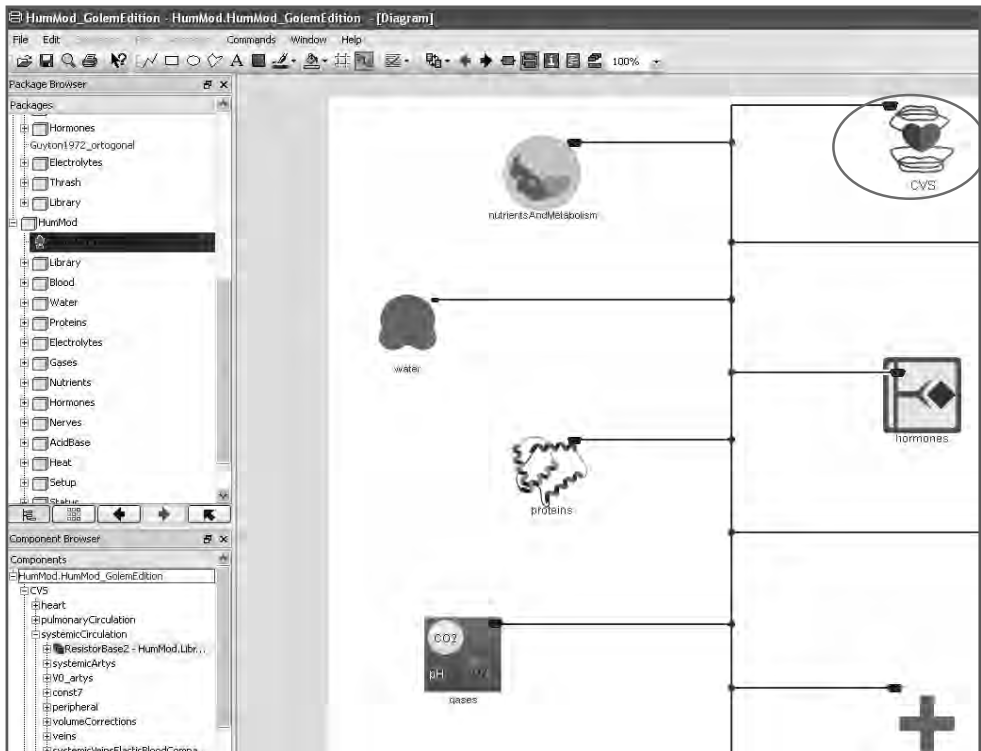
Figure 13: Visualization tool QHPView, created by us, simplifies viewing of the QHP/HumMod simulator structure, containing more than three thousand XML files, scattered in thousands of directories, where quotations and links between them may not be apparent.

responds to the physiological reality. The structure of our model called “**HumMod-Golem edition**” is published at the project website (<http://physiome.cz/Hummod>) in its source form, together with the definitions of all variables and all equations. Unlike the American colleagues, our model is implemented in Modelica, which makes it possible to provide a very clear expression of the model structure.

The model **HumMod** has been modified and expanded particularly in the field of blood gas transfer modelling and modelling of the homeostasis of the inner environment, especially of acid-base equilibrium – considering that disorders precisely of these subsystems occur frequently in acute medicine for which our simulator and educational simulation plays have been designed. Besides others, our modifications stemmed from our original complex model of physiological regulations, namely the core of the educational simulator **Golem**<sup>[37]</sup>.

Illustrations of the hierarchic structure of the model Hummod-Golem Edition are shown in Figures 14–20.

The model allows form simulating a number of physiological and pathophysiological actions – failure of individual organs and organ systems, and subsequent adaptation responses of the body, the effect of any chosen therapy, response to physical load, and adaptation of the body to the change of some external conditions (for example, response to changed temperature). The integrated model of physiological systems **Hummod-Golem edition** is a theoretic foundation of the medical educational simulator **eGolem**. However, its further development and identification are only the first kind of challenges to be faced. Another problem consists in programming the simulator itself as an educational aid. Our aim is to make the simulator available as a teaching aid available through the Internet. Our web simulator design technology described



**Figure 14:** Structure of HumMod model. Model consist of cardiovascular component (CVS), nutrition and metabolism component, water and osmolarity component, proteins component, O<sub>2</sub>, CO<sub>2</sub> and acid-base regulation component, electrolyte component, nervous regulation component, hormone regulation component, status of virtual patient component and setup component. All components are connected with bus connectors.

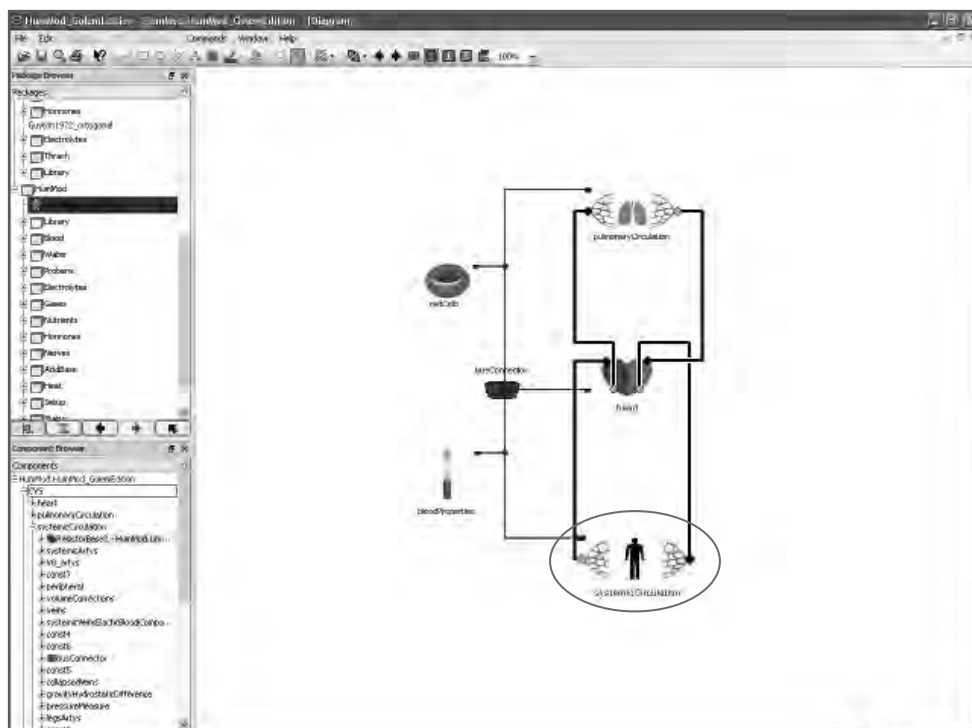
in greater detail in the habilitation thesis (<http://www.physiome.cz/kofranek/habilitacni prace.pdf>) and in [14] will be used in its design.

## 9. From “art” to “industry”

The times of enthusiasts who created the first educational programs at the turn of the 80s, excited about the new potential of personal computers, has long been gone. Today, the design of good-quality educational software capable of utilizing the potential offered by the development of information and communication technologies is not built on the diligence and enthusiasm of individuals. It is a demanding and complicated process of a creative team of specialists from various professions: Experienced teachers whose scenarios provide the

foundation of a good-quality educational application; system analysts responsible, in cooperation with professionals of any given field, for the creation of simulation models for educational simulation plays; artists who design the external visual form of the simulator; and finally, information science specialists (programmers) who “stitch up” the whole application to its final form<sup>[36]</sup>.

For such interdisciplinary cooperation to be efficient, numerous developmental tools and methodologies are needed for every stage of development; such tools and methodologies make the work of individual team members easier and help them to overcome interdisciplinary barriers. Considerable efforts must be devoted to the process of creating and mastering the tools, but it pays in the end. The process of educational program design thus acquires ever more features of engineering design work.



**Figure 15: Structure of systemic circulation component.**

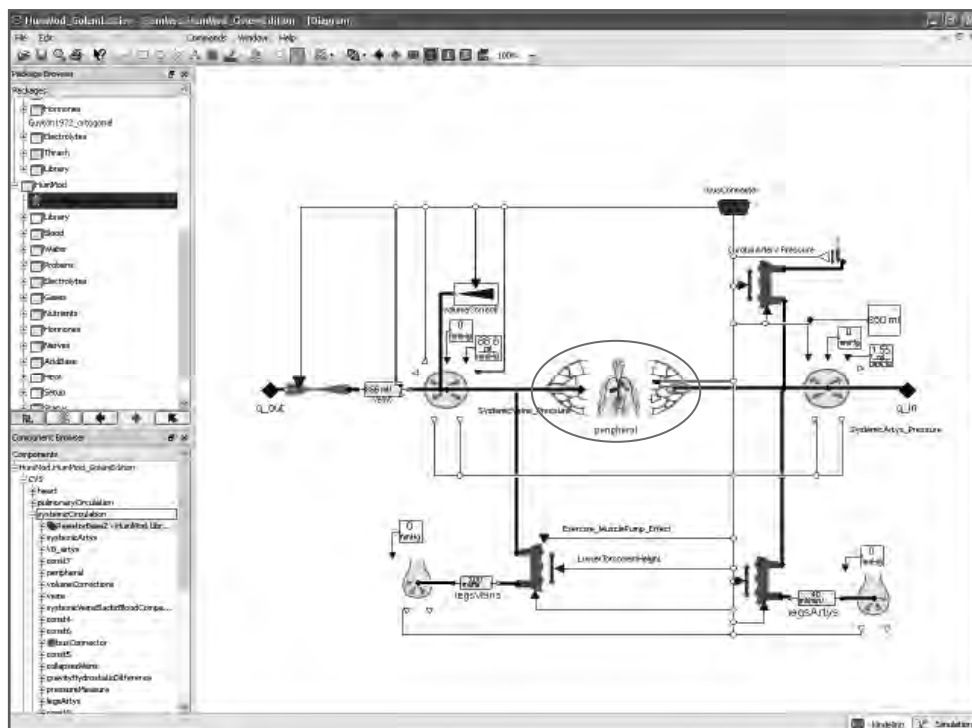


Figure 16: Structure of systemic circulation component (SystemicCirculation class from fig. 15).

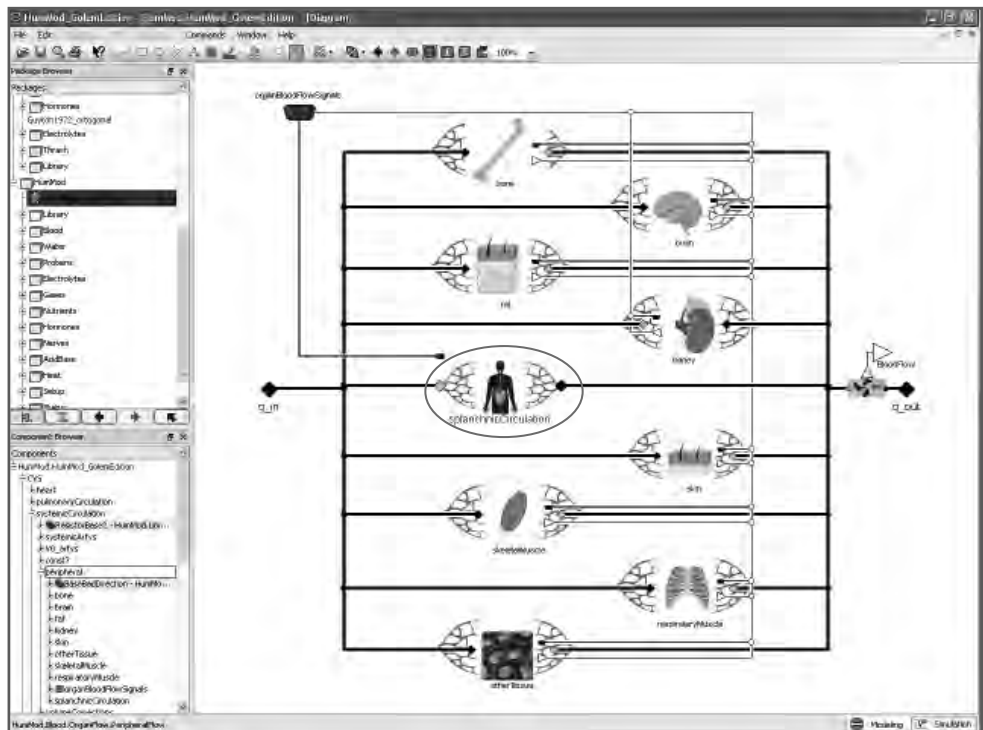


Figure 17: Structure of systemic peripheral circulation component (Peripheral class from fig. 16).

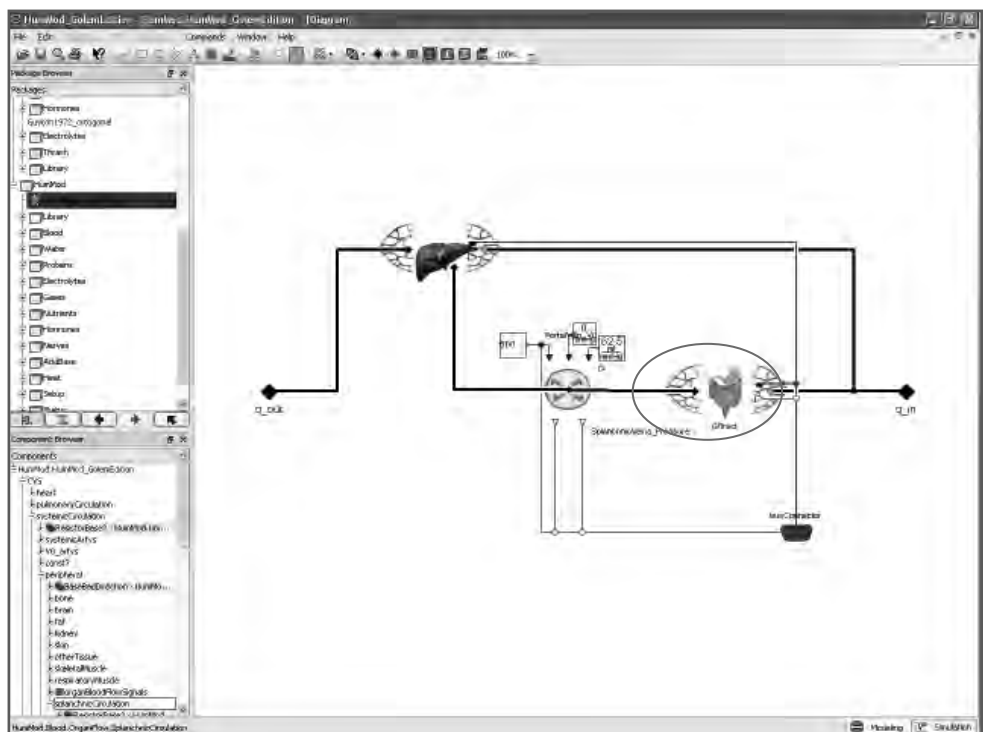


Figure 18: Structure of splanchnic circulation component (SplanchnicCirculation class from fig. 17).

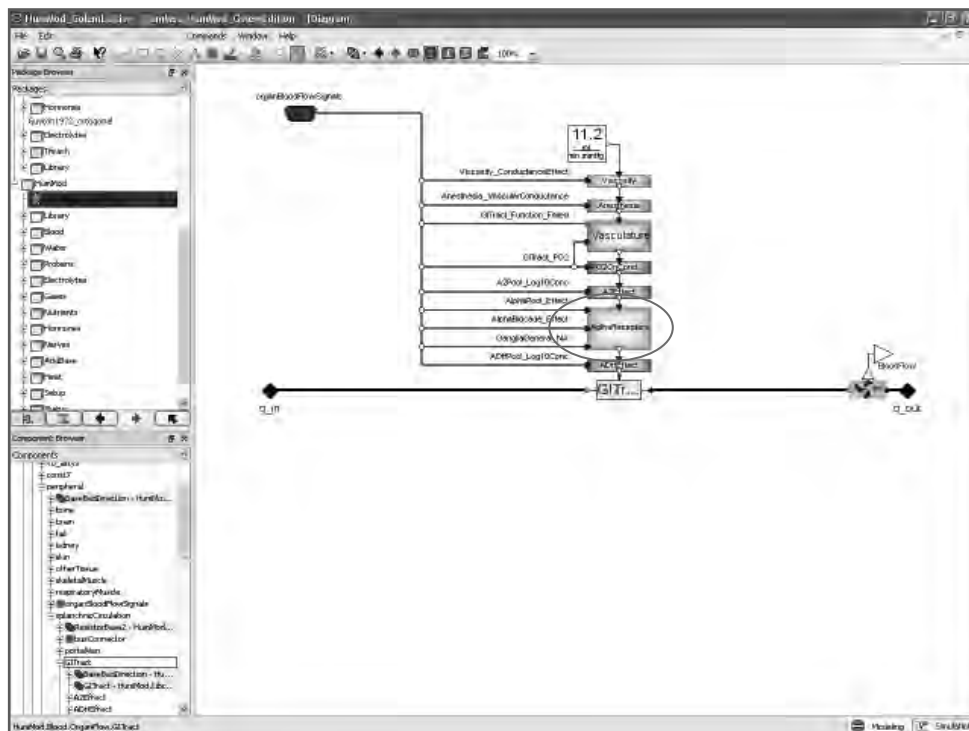
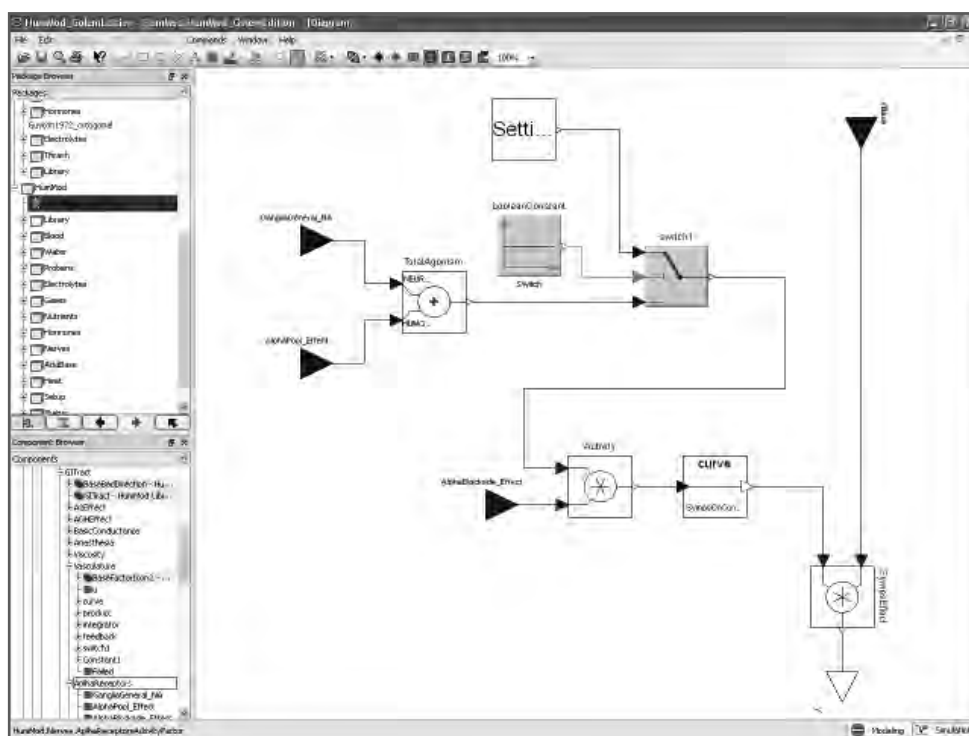


Figure 19: Structure of gastrointestinal vascular resistance component (GITract class from fig. 18).



**Figure 20: Structure of component calculating influence of alpha receptors stimulation on gastrointestinal vascular resistance (AlphaReceptors class from fig. 19).**



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# HISTOLOGY PRACTICAL IN ELECTRONIC FORMAT OF VIRTUAL SLIDES

07

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## Abstract

The aim of this project was to create a new format of practical teaching of histology using digital scans of classical glass histology slides. These “virtual slides” will enable students to study structures of tissues and organs on high quality, variably magnified images simulating on their personal computers microscope-like examination of structures. The core of this e-learning system is our new database of histology practical placed on the teacher's PC and functioning as a server facility in the PC equipped and networked practical room. For each topic of practical sessions we prepared a set of virtual slides supplemented with several supporting documents in Czech and English languages related to the contents of the session. According to our experience and student's evaluations, this new system of histology practical has many advantages over the traditional way of teaching. It provides equal quality of slides for simultaneous study in large groups of students, improves communication and tutoring of students by their teachers, and stimulates student's activity in practical session. It provides bilingual teaching environment to local and foreign students.

## Keywords

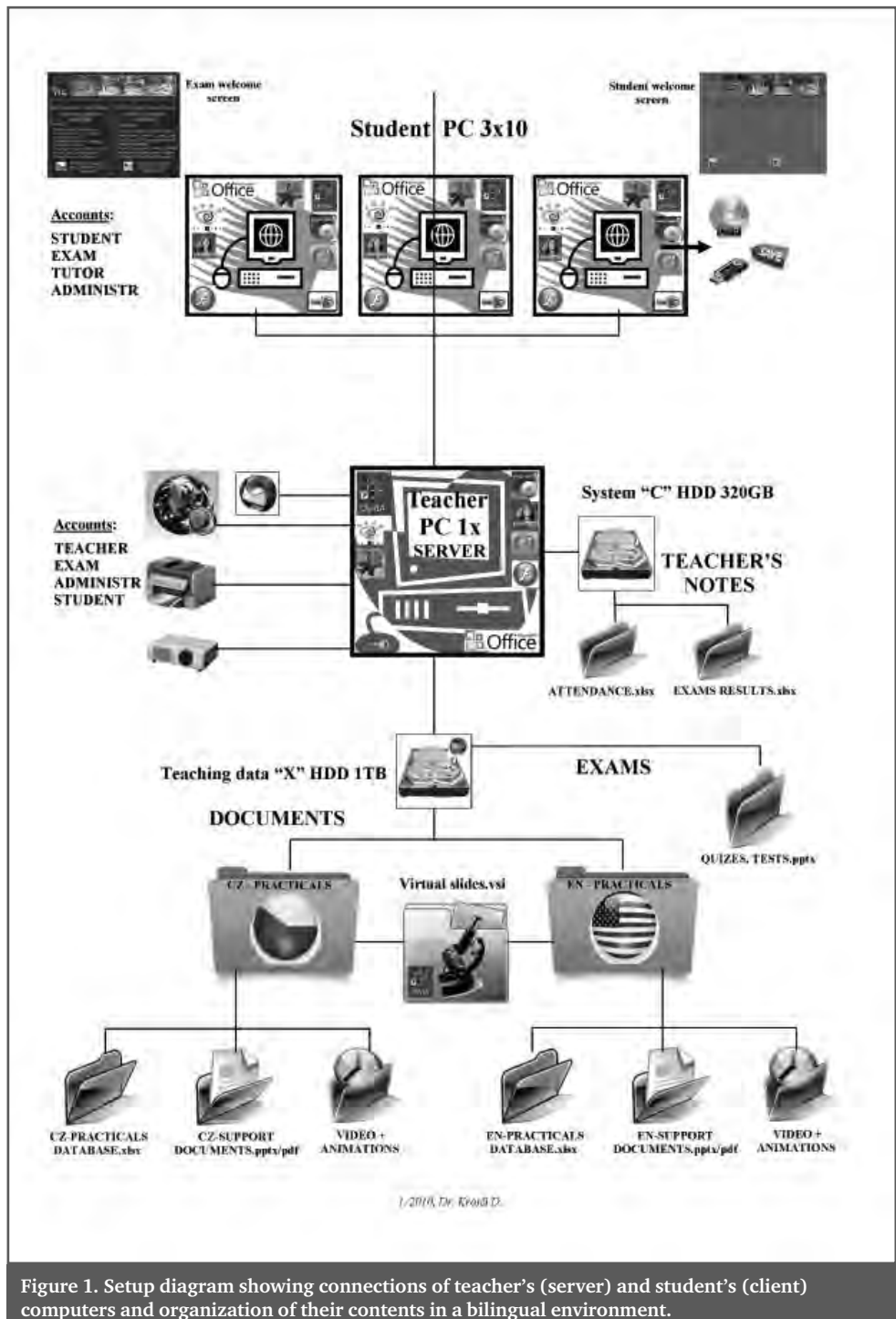
histology, education, electronic practical, virtual slides

## Introduction

In the last decade, we are witnessing a shift from classical educational methods to new methods using various electronic media. Since the years of histology pioneers like C. Golgi, S.R. Cajal and others, the microscopy observation tools and specimen preparation methods changed substantially. All innovations in microscopy equipments have been soon reflected in teaching methods of biology and histology classes. Monocular, sun- or candle-illuminated microscopes were replaced by binocular, self-illuminated microscopes with quality lenses. With the advent of color film photomicrography the practical sessions were supplemented by projection of 5×5 color slides and movies to brief students during pre-lab sessions with structural and diagnostic features of microscopic anatomy of tissues and organs. Later, this teaching format was further enhanced by the use of modern multimedia technol-

ogy like laser discs, CD-ROMs and DVDs with histology contents played back by dedicated hardware players or personal computers (PC) connected to data-projectors.

Despite the variety of supporting educational tools the direct observation of histology glass slides by students remains the most important activity during practical sessions often held in groups of 20–50 students. In order to provide equal contents and quality slides to all participants in the session, the glass slides have to be available in numbers corresponding to the number of attendants, plus a few extra slides to replace broken or lost ones. Emerging digital microscopy technology and newly developed scanning light microscopy systems enable histologists to transfer analog image data of entire slides into digital ones, and to provide them to all students in the class with identical contents and quality<sup>[1, 2]</sup>.



**Figure 1. Setup diagram showing connections of teacher's (server) and student's (client) computers and organization of their contents in a bilingual environment.**

At our Department of Histology and Embryology in Olomouc, we have recently started a major innovation of our system of practical teaching using e-learning methods in delivery of high quality histology virtual slides and supporting documents using PC.

## Virtual slides

The recently adopted virtual microscopy system Dot.Slide (Olympus) provides a possibility of scanning entire histology sections and creating thousands of overlapping images saved in a proprietary file format (vsi).



Figure 2. A view of the histology practical lab with students using virtual slides.

Scanning can be done with standard optical lenses  $2\times$ ,  $10\times$ ,  $20\times$ ,  $40\times$  or  $100\times$  and the integrated autofocus system refocuses each image to guarantee in-focus shots. The preselected scanning coordinates are PC controlled through a motorized specimen stage<sup>[3]</sup>.

Using dedicated viewer software (Olyvia, Olympus) the images can be viewed on local PC or in a web browser as a single image map with variable magnifications<sup>[4]</sup>. Depending upon the size of the scanned area, the files of virtual slides can be quite large (up to a gigabyte or more), but due to the principle of sequential observation of small areas of microscopy images, they are easy to open and quick to reload when changing the field of observation or magnification. With the Dot.Slide software, the resulting images can be color-, contrast- and brightness-corrected to further improve the quality of faded stains in sections. Additionally, the virtual slides can be annotated with flags, labels or arrows and corresponding descriptions of indicated structures. During the slide observation by students, various magnifications corresponding to optical  $2\times$  up to  $400\times$  can be used, the field of view can be moved over the entire section area using a mouse click

and drag commands. The region of interest can be copied to clip board and subsequently transferred to a PowerPoint presentation or another document, where an additional description can be added and saved for later revision study.

In the Olyvia viewer Properties window, students can read additional data about document scanning properties, specimen information, microscope working data and image data. The Image navigator window displays the overview image of the entire section with a rectangle indicating the recently observed part of the image when using higher magnifications. In the Annotations window reference information about preselected regions of interest and annotation flags can be read out. A magnifying selection and zoom tools are also available when observing the image in the main viewing window. A calibrated scale bar can also be displayed in the corner of the viewed image.

## Setup of the practical room local network

Virtual slides can be provided to students in several ways. The original vsi files can be compressed and exported into Flash format



for display on educational website for distant learning, but the speed of internet connection is critical for their smooth display. Virtual slides can be also burned on DVD media for direct personal viewing on home PC, but the large size of digital files and limited capacity of available disk media limit the amount of slides that can be distributed in this way. Olympus Co. offers their Net Image Server SQL database for virtual slides where the slides can be organized and additionally annotated. They can be viewed by a number of simultaneously logged-in users depending upon the number of licenses purchased.

We have decided to create our own closed teaching environment in a computer-equipped and networked class room dedicated to histology practical sessions. It consists of 1 server PC used by a teacher and 30 client PC used by students. The server is a standard microtower PC (Processor Intel® Core™ 2 Duo E8400, 3.00 GHz, 2×2GB RAM, L2 6 MB cache, FSB 1333 MHz, 2×HDD) running on MS Server 2003 Standard Edition, SP2 operating system in order

to serve data to 30 client stations simultaneously. The installed Real VNC Server Free provides remote access to desktops of client PCs, and the Remote Shutdown (server) software automatically shutdowns all classroom computers on LAN network at the end of the session without having to go round to each PC to manually power them down. Application software installed is the Microsoft Office 2007, Olyvia viewer, PDF reader, QuickTime player, Flash player and CD-DVD burning software. The server PC has four accounts set up. Administrator account – with full administrator's rights, Lector account – with partially limited power users rights. Student account and Exam account – with limited user's rights, enable remote access of student's workstations to the server (Fig. 1). The second physical hard drive (X:\) of the server PC is used only for storing teaching data. It contains two shared folders X:\DOCUMENTS and X:\EXAM. The shared folder Documents contains all teaching documents, virtual slides and a database of the histology practical in Czech and English lan-



guages. Under lector's login, these documents can be exchanged, edited, added or deleted for incremental updates. The shared folder Exams is prepared to temporally contain examination materials like MCQ tests prepared for in-practical quizzes, and in-course or final examinations. Under lector's login, examination materials can be written to or deleted from this folder after the exam is over. This folder can be remotely accessed by students for reading only, but no remote copying or saving is allowed in this exam mode.

The students PC are standard ultraslim units running on Windows XP, SP3 operating system, under strict administrator's control with Microsoft Steady State software, Real VNC Client Free software and Remote Shutdown (client) software (Fig. 2). Application software is the same like on the server PC. Client computers have also Administrator, Lector, Student and Exam accounts set up. Students can access only the last two accounts without any login password. When opening the Student account they are presented with a welcome screen where they can select their preferable language of instruction for practical class (Fig. 3). Clicking further on the appropriate icon, they open the contents page of

the database of histology practical. In this login mode, students can read the slide information in the database, view virtual slides as they open in the Olyvia viewer, and read and save to external media all the supporting documents of the practical session. On the other hand, students are prevented to permanently modify or even delete any of the teaching documents. When opening the Exam account, the students can access a folder with pre-loaded examination materials prepared for the current exam. Students can read the exam texts, open examination materials in PowerPoint or Flash formats, but they cannot remotely copy or save any of these documents as the mouse right-clicks and all USB ports are disabled in this exam mode.

## Database and supporting documents

The core of this e-learning system is our own Database of histology practical saved on the X:\ drive of the server PC. It is build up in MS Excel format having the first contents page, followed by practical pages devoted to all 24 topics of general and special histology practical. The practical pages are format-

**PRACTICAL No: 8 - NERVOUS TISSUE**

**HISTOLOGY & EMERGOLOGY DEPT.**  
FACULTY OF MEDICINE, U.P., COLOMBIA

**OLYMPIUS DOT SLIDE SYSTEM**  
Slide total: 11  
Supporting documents:

Slide Properties	Keywords	VSI info	Section overview	Display
Slide n: 105A File name: 01300A_Neurons_Giant_Sm Slide name: Giant multipolar neurons, smear Slide origin: IWARD'S B3M3617, Anatomy, D Body system: Nervous tissue: CNS Specimen: Multipolar neurons, smear Species: Animal Tissue: Nervous tissue: spinal cord Preparation: Fresh smear, this film Staining: Thionin, Neural stain	Neurons, multipolar, smear; Nissl, dendrites, axon; nucleus, nucleolus, glial cells	70 MB Max. 80x Glass: NO		1 J=51 K=70 7-B-3
Slide Properties File name: 0161-SpCord_HE.vai Slide name: Spinal cord, micha Slide origin: HEU - Olinous Body system: Nervous tissue: CNS Specimen: Multipolar neurons, glial cells Species: Animal Tissue: Nervous tissue: spinal cord Preparation: Paraffin, section, 1.s Staining: H&E, stains	Neurons, multipolar, dendrites, gray matter, axon; nucleus, nucleolus, glial cells, white matter, ependyma, central canal, anterior horn, posterior horn	17 / MB Max. 23x Glass: YES		2 J=51 K=60 7-B-3
Slide Properties File name: 0161-SpCord_200.vai Slide name: Spinal cord, micha, Kluver-Barr Slide origin: HEU - Olinous, Prof. Malinsky J Body system: Nervous tissue: CNS Specimen: Multipolar neurons, glial cells Species: Animal Tissue: Nervous tissue: spinal cord, myelin Preparation: Paraffin, section, 1.s Staining: Luxol blue+Crystal violet, Kluver-Barr stain	Neurons, multipolar, dendrites, gray matter, axon; nucleus, nucleolus, glial cells, white matter, ependyma, central canal, anterior horn, posterior horn, myelinated axon, myelin, neurofibrils	614 MB Max. 23x Glass: YES		3 J=52 K=60 7-B-3
Slide Properties File name: 0161-SpCord_Bod.vai Slide name: Spinal cord, micha, Bodian Slide origin: HEU - Olinous, Prof. Malinsky J Body system: Nervous tissue: CNS Specimen: Multipolar neurons, glial cells Species: Animal Tissue: Nervous tissue: spinal cord, neurofibrils Preparation: Paraffin, section, 1.s Staining: Silver impregnation, Bodian method	Neurons, multipolar, dendrites, gray matter, axon; nucleus, nucleolus, glial cells, white matter, ependyma, central canal, anterior horn, posterior horn, myelinated axon, myelin, neurofibrils	632 MB Max. 23x Glass: YES		4 J=52 K=60 7-B-3

Supporting documents:

- OLYMPIUS DOT SLIDE SYSTEM
- SLIDE GUIDE.pdf
- NERVOUS TISSUE PRESENTATION.ppt
- EM PICTURES.pdf
- ANATOMY LECTURE 1.ppt
- YOUR SLIDE 5.ppt

Save your notes to external medium before leaving the PC.

**PRACTICAL no. 8 - NERVOUS TISSUE**

Figure 4. Graphical interface of the histology practical database, topic no. 8, Nervous tissue.

ted as a set of tables containing virtual slide properties, keywords for easy searching of structures in slides across the database, file information data and a slide preview picture at overview magnification (Fig. 4). A cell labeled Comment, related to the overview picture, contains a brief slide-commenting text that opens while the cursor rolls-on. Clicking on a small hyper-texted icon in the corner of the preview image opens the virtual slide directly in the Olyvia viewer.

A sidebar menu, displaying supporting documents of the practical session in pdf and pptx formats, shows their names and provides hypertext connections to open them by a mouse click. The Olyvia User Guide document helps students to master this dedicated viewer. The Slide Guide document contains learning objectives of the current practical session and a brief description of virtual slides accompanied by labeled color photomicrographs taken from these slides stressing the most important diagnostic features to be remembered. Several control questions and references to available internet resources are also included in this document. The Slide Presentation document is intended for use as a pre-lab session tool to make introductory teachers presentation and revision of the subject. Document entitled Presentation of Electron Micrographs shows the ultrastructure of cells and tissues on selected labeled electron micrographs related to the topic of the practical. From this sidebar menu a special folder containing selected videos or animations can also be accessed. The last item on this sidebar is the hypertext connection to open a new Student's pptx presentation, which can be used to save clipboard-copied images and student's notes for later revisions, when taken home on student's external memory media.

## Examination methods

This e-learning system of histology practical can be complemented with innovations of practical slide examinations. Histology is a visual science, where recognition of structural detail of cells, tissues and organs in prepared slides, displayed or printed images is critical for successful identification of organs in normal organisms, and specification diagnoses in pathological cases. In the past, vari-

ous methods have been used for practical exams in large groups of students, like direct slide observation of glass slides under a light microscope, spot exam with identification of preselected and pointer marked structures under a light microscope, spot exam of images displayed on a monitor, identification of images projected on a white screen etc. Having a teacher's PC and a dataprojector we have used in the past the method of projection of images on the white screen for certain period of time requesting students to write their answers into prepared answer sheets. This old system was having some drawbacks. First – students, sitting in benches more distant from the display screen could not resolve some details well, second – lateral communication between students in large examination groups was difficult to control, third – exam had to be done in a dimmed room where writing of answers was difficult. Having a fully computerized practical room we can now apply practical test to thirty students simultaneously using the Exam account login.

## Evaluation of histology practical with virtual slides

During the last decade the virtual microscopy has been introduced as a new histology teaching method at several universities in Europe and overseas. It has been incorporated into courses of human histology, histopathology, dental histology and veterinary histology<sup>[5]</sup>. A web-based virtual microscopy has also become a beneficial tool for histopathology consultations and slide seminars<sup>[6]</sup>. At our Faculty of Medicine in Olomouc, this new format of e-learning based practical sessions with virtual slides has been applied during two semesters of histology classes for medical and dentistry students. It was well accepted and evaluated by students and teachers alike. Students positively valued the high quality and up-to-date technology displaying the virtual slides and the other supporting documents (Fig. 5). They have been able to ask for explanations of cells or tissues while pointing exactly at the structures on their monitors. This feature improved communication between students and teachers

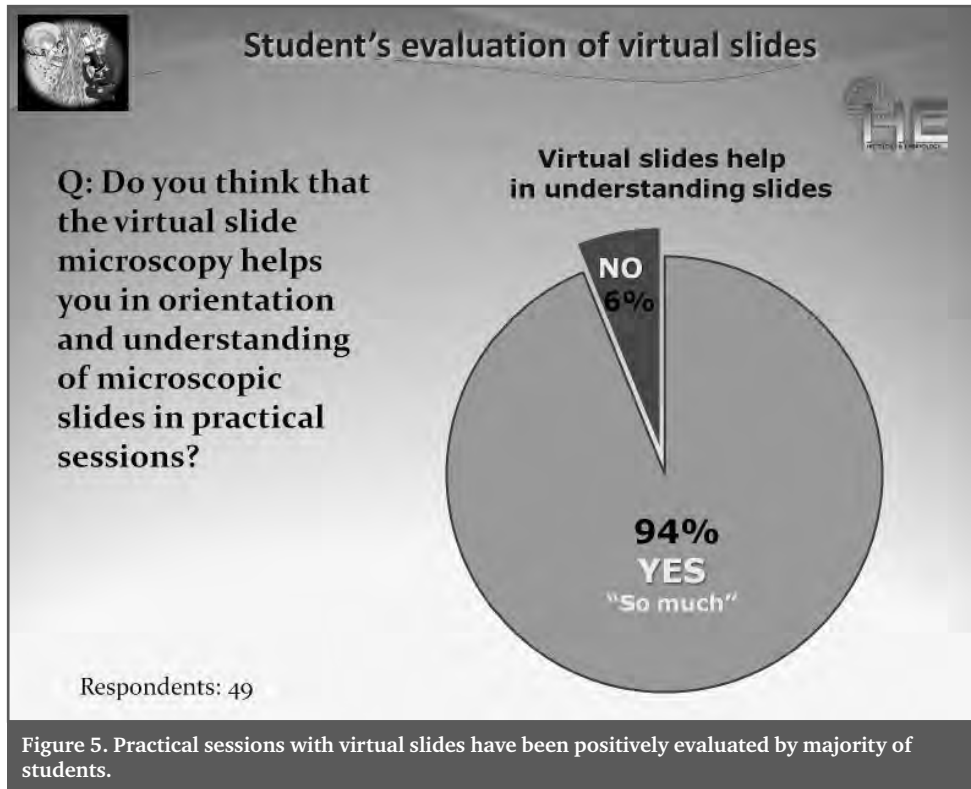


Figure 5. Practical sessions with virtual slides have been positively evaluated by majority of students.



Figure 6. Communication between teachers and students is easy and straightforward when searching for structures in virtual slides displayed on monitors.

and improved their understanding. It also improved hygiene environment for tutors as they no longer needed to lean over shoulders of students in order to share with them eyepieces of classical microscopes to know which structure in question is to be helped with, identified or explained (Fig. 6). With the help of supporting documents included in each practical, students were able to work independently while still having the tutors within their reach.

The observation of virtual slides is a highly interactive activity that stimulates students to observe slides at various magnifications and to select themselves the most typical fields of view for correct identification of the studied organ. They can also compare their virtual slides with identical virtual slides being simultaneously projected on the classroom white screen and commented by teachers. The active observation of virtual slides prevents students from simple memorizing static images in atlases or slide shows. They can now observe large areas of histology sections and understand morphological and functional relations of different parts of microscopic anatomy of organs. They are helped in their orientation with the image navigator window being continuously on display in the main observation window.

With the screen-printing function of the Olyvia viewer, students were able to create their own presentations that helped them with later pre-exam revisions of the practical part of this subject. Their self-created PowerPoint files with micrographs and text legends fully substituted the hand-drawn and written practical notes used in earlier years of histology practical teaching. Students have also been able to demonstrate these presentations during tutorial classes. This form of in-group presentation of teaching materials and student's notes substantially increased their interest and activity during hours of practical sessions of this preclinical medical subject. It stimulated students in their self-dependent learning activity when observing and identifying histology slides and, on the other hand, this method provided a good tool to teachers for their concurrent control of student's activity in large groups. Our own database of histology practical enabled us to bring various teaching materials, multi-

media resources and virtual slides into one integrated teaching system, which provides identical learning contents to all students in the class. The database can be easily updated with new virtual slides and documents. When using the virtual slides, the physical glass slides no longer need to be available in hundreds of copies, and also some rare, historical glass slides or slides prepared with special staining methods can now be safely presented to students. The database of histology practical is build in a simple yet effective format of MS Excel spread sheet, that can be open in every PC running MS Windows operating system having MS Office pack installed. The server-based configuration of our local class network runs smoothly even with the full load of thirty student's PC in use. The delay in loading and magnifying virtual slides on client PC is negligible, and multiple supporting documents open quickly as if they were saved directly on student's PC. This virtual slide-based e-learning system can be supplemented with an electronic form of in-course and final examination of practical knowledge and observation experience of students. Tests and quizzes containing MCQ format questions with quality micrographs and also theory questions can be easily delivered to students PC during practical sessions or special examination days. Continuous reshuffling of sequences of questions and answers and the automatic evaluation of results makes these PC based assessments fare and objective.

## Conclusions

The system of teaching practical histology with virtual slides and supporting document represents a major innovation in didactic methods of this morphological science. It substantially improves delivery of the practical contents to large groups of students and stimulates their active engagement during practical sessions. It helps teachers to overview easily the activity of students in the practical room and also to deliver explanation and tutorial activity to individual students. It creates a good environment for in-group revisions and examinations in the PC-networked classroom. Due to the use of modern technology, this system attracts attention of students and makes this sub-

ject more interesting to study. This method of teaching improves interactions between students and teachers. It also provides equal learning opportunities in bilingual educational environment. When made available on a learning portal, this system can be easily used also for distant learning.

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## 08

# FROM EDUCATIONAL MODELS TOWARDS IDENTIFICATION OF PHYSIOLOGICAL SYSTEMS

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## Abstract

Modeling gives a simplified view on the physiology of human body using mathematical equations nevertheless non-trivial relations could be seen. Validation of a model means that the modeling physiological system is compared with the reality on a patient. This validation consist of estimating quantities, which are not usually measurable under normal condition. Validating of an educational model and so-called identification of physiological system could be done using optimization algorithms. We show an identification method on the last model HumMod. For computation purpose we utilized computation capacity of the desktop PC on laboratory and formed a desktop grid system based on well known BOINC.

## Keywords

identification of physiological systems, desktop grid

## Introduction

Atlas of Physiology utilize new opportunities of multimedia and simulation models. These models connected with multimedia application can educate students of medicine the aspects of human physiology and demonstrates how the physiological systems are interconnected<sup>[1]</sup>. The models were described by causal and non-hierarchical languages in the past, e.g. in Matlab/Simulink, which describe the process of the computation. An essential innovation introduced by new “acausal” tools consists in declarative (thus acausal) writing of models when individual parts of the model are described directly as equations and not as an algorithm to solve the equations. We are in the process of making our own development tool for this perspective modeling language Modelica, which shall make it possible to generate the resulting model in the environment Microsoft .NET<sup>[2]</sup>.

## Identification of parameters

With cooperation of partners from clinics and laboratory we are researching methods that will improve computational abilities to support comparison of measurements with a computed physiological models – so called identification of physiological systems. Some of the parameters are not measurable by any technique or it's hard to measure them. The identification of a parameter is a process to determine values of such model's by numerical methods finding local minimum or maximum. We've tried the simplex method<sup>[3]</sup>, conjugate gradient method<sup>[4]</sup>, genetic algorithms (CMA-ES), simulated annealing, multistart methods and inversion methods ANNIT<sup>[5]</sup> and isometric methods<sup>[6]</sup>. The mentioned methods were implemented in MATLAB, where models describing physiological system are compiled from Modelica

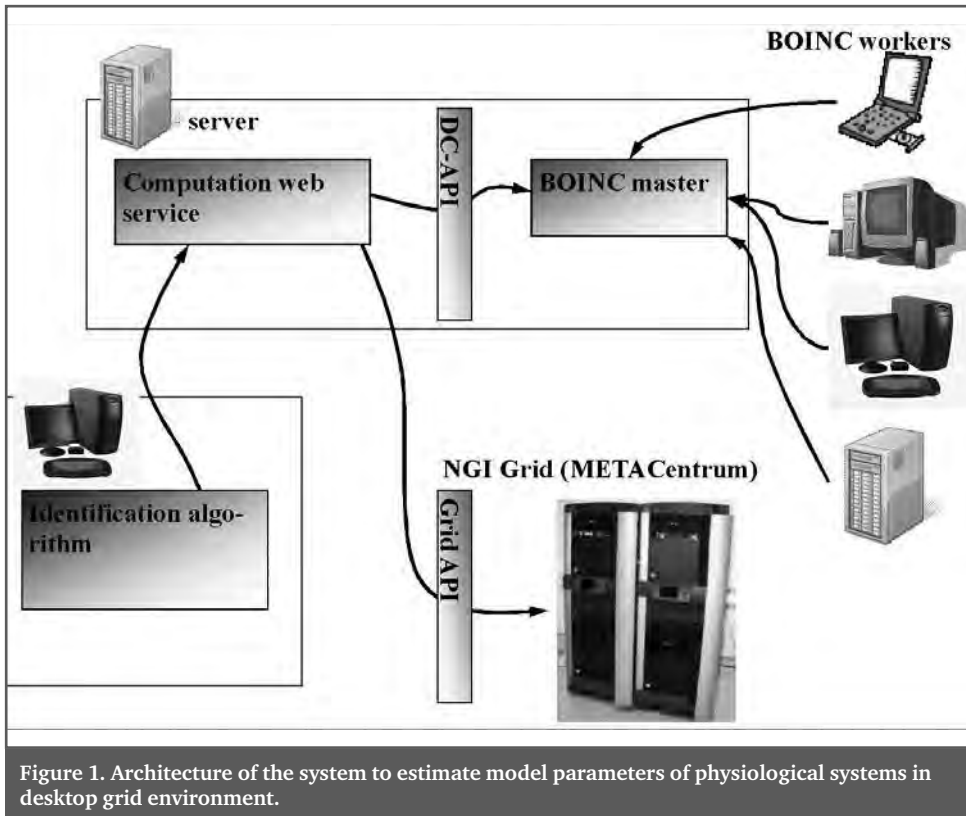


Figure 1. Architecture of the system to estimate model parameters of physiological systems in desktop grid environment.

language as library of evaluating function in C++ or .NET which can be called from MATLAB directly.

## Distribution of computing task to computation grid

The estimate of parameters needs to search multidimensional space and is demanding on computation time. Our preliminary estimation shows that some tasks may take more than hours, days, weeks. Thus there is an effort to develop a system which will integrate technologies of parallel distributed computing with the optimization methods to estimate parameters and identify parameters of physiological models. The aim is to decrease the amount of time needed to compute the parameters from models.

The architecture of the system on the fig. 1 consists of identification algorithm, implementing one of the mentioned optimization method. When there is need to compute a subtask the identification algorithm

may call a remote SOAP web service which can distribute the computation task among multiple connected computers. The computation tasks may be distributed to the final computation nodes (computers which computes the task and returns the result) using desktop grid API DC-API and system BOINC well known from e.g. seti@home program<sup>[7,9]</sup>. This type of grid can be based on voluntary effort. Anybody can join his computation resources to the grid downloading small universal client application and select which computation project can use his computation resources. Such grid is built not only by fast powerful server machine but also by usual desktop PC and notebooks.

The web service part of the system is deployed on virtual machine which is part of the virtual infrastructure built with a pilot test project Globus MEDICUS in CESNET network<sup>[8]</sup>. The same virtual machine hosts a server part of BOINC system which acts as a web page and distribution point for computation tasks. The client side of BOINC is universal and a user selects web page of project.



The BOINC client downloads specific binary files belonging to the selected project from the project server. Any task is split into smaller tasks by the master process on the BOINC server. BOINC client then connects to a BOINC server periodically and asks for new tasks to compute. Results are sent to BOINC server and processed and joined by the master process to the final result.

To implement identification of physiological system using BOINC system, there were implemented only master process and project binaries which were integrated with universal BOINC server and BOINC client. The connection between BOINC client and BOINC server is initiated by the client side. Thus the client may be deployed generally behind any firewall. Only connection via HTTP should be permitted, thus a BOINC client may reside on any place connected to the Internet.

The proposed system may be integrated with a national grid initiative METACENTRUM, which provides a computation grid based on shared environment of virtual machines connected within CESNET network. But this option was not tested.

## Summary

The introduced system produces first results which show that the optimization method used by identification algorithm may be distributed among several desktop computers and may reduce time needed to wait for final results. The results also show that the system based on grid technologies is appropriate for batch-like long-term tasks where there is no strict demand on time of result delivery, but there is expectation that the time will be significantly lower than the time of computation on single machine.

Some of the applications based on physiological models would need more interactive cooperation with the computation part of the system. This is not appropriate for grid systems in general.

The models could be used not only as a part of educational application, but also as a base for estimating unknown parameters during research and estimation of further development on the real patient. The further development of such system may be beneficial also in simulating further development of pathological condition on the real patient.

## Acknowledgement

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## 09

# THE USE OF VIRTUAL MICROSCOPE IN HISTOLOGY TEACHING

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## Abstract

The paper presents a system for teaching histology using virtual microscopy. The complete set of histological slides was digitized by digital ScanScope scanner from the company Aperio. Using ImageScope Viewer software, virtual slides can be viewed in high resolution and quality. A virtual microscope used in histology practical exercises offers a lot of advantages and opportunities, which are appreciated by both, students and teachers.

## Keywords

histological slide, digitized image, virtual microscope

## Introduction

Practical exercises in histology take place in the microscopic hall with capacity of 66 working sites. Each site is equipped with high-quality light microscope (Nikon or Olympus) and a set of histological slides (their total number in set is 100). Students are divided into 3 groups (about 20 stu-

dents/group) and each group has its own teacher. The previously existing system of education was based on an individual study of slides in the light microscope without good accompanying projection centrally controlled by teacher. It places high demands on teacher's individual work and consultations with each student.

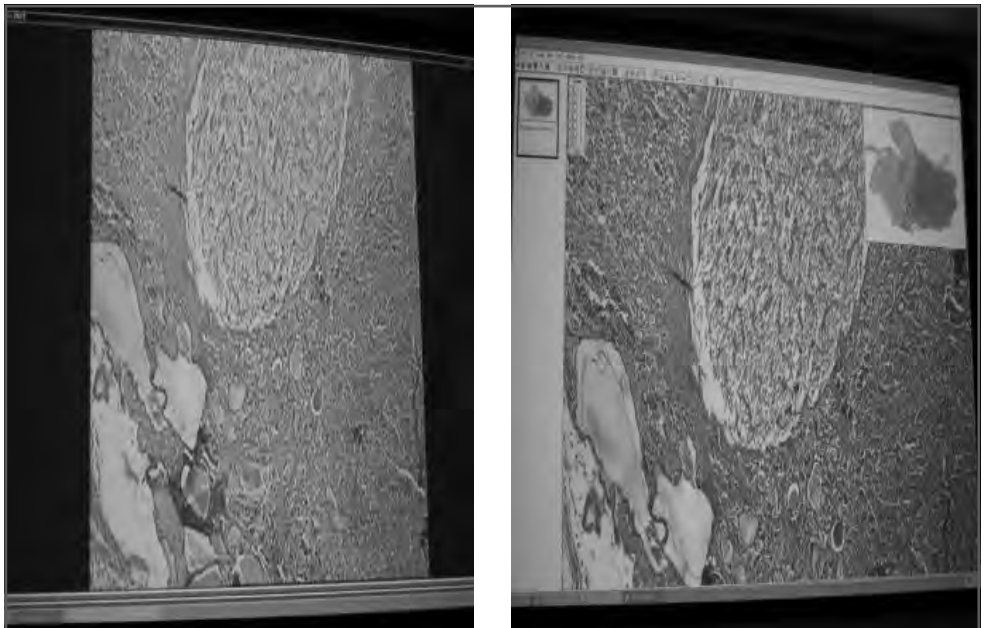


Figure 1. Projection of slide from classical microscope with camera (left) and from virtual microscope – Aperio (right): Aperio shows an overview of the whole slide together with details in selected area.

This system was later supplemented by a screening of examined slides on a TV monitors through a camera installed on demonstrating microscope. Image quality, however, did not correspond to the needs and sometimes the reality, and each exchange of slide requires manual correction (light intensity, focusing, color tuning, etc.).

In 2008, we have completed set of digitized histological slides using digital ScanScope scanner from the company Aperio, a provider for digitizing video microscopic slides. Slides can be viewed with ImageScope Viewer software.

### Experiences with Aperio

A collection of digitized slides captured by ScanScope scanner (Aperio Technologies, Inc.) represents now, the third year, an essential educational tool for our students and teachers. During digitization, a total of 140 histological slides was scanned and the objective magnifying 20× was used. Virtual collection of specimens, having 12 GB, was prepared. Images were saved and can be viewed with ImageScope Viewer software, which is free to download on producer web-

site (<http://www.aperio.com/documents/>). The images achieve high resolution and quality.

The advantage of Aperio using is the ability to zoom and view the whole extent of tissue section on the slide and further enlargement and details study from any site on slide (Fig. 1 and 2). Details can be highlighted by using of magnifying glass. These functions simulate functions of the classical light microscope, but in incomparable output picture quality and without manual work with objectives and adjustment knobs. Aperio connected with FULL HD data projector ensures required quality of the accompanying projection. The system offers many other technical achievements e.g., insertion of description, graphic signs, the ability to measure the size or distance of the structures in slides. The image without or with graphic adjustment can be recalled and/or printed with regard to the needs for teaching. Quality of image projected from classical microscope with camera and from virtual microscope – Aperio can be compared in Fig. 3. Better quality of virtual microscope image is evident (brightness, sharpness). The colors

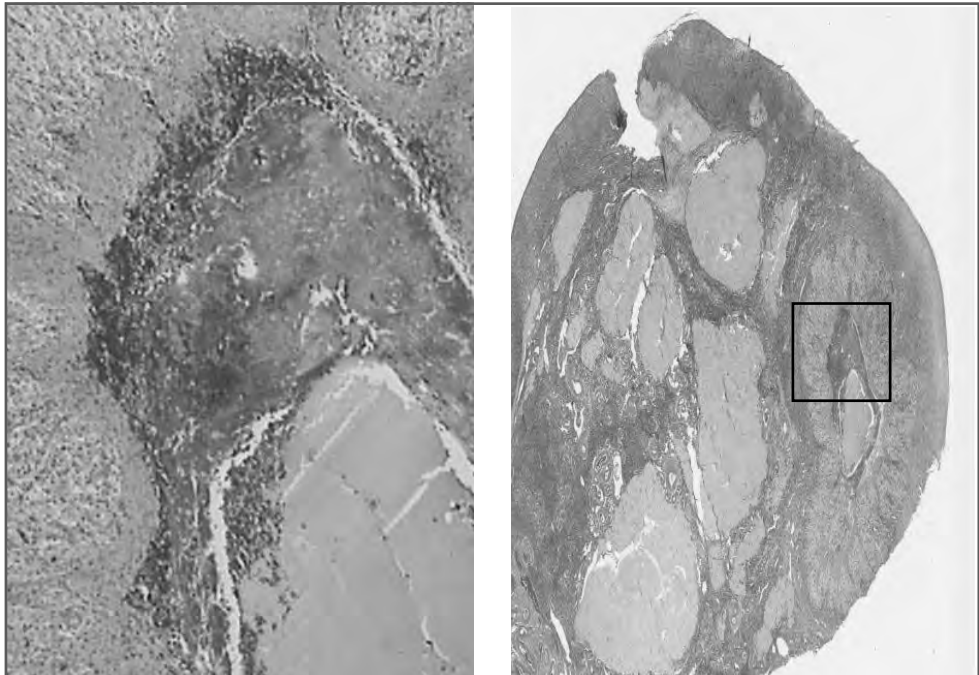


Figure 2. Projection of slide from classical microscope with camera (left) and from virtual microscope – Aperio (right): The smallest magnification in classical microscope is not able to demonstrate the whole slide. Aperio demonstrates it and is able to enlarge image continuously in any selected region.

in the projected image correspond to reality (it cannot be demonstrated in figure).

An involvement of all students together into the study of slides helps teachers and students intensely and effectively cooperate during practice. Paradoxically, teacher has more time for individual consultations with

students. This is the result of better organization of work.

Unquestionable economic benefit can be mentioned finally. Virtual collection created by Aperio system eliminates equipment maintenance costs (acquisition and transport of biological material, chemicals and

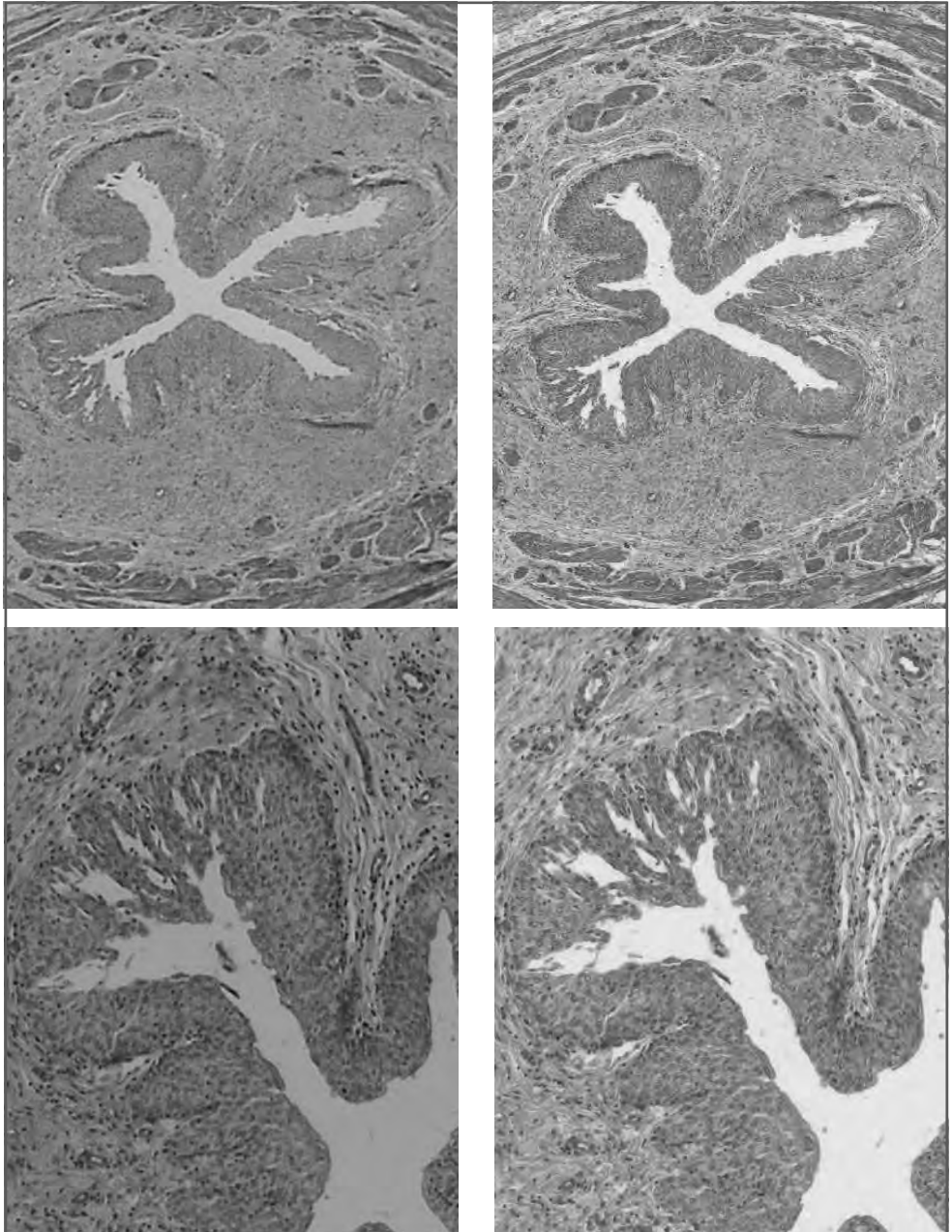


Figure 3: Projection of slide 40 $\times$  and 100 $\times$  magnified from classical microscope with camera (left) and from virtual microscope – Aperio (right): Better quality of virtual microscope image is evident (brightness, sharpness, true image of colors cannot be demonstrated).

Table: Camera vs. Aperio – comparison of some properties.		
	CAMERA (classical microscope)	APERIO (virtual microscope)
monitored area of slide	is limited by the size of visual field	overview of the whole area
handling the microscope	manual:	PC mouse:
objectives (lenses) replacement	manual	continuous zoom + magnifying glass
exchange of slides	slide storage (box)	virtual slides
focusing	adjustment knobs	automatic
graphic adjustment	no	yes
measurement of slide compartments	(yes)	yes
print of pictures during microscopy	no	yes
screening of more slides together	no	yes

Differences in quality of pictures created by camera and Aperio are seen on Figures 1–5.

glass purchase and storage of new slides). An expensive service of microscopes can be also reduced by using of virtual microscope, but the need the microscopes cannot be eliminated completely. The work with the microscope should be one of many practical experiences for medical students.

Conclusion

The primary and main purpose of acquisition and use of the virtual microscope in teaching histology was the effort to engage

students in intense and effective study during practical exercises and to facilitate cooperation among students and with teachers. Expected improvement of histology study has been confirmed in practice during past 3 years of virtual microscopy use. The further planes for Aperio use are 1) updating of current slide collection and its transfer to internet and 2) digitization of similar collection of histological slides of embryo.

## 10

# EDUCATIONAL TOOLS AT WEB PAGES OF THE DEPARTMENT OF HISTOLOGY AND EMBRYOLOGY IN THE FACULTY OF MEDICINE, HRADEC KRÁLOVÉ

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## Abstract

The authors inform about two items that belong to a larger spectrum of electronic educational objects. The mentioned tools are available at Internet pages of the Department of Histology and Embryology in Hradec Králové. In the atlas of histology, the first part is processed. Here “virtual microscopy” is offered to users. Microscopic images cover extensive areas of histological preparations which include human (and exceptionally also animal) tissues and organs. The photographed histological preparations are routinely stained and come from standard sets of slides which are used in the practicals of the pregradual medical study programme. Moreover, the atlas contains also non-standard preparations: paraffin sections where the tissue components important for diagnostics (eg, reticular or elastic fibres, mucus, glycogen) were detected; semi-thin or, on the contrary, unusually thick histological sections; immunohistochemical detections. These preparations reflect the progress in histology as well as its modern (functional) conception and also respect that histology must be vertically bound to other medical disciplines, especially pathology. The following electronic tool serves for embryology education. The picture atlases (in Czech and English versions) demonstrate two different developmental stages of the human fetus in histological sections. At present the atlases include classically stained preparations of the fetal organs. As correlatives to these sections, immunohistochemical preparations will be added. A bilingual text which elucidates developmental stages and histodifferentiation of the organs involved in the atlases is also available.

## Keywords

e-learning, atlases, histology, embryology

## Histology atlas: The concept and first part of the atlas

Electronic histological atlases equipped with a rich picture documentation are able to fill in a noticeable gap which exists in the contemporary Czech printed education literature. Standard Czech histology textbooks, on the one hand, present an abundant and well researched explanation which is necessary to understand deeper relations in this discipline. On the other hand, the picture material (i.e., micrographs of histological preparations), which unquestiona-

bly has a key importance for morphological branches, uses to be insufficient in these textbooks. This fact is caused mainly by economical reasons – high prices for colour textbooks or atlases. But on the staining properties of microscopically examined cellular or tissue components, the correct diagnostics, not only in histology but especially in histopathology (which is tightly related to clinical disciplines) depends very often. Immunohistochemical detections represent the most important proof of this reality. The authors present the concept and first part of an electronic Histology Atlas which is based on histological preparation images that ena-

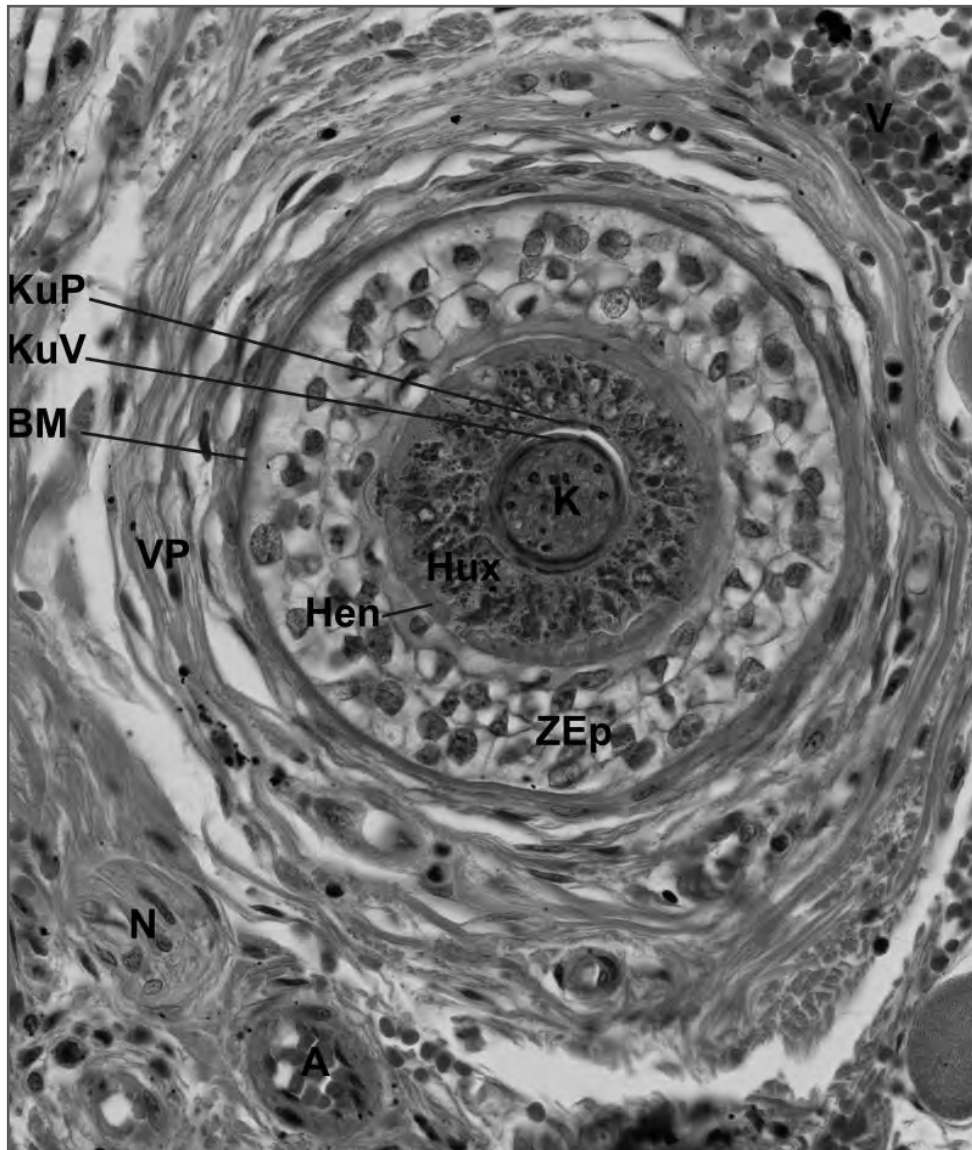


Figure 1. Slide of the human hair (included in Histology Atlas). The image can be observed by the way of virtual microscopy.

ble “virtual microscopy”. At present, the atlas comprises about 50 images which were taken with a kind permission of Assoc. Prof. J. Feit, MD (Department of Pathology, Faculty of Medicine, Masaryk University, Brno). The mentioned technique enables to scan many fields (“tiles”) in one histological preparation. Small micrographs are subsequently arranged into the mosaic, ie, into the picture of the complete histological preparation. Newly we are changing the Brno device because we have the possibility to use the appliance MIRAX SCAN (Zeiss) for a further

creation of our virtual slides. The access to this appliance was kindly provided by Prof. A. Ryska, MD, Ph.D. (Fingerland Department of Pathology, Faculty of Medicine in Hradec Kralove, Charles University in Prague). The virtual slides can be studied similarly as classical histological preparations in the true microscope: with the use of larger magnifications the observer reveals new, in smaller magnifications hidden details at the computer monitor. By the moving of the image, the illusion of the work with the microscope is provided. The images are sharp at all mag-



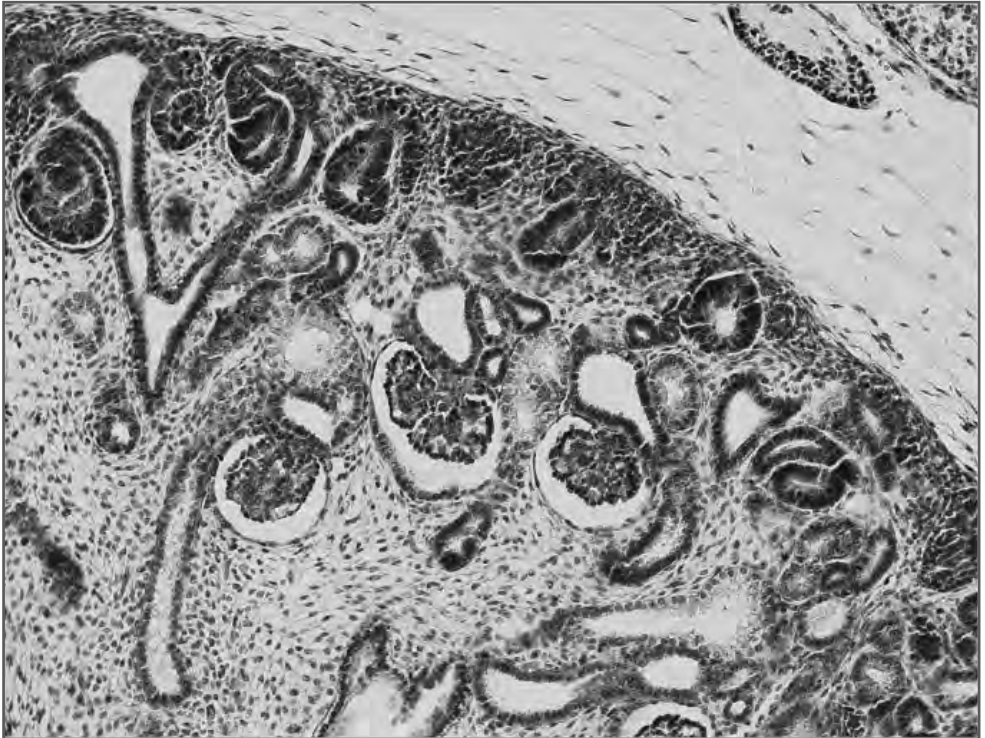


Figure 2. Micrograph of the human fetal kidney (included in Embryology Preparations).

nifications. This makes the impression as if the microscope objectives are changed. The images in our atlas are furnished with uniform symbols which are referred to in the related legends installed below. The symbols can be either hidden or revealed successively. It is advantageous for the self-study purposes. The inset with a small floating window in one corner of the image makes the orientation in higher magnifications easier. The first series of our images is scattered into various chapters of the atlas. The aim of the work at this phase was to demonstrate what possibilities will be given when this atlas is finished. Therefore, included are virtual slides of the luminal organs – eg, of the colon, uterine tube; images of the parenchymatous organs – the liver, parotid gland etc. To demonstrate the spectrum of histology staining methods, different techniques which visualize important cell or tissue components (mucus in cells of the intestinal epithelium, reticular fibres in basement membranes or in the stroma of lymphoid organs, insulin in endocrine B-cells of the pancreas etc) are present.

The whole project is to be cover complete human histology – cytology, general histology and microscopic anatomy. As a side issue (one thematic field only) embryology preparations will be included. In a separate chapter histological techniques which are important for histological (or histopathological) diagnostics will be demonstrated. We will lie back not only on classical paraffin histological sections which are required for the practical part of the examination in histology. In the atlas, contained will be also untraditional light microscopical preparations – sections in different embedding media, eg, in plastic resin; semithin ( $1\ \mu\text{m}$  thick) or unusually thick (20 to  $100\ \mu\text{m}$ ) light microscopical sections; sections prepared with the use of special staining techniques including immunohistochemical detections and also examples of electronmicrographs (which were taken on the transmission electron microscope). Thus the user of the atlas will not be given only the target needed to pass the histology examination. According to the interest a reader of the atlas will have the possibility to acquire a wider knowledge.

The atlas, in its final form, will be dedicated to pregradual students of medicine. Our goal will be to help the students in their self-study but we also plan the utilization of individual chapters of the atlas in educational lectures, practical classes and especially in revision seminars. At present the first part of the atlas is available at web pages of the Department of Histology and Embryology, Faculty of Medicine in Hradec Kralove. The admission to this tool for our students is possible via the faculty computer network but also via another way (the information is available in the atlas).

## Atlas of slides in embryology

The picture atlases of embryological microscopical slides (Embryology preparations – available in Czech and English versions) document two various stages of the human fetus. Micrographs taken by the digital camera Olympus DP71 (combined with the light microscope Olympus BX51) demonstrate the pulmonary tissue and pleura, liver, small intestine with the mesentery, pancreas, lymph node, kidney, suprarenal gland, testis and epididymis of the 12 to 13-week fetus and the fetus in the 17<sup>th</sup> week of development. At present the two mentioned

series of images comprise routinely stained (H & E) paraffin sections. Now the spectrum of the examined fetal organs is enlarging. As correlations to the mentioned classical sections: a) new preparations stained with special histological staining methods (Masson's trichrome, Gomori's technique for reticulin, van Gieson & elastin, alcian blue) and b) preparations with various immunodetections (for nestin as the marker of neural stem cells, newly formed endothelium etc; for desmin – the marker of muscle tissue; for vimentin, von Willebrand factor and S 100 protein – ie, antigens of mesenchymal tissue; for PCNA which detects proliferative cells) are gradually added. By this way, histogenesis of developing organs is more precisely elucidated. The micrographs in atlases are accompanied by a bilingual educational text which is outlined to stimulate the student. An active approach to the presented topics is demanded. The atlases of embryological preparations and the corresponding texts are dedicated for practical classes in embryology. Consulting these tools during the practicals, the students have the possibility to observe true microscopical sections. Moreover, the protocols which are included in the texts contain outcomes which can be monitored and controlled by the teacher during the practical.

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(Prepared to be published at <http://moodle.lfhk.cuni.cz>)
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(Prepared to be published at <http://moodle.lfhk.cuni.cz>)

## 11

# VIDEO – A SUITABLE TOOL FOR PRACTICAL TEACHING OF PHYSIOLOGY?

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## Abstract

Physiology is one of the essential theoretical fields of study at a medical faculty. Since physiology is an experimental discipline, it was taught with the help of experiments on animals in the past. Students performed physiological experiments on species commonly used in laboratories. In the last decades of the previous century, the attitude of society as well as our students regarding experiments on animals started to change. We often encountered situations in which students refused to perform biological experiments pointing out their inutility. After the Act No. 246/1999 on animal protection was passed, we decided to stop using experiments on animals for teaching purposes and to replace them with other alternative ways of teaching, particularly with educational films. Our experience shows that a simple watching of videos leaves a minimal memory trace, which is why we decided to make educational films with interactive features (diagrams, charts, animations or assignment for students). The videos were shot in cooperation with the Centre of Didactic Technology our faculty and the animations were created by one of our medical students. These films will be used for practical exercises in general physiology, physiology of respiration, cardiovascular system and special senses. Moreover, the authors deal with importance of educational films in the practical training of physiology. The streamed versions of videos will be available on website of Department of teaching and application of computer technology and on Mefanet portal. The video files will be uploaded to and distributed by the central server of Medical Media ([www.medical-media.eu](http://www.medical-media.eu)).

## Keywords

physiology, practical training, video

## Introduction

Physiology is one of the essential theoretical fields of study at a medical faculty. Physiology teaching at Faculty of Medicine in Plzeň is designed for students of two study programs – General Medicine and Dental Medicine. Both study programs are taught in Czech and English. Inasmuch as the practical training in physiology occupies a significant part of the physiology teaching (4 hours in winter semester and 5 hours in summer semester for general medicine students; 3 hours in both semesters for dental medicine students), a curriculum of the practical

exercises in physiology must be meaningful, interesting and attractive for students. Since physiology is the experimental discipline, it was taught mainly with the experiments on laboratory animals in past. We performed the physiology experiments in practical exercises on species commonly used in laboratories, i.e. frogs, rabbits, rats or mice. In the last decades of the last century, the attitude of Czech society as well as medical students regarding the experiment on animals started to change. We often encountered situation in which students refused to perform the biological experiments (often legit-

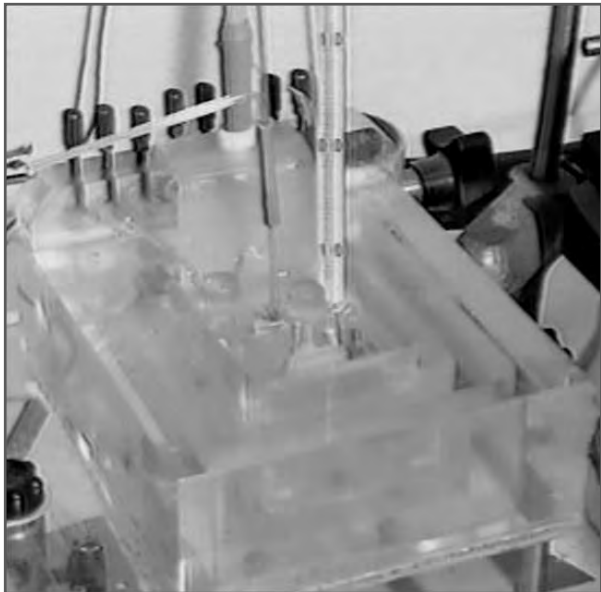


Figure 1: Video – Isolated rat heart atria

## Educational films

The first educational videos made at Department of physiology ten years ago were used in practical exercises in general physiology (Neuromuscular junction, Determination of plasma volume using Evans blue), respiration (Demonstration of negative intrapleural pressure), cardiovascular physiology (Chronotropic effect of vagus nerve, Isolated rat heart atria – figure 1) and central nervous system (Examination of somatic reflexes).

In these films, the biological experiments were simply transformed into movie and our teachers simultaneously provided a commentary. Over time the disadvantages of this procedure appeared including low technical

quality of films and obsolete experimental methods. Moreover, our experience shows that a simple watching of videos leaves a minimal memory trace. That is why we decided to make educational films with interactive and activating features comprising diagrams, charts, animations or assignment for students. The new videos were shot in cooperation with the Centre of Didactic Technology at our faculty and the animations were created by one of our medi-

ately) pointing out their uselessness. After the Act No. 246/1999 on animal protection was passed, we decided to stop using experiments on animals for teaching purposes and to replace them with other alternative ways of teaching. On the present, the practical training in physiology is realized in the form of classic experiments, simulation software, measurement of physiological parameters in the student's laboratory Biopac, virtual patients and educational films.



Figure 2: Video – Determination of plasma volume

cal students. The results of this cooperation are films in Czech and English versions used for practical training in general physiology (Determination of plasma volume – figure 2), physiology of respiration (Lung compliance), cardiovascular system (Vagus nerve and heart, Isolated heart) and special senses (Demonstration of optokinetic and postrotatory nystagmus, Hearing tests).

The advantages of educational films includes animal saving, lower financial demands, clearness, possibility of repetition and last but not least a crystal clear result of the biological experiment. On the other hand, the disadvantages like an absence of practical experience and of practical training learning must be also mentioned. However the results

of a student's survey show the popularity of educational films among the students who evaluated them like a high effective tool for the practical physiology training (figure 3).

## Conclusion

The educational film will be used in the practical training of general and dental medicine students. The streamed versions of videos will be available on website of Department of teaching and application of computer technology of Faculty of Medicine in Plzeň and on Mefanet portal. The video files will be uploaded to and distributed by the central server of Medical Media ([www.medicalmedia.eu](http://www.medicalmedia.eu)).



# **C** | **E-LEARNING AND ON-LINE ASSESSMENT**





## 12

# E-LEARNING COURSES OF TOPOGRAPHICAL ANATOMY OF LIMBS

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## Abstract

Faculty of Medicine in Hradec Kralove is specific for its syllabus of anatomy, which takes only 2 semesters. Unfortunately, time stress makes students to focus on systematic anatomy and to sidetrack topographical anatomy. In spite of it, topographical anatomy is more practical than systematic anatomy and is closer to perception of clinical medicine. It does not cope with separate organs, however, it describes their mutual relationships.

Our E-learning courses dealing with topographical anatomy of limbs are made in the learning management system Moodle. They are available on web sites of our faculty and Mefanet network without any restriction, but of course, aimed to students of medicine. Multimedia components of courses comprise videos, photos, presentations, interactive pictures, texts, quizzes, glossary, questionnaires, and forums.

Loading of these elements is preceded by many steps: diligent dissection or detection and adaptation of older specimens, recording, work with graphic editors or video editing software, editing in a html editor or other text editors. Final files are loaded into units of the Moodle, or eventually made just in the Moodle on-line.

Important feature of E-learning is a feedback aimed to both teachers and students. Preferring the individual feedback we want to avoid official evaluation anyway.

In conclusion, we effort to create a quality source of information but it does not mean that we plan to replace regular education in practical classes. The study of anatomy belongs into dissection rooms seriously. We would like to enable students to repeat the contents of classes after education or to prepare better for following classes in comfort of computer rooms. Thus, our courses have a task to clear blind spots not in syllabi, but better to say, in motivation of students.

## Keywords

E-learning, Moodle, topographical anatomy

## Introduction

The article refers to E-learning courses Topografická anatomie dolní končetiny (in Czech language), Topographic anatomy of lower limb (English), and Topographic anatomy of upper limb (English). These courses are available on Mefanet central gate in the form of an article and they undergo a review procedure actually. The links are below. Mentioned courses are concerned in topographical anatomy. This branch of anatomy does not cope with separate organs, however, it describes their mutual relationships. It is more practical than systematic anatomy and is closer to perception of clinical medicine.

## History of the project

Faculty of Medicine in Hradec Kralove is specific for its syllabus of anatomy, which takes only 2 semesters. Unfortunately, time stress makes students to focus on systematic anatomy and to sidetrack the topographical anatomy. For this reason voluntary students of higher years tried to teach topographical anatomy in their leisure time over the extent of schedule. However, the success was disputable, this education suffered for straggling, and despite of the kindness of volunteers, this education was not guaranteed by academic workers.

That is why we became to think about e-learning courses. We decided to compose

them from experiences of the voluntaries and teachers, from their perception and remarks, authorized pictures and schemes, photos of their dissection. Authorial approach should guarantee an absence of any extraneous copyrighted materials. Unfortunately, this condition is not automatically kept nowadays in the time of scanners because number of similar Internet sources does not observe this base.

The creation of E-learning courses has started promisingly two years ago. It was even presented in the professional circle (congress Morphology 2009, Pilsen, Czech Republic), however, it aborted immediately after the congress. Students initially professed authorship of the project were not interested sufficiently and they turned their attention to their study duties. Probably they were affected by absence of any grant support, which should cover technical solutions, expendable property, and honoraries.

After one year's break the author of this article had decided to accomplish the project with own effort. He created a pre-version of Czech course and complete serial in English. Such special care for foreign students studying in English language had a task to integrate various foreign sources and to offer help to students situated in outland. A project for the grant support covering the completing of the Czech versions and their extension in Topographical anatomy of the head and neck was submitted. This project won the competition in FRVŠ fund and currently it is intensely performed under registry number FRVŠ 1073/2011.

## Purpose

Our ambition was to create an Internet course of the topographic anatomy available to all students of medical faculties. Similarly oriented Internet atlas was created by students of Palacky University in Olomouc as well. Their study material was based on photographs of delicate dissection work as it is a good tradition in Olomouc's anatomy, but unfortunately it was small personal and friendly in its first versions, with no feedback. At our department, we wanted to create real E-learning course in accordance with standards of modern education, not only copied chapters of any textbook.

Our courses were equipped by feedback from the same beginning. Feedback components are built not only for students but also for the creators, so the courses can be improved and completed continuously. The courses aspire to complete current contents of practical classes suitably. However, they have a task to clear blind spots not only in syllabi, but better to say, in motivation of students.

The materials are aimed to the undergraduate study of General Medicine, but they may serve for study programs of Dentistry or Physiotherapy as well. The courses are opened not only for students of the 1<sup>st</sup> year studying the anatomy by their schedule but also for students of highest years to remind topographic relations in various regions of the body. Present list of the visitors acknowledges this assumption. Moreover, target group is not restricted only to students of our faculty, because the publishing in the network Mefanet may extend it to populous group of potential visitors.

## Principles of the creation

Correctly built E-learning course should be not restricted only to publishing of text sources and pictures. That is what we confess. The course should use possibilities of multimedia world at the most offering also video or audio files, flash media etc. Furthermore, E-learning is associated with links to alternative sources, forums allowing discussion with a teacher, and especially feedback components.

The feedback should act as a mirror both for the students and for the creators of a course. Students need to confirm after their study of any lesson whether they understood the topic and they are ready to continue by following lesson. For this purpose, each lesson should be concluded by a quiz. Such quiz may not be in form of an official evaluation at any cost but it should handle valid information about level of student's learning. On the other hand, the author of a course has a feedback from questionnaires or discussion forums which can be or generalized or aimed to any specific problem of studies by appropriate question.

Learning management system Moodle (LMS Moodle) belongs among the most frequently used LMS. It is provided by server of Fac-

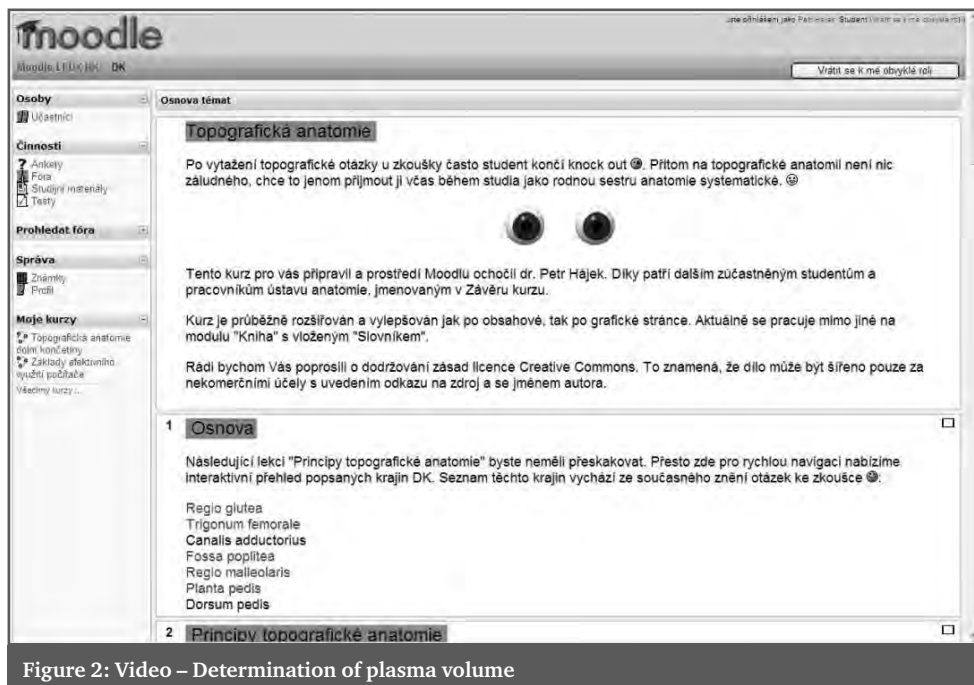


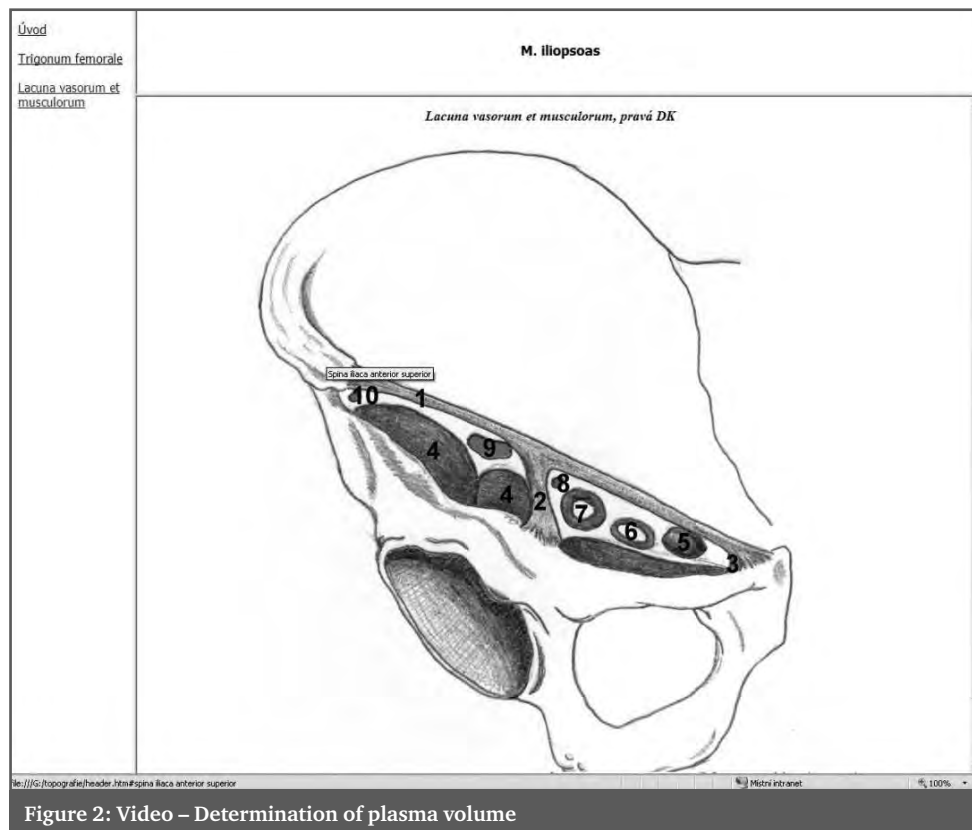
Figure 2: Video – Determination of plasma volume

ulty of Medicine in Hradec Kralove as well. The benefits of using Moodle to create an E-learning course are as follows. It facilitates the technical solution, e.g. various levels of access privileges and many others details. It contains prefabricated modules and it forms a graphic template. Moodle can be a ground for classification or statistical indexes. Author of this project appreciates especially the solution of quizzes. Quizzes in Moodle offer several types of questions and many other supplements and preferences, for example time limit, responses to bad answers, possibility of the repeated answer with a penalty factor, number of attempts and others. Moodle allows sending the results of tests under the name of a student to the teacher. These results can become a ground for classification, even to credit. However, if the evaluated students are not gathered in one room equipped with sufficient number of computers and a necessary inspection, the validity is dispute. Then it is not possible to guarantee that the quiz is answered by logged students and not by collection of helpers. This is the limit of using E-learning and each creator can decide whether a credit can run in such symbolic way. We will not concede official evaluation of results by Moodle, but we will let the results as an individual feedback.

## Solutions

Specific way of our solutions result from the pattern proving good within primary creation of the Czech course Topographic anatomy of lower limb. The first step is a diligent dissection of selected region, occasionally adjustment of older dissection specimens followed by photography and drawing. After data capturing there is the time for work with graphic editors or video studio in case of video files. The other used software includes html editors and text editors. The records are then loaded into modules of LMS Moodle or they are made in Moodle directly on-line (quizzes, questionnaires).

All mentioned courses are subdivided to several lessons. In all cases, the first lesson explains the principles of the topographical anatomy in general, because we believe that this question is principal. It makes the students to distinguish the topographical anatomy and the systematic anatomy, to impress the plan of description of regions. Following lessons are divided just by the regions of human body. They are arranged from proximal part of a limb to distal parts, however, they allow to be studied on demand. The regions named in the final examination questions were preferred at first. Each lesson is started out by brief text explaining sepa-



**Figure 2: Video – Determination of plasma volume**

rate sources and their significance. We make effort to use not academic phrases but language familiar to students both in Czech and in English versions.

We use these components offered by Moodle:

1. Uploaded PowerPoint presentation as principal source containing described photos, illustrations, and supporting text. We preferred this form for advantage of off-line creation.
2. Document of Microsoft Word is more continual and complete text source in comparison with the first type of material. All texts are original works of the author based on knowledge of literature and also experiences from own dissection works, that is why they may differ from some commonplaces known from textbooks. The texts are clearly structured by bullets, anatomic terms are highlighted. Document to each lesson is in extent of 2–3 A4 pages and it fits to be printed.
3. Video files in mpg format should bring demonstration of dissected specimens. They can be created by editing of older

records and post-dubbed. The duration takes several minutes. These videos are currently loaded only into two lessons, however, their creation comes up.

4. Interactive pictures come from authorial illustrations by covering with interactive zones in html editor. When the cursor is over any osseous structure, a title with anatomic name appears on screen while the other structures (muscles, vessels, etc.) have to be answered. Their correct name appears in upper frame of the window after clicking. So this material can serve both to study and to examination. The interactive pictures are made in well-tried program FrontPage as integral part of the courses and they are loaded into Moodle in form of links to html pages.
5. Quizzes are built to represent and evaluate level of acquirements of a student. After the student finished the test, a verbal grade allows him to continue to another lesson or it recommends him to turn back to study materials of the not-mastered lesson. There are several types of ques-

tions offered in Moodle. We use mainly the multiple choices and matching, less commonly other types like correct short answer or true/false. The results are not planned to evaluate officially for the reasons described above but also to keep the voluntariness.

6. In a questionnaire we ask either about matters concerning a content of the course, e.g. difficulty or priority of selected sources or about situations concerning accessing to a course, e.g. which part of the semester evoked the need to enter a course.
7. Discussion forum, as was mentioned above, can be either opened to all remarks or aimed to the content or processing of the course. We use this component for both purposes, moreover the former case may be used just to contact a teacher.
8. The book and the glossary are the names of modules using reciprocal interaction. They represent the last components added

to our courses. The glossary contains a list of anatomic terms with a description of about 3 sentences. Each term loaded in the glossary is automatically highlighted if it is found in Moodle pages.

## Conclusion

In conclusion, we effort to create a quality source of information but it does not mean that we plan to replace regular education in practical classes. The study of anatomy belongs into dissection rooms seriously. We would like to enable students to repeat the contents of classes after education or to prepare better for following classes in comfort of computer rooms. Of course, these courses can be very useful for the time of vacation when is not possible to study in the dissection rooms for incomplete staffing. Moreover, the courses motivate the students and offer them to cooperate on the education by participation on feedback.

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# E-LEARNING ON PRACTICE OF MEDICAL BIOPHYSICS

13

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3<sup>rd</sup> Faculty of Medicine of Charles University in Prague

## Abstract

Multimedia support of experiments in practice of medical biophysics (MB) and e-learning courses determined for self-study and testing were launched at 3<sup>rd</sup> Faculty of Medicine of Charles University in Prague. E-courses and on-line support are now undergoing pilot testing in MB practice of first year medical students in the winter semester of 2010. On-line support was opened at Moodle portal, a free open-source PHP web application for producing modular internet-based courses. E-courses focused on theory related to practical experiments from MB were integrated into basic education of MB at our faculty. The Biophysical practice was completely rebuilt using new devices and setups for Physiotherapy, Ophthalmology, Electrophysiology, Ergometry and Thermo vision. Whole practical exercises of MB are now realized in different experiments on thermal effects of ultrasound therapy coupled with thermo vision imaging technique, Ergometry with special focus on ECG and blood pressure measurement, biosignals recording, electro-therapy with focus on recording of rheobase and chronaxy, optometry and ophthalmology, spectrometry of gamma radiation and half-thickness of materials in radiology, audiometry and bioimpedance measurement. After implementation of pilot test outputs, the whole on-line support of biophysical practice will be shared with all medical faculties in the MEFANET network.

## Keywords

multimedia, practice, biophysics

## Introduction

Biophysics education at 3<sup>rd</sup> Faculty of Medicine follows advanced trends in education. The emergence of modern, well equipped classrooms and a comprehensive integrative medical biophysics practical training with theoretical knowledge gained by using multimedia study materials and e-learning courses on “Medical Biophysics” moved 3<sup>rd</sup> Faculty of Medicine of Charles University in the quality of teaching this course to the front of others. Master Degree Students ‘General Medicine’ not only get a chance to try to work with modern medical equipment, but due to the form of multimedia learning materials for practical tasks they will be able to understand the function, use of medical devices and limits of contemporary medical practice.

Contribution to the development of the faculty will be thus better prepared graduates on the use of medical instrumentation

in practice and potential of better qualified medical doctors. Students of ‘General Medicine’ get through the practical tasks supported by multimedia web-accessible teaching materials, courses and e-skills needed in medical practice.

Thus, multimedia and distant study of the function, use and limits of modern medical equipment will facilitate the acquisition of practical skills of future physicians and reduce the risk of patient harm.

Multimedia support integrated teaching and classroom equipped with modern instruments as the basis for a comprehensive upgrade of exercises Medical Biophysics. A fundamental change in the quality of practical training is completed with following the development of multimedia study materials and e-learning courses for each experiment in practice.

The aims of the project were to achieve the state where (1) each of the problems of bio-

physical practice has own support available on-line on the web; (2) the theoretical teaching of medical biophysics and practical exercises are closely linked with web content created in this project; (3) each practical course in medical biophysics is having an e-learning course from a practical point of view including with required knowledge and skills; (4) students can successfully prepare themselves for biophysical practice from the web material only, with use of interactive professional materials, including independent testing and evaluation of online access to full preparation for practice 24/7; (5) students will have an interactive web-accessible materials about the devices in the biophysical practices which they can meet later on in own career. Device related materials will include both specifications, methods and limits the use and risks of the devices respectively methods.

From the perspective of teaching medical biophysics, this means that an overall biophysical innovation practices. Custom multimedia support of practical problems in medical biophysics will be after the pilot testing phase and interior

revision permanently located at: website of the Institute of Biophysics and Medical Informatics of the 3<sup>rd</sup> Faculty of Medicine of Charles University in Prague, and at the server MEFANET which is accessible to medical students outside of the school.

The target groups are students of these fields of study and subjects:

1) one year master's program General Medicine, 3<sup>rd</sup> Faculty of Medicine of the Czech and English curriculum – the subject of Biophysics and Medical Informatics; 2) one year bachelor degree programs: Physiotherapy, Public Health and Dental Hygienist – Medical Biophysics course.

## Methods

Solution of the project carried out in two phases. In the first half of 2010 will create a multimedia support and eLearning courses (in LMS Moodle) for individual tasks in practice. In the winter semester of the academic year 2010–2011 will be created modules and courses tested in a pilot run, and finally adjusted. Thereafter, multimedia modules and e-course for internal peer review and

then published MEFANET network as well. The creation module, teachers will participate in the Institute of Biophysics and Medical Informatics and where external expert on distance learning. Custom multimedia support any practical problems in medical biophysics are now in pilot testing phase, at the end of 2010 they will be permanently available on the website of the Institute of Biophysics and Medical Informatics of the 3<sup>rd</sup> Faculty of Medicine and the server MEFANET 3<sup>rd</sup> Faculty of Medicine, which is accessible to students outside of the 3<sup>rd</sup> University in Prague.

## Results

The project aim was to make electronic on-line support for the practical problems of Medical biophysics for following practical tasks:

1) Ultrasonography – the use of ultrasound in medical diagnostics.

Used instruments: medical therapeutic ultrasound, probe for ultra-sonography.

Tasks: [1] – measure size of objects using ultrasound, [2] – measure speed of model liquids by ultrasound, [3] – find out biophysical properties of ultrasound reflection and absorption.

2) Ergometry – the capture and analysis of vital functions during exercise.

Used devices: Phantom for training intensive care and monitoring of physiological functions, ergometer, monitor of vital functions, ECG, pressure gauge, pulse oxymeter, computer. Tasks: [1] – measure and analyze 12-lead ECG at rest and after physical activity aiming to find the rhythm, frequency, waves and oscillations (P, PQ, QRS, QT); [2] – measure blood pressure and oxygen consumption during physical activity, [3] – carry out a comprehensive stress test analysis of measured data.

3) Electrophysiology – bio potentials measurements. Used devices: multi-sensor and transmitter physiological bio potentials, computer. Tasks: [1] – set and justify the conditions of action potential in a computer model of the neuron; [2] – measure and myopotentials analyzed at different stages of muscle.

4) Electro-therapy – measuring the parameters of electric current irritation.

Used devices: electro-therapy device, computer. Tasks: [1] – determine a threshold intensity of electrical current that causes irritation (rheobase) [2] – determine the time needed to elicit responses when exposed to more than 2 rheobase (chronaxy), analyze the dependence of intensity on the duration of the stimulus ( $I/t$  curve).

5) Optometry – measuring the optical power of lens and composition in the human eye. Used devices: optometric system, models of colour vision, computer. Tasks Exercise: [1] – measure the optical power of selected lenses and demonstrate various visual malfunctions, [2] – create the desired colour on the model of colour vision.

6) Thermo vision – infrared imaging in medical diagnostics.

Used devices: scintillator, photomultiplier, gamma radiation detector.

Tasks: [1] – measure temperature and its gradient of model elements using thermography, [2] – compare selected parts of the body using thermography measurements.

7) Spectrometry of gamma rays – the physical properties of gamma radiation. Used devices: scintillator, photomultiplier, gamma radiation detector.

Tasks: [1] – detect radiation spectrum of the three sources, [2] – identify unknown radionuclide by energy spectrum measured by two known radionuclide.

8) Material half-thickness – material properties in gamma radiation.

Used devices: scintillator, photomultiplier detectors and gamma radionuclide.

Tasks Exercise: [1] – measure / calculate material half-thickness of three different materials [2] – draw graph absorption of gamma radiation on the material used.

## Conclusion

The form of realized solution is different in several aspects from original proposal. Each practical experiment consists from three parts: Theory, Tasks, Test. Theory part is focused on physical background necessary for understanding experimental phenomena and to accomplish the tasks. Two tasks along with detail method / procedure description are written in one page format so that students can orient easily in practice in it. Test includes 60 questions is multichoice with four randomized answers. Students can do that test freely over internet on our Moodle server. Students suppose to train themselves prior practice aiming accomplishes entrance practice examination which usually includes 3 of those 60 questions.

The output of the project is not only a fundamental change in the form of teaching theory, training practice and preparation for it, but also 24/7 availability of multimedia support and e-learning courses on medical biophysics what represents a qualitative change in the concept of practices in biophysics.

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## 14

# BIOMEDICAL STATISTICS IN DENTISTRY TRAINING AT THE FACULTY OF MEDICINE AND DENTISTRY, PALACKÝ UNIVERSITY IN OLOMOUC

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## Abstract

The presentation describes a new concept in teaching biomedical statistics in the subject “Dentistry Software”. This concept is based on an e-learning course newly created to teach the basics of biomedical statistics. The statistics module is one of seven modules making up the course. It consists of text materials, instructions for practical tutorials on computers and on-line knowledge tests. Practical tutorials focus on making frequency and contingency tables and various types of graphs, testing statistical hypotheses by Student’s t-tests and the chi-square test. The instructions for tutorials contain a number of model examples as well as examples for students to solve without assistance. All of these examples use data related to stomatology. For solving examples, statistical functions and tools in Microsoft Excel 2007 are used. This program was chosen as it is widely available to all students.

The modules can be accessed at a new e-learning portal and a computer room has been equipped with new hardware for students to do so. This new system will be tested on 120 students in the course “Dentistry Software” in the summer term of year 3.

Students can access the portal at [www.stoma.upol.cz](http://www.stoma.upol.cz). Site access statistics is recorded. The portal lets the students register and personalise their account. It contains active elements (forums, chat), feedback functions (evaluation questionnaires, appending comments to modules) and so on. The portal aims to become a community centre enabling effective communication between students and teachers.

This project is co-financed by the European Social Fund and the state budget of the Czech Republic.

## Keywords

biomedical statistics, dentistry software, e-learning

## Introduction

The biostatistics module of the Dentistry Software course aims to teach students to clearly and effectively process biomedical data and to interpret results of various statistical tests. This module teaches students to think statistically and gives them a general understanding of the field. A two hour lecture focuses on theoretical knowledge and essential statistical terms (types of data, population, random sampling). Other areas presented include elementary methods of descriptive statistics and the basics of statis-

tical thinking – statistical inference. The lecture is covered in a textbook available online at [www.stoma.upol.cz](http://www.stoma.upol.cz)

The lecture is followed by two series of tutorials in which students on computers work with lecturers. The program used for processing data is Microsoft Excel 2007, easily accessible to students. The first series of tutorials aims to teach students to construct simple frequency and contingency tables focusing on several attributes at once. The information from the tables is then expressed by pie and bar charts. All data the students

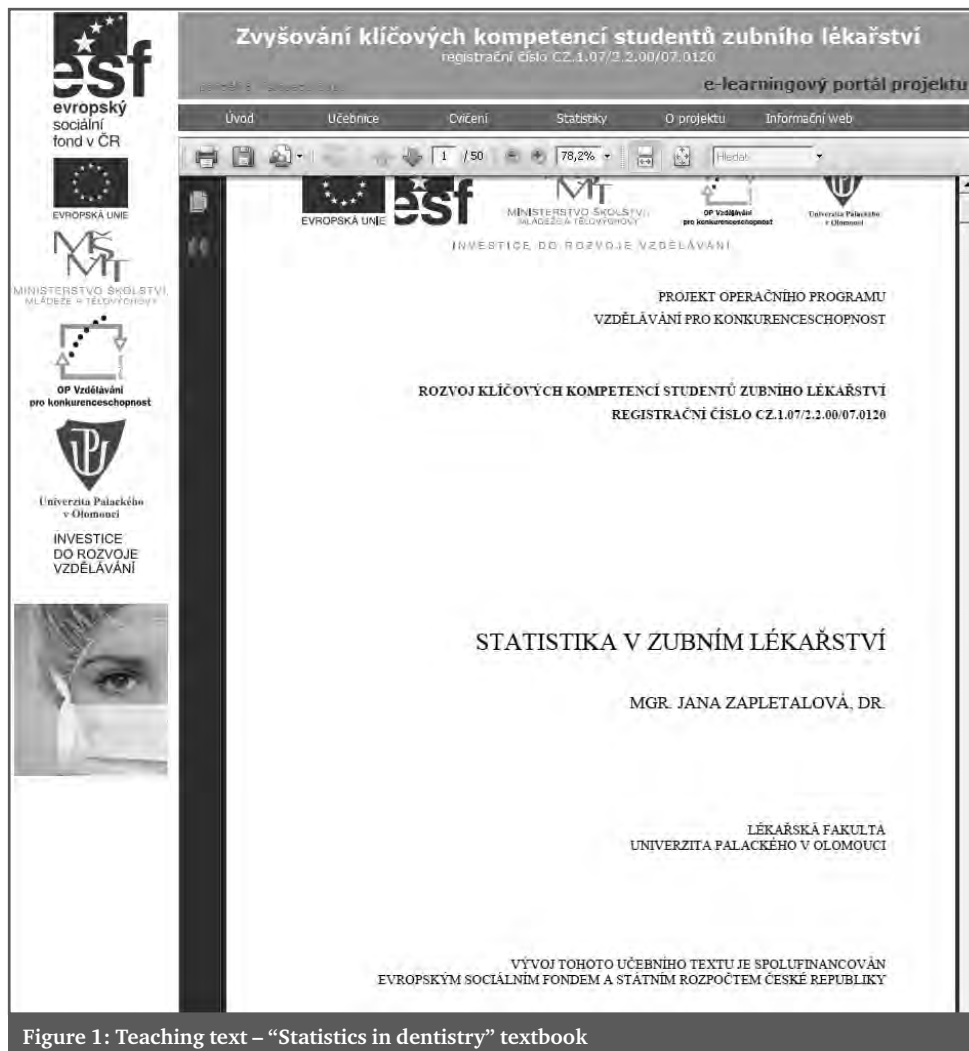


Figure 1: Teaching text – “Statistics in dentistry” textbook

use is connected to dentistry. The second series of tutorials gives the students practice in using the Data Analysis tool. It allows them to perform the two sample F-test for variance, the independent sample t-test and the paired t-test. At the end of the tutorial, the students will learn the chi-test function and use it to analyse the dependence of categorical data. A complete set of directions is available on the stomatology website.

The site also contains data for the students to process, instructions for assignments, a number of model examples and exercises for individual work.


The e-learning site also contains tests which allow students to check their understanding of the course.

## Conclusion


Students taking this course are motivated to think about medical questions related to statistics. After having completed the course, they should be able to answer them. They can use the e-learning site to practise, giving them space to set their own pace and the method of learning that suits them best.

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**e-learningový portál projektu**

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**Vítejte do e-learningového portálu projektu**

**Vyberte vzdělávací modul nebo cvičení**

1. **Informační zdroje pro stomatologii**  
*Cvičení k modulu*
  - 1. Vyhledávání informací o prevenci zubního kazu u dětí školního věku v databázi MEDLINE/PubMed
2. **Digitální obraz a databáze**
3. **Základy biomedicínské statistiky**  
*Cvičení k modulu*
  - 1. Konstrukce jednoduché četnostní tabulky
  - 2. Konstrukce četnostní tabulky pro dva kvalitativní znaky
  - 3. Tvorba koláčového grafu
  - 4. Tvorba sloupčového grafu
  - 7. Chi-kvadrát test
  - 5. Dvouvýběrový t-test
4. **Kancelářský software**  
*Cvičení k modulu*
  - 1. Microsoft Office Word 2007
5. **PCDent**  
*Cvičení k modulu*
  - 1. První cvičení PC DENT
  - 3. Třetí cvičení PC DENT
  - 2. Druhé cvičení PC DENT
  - 4. Čtvrté cvičení PC DENT
  - 5. Páté cvičení PC DENT
  - 6. Šesté cvičení PC DENT
  - 7. Sedmé cvičení PC DENT
6. **Dentist+**  
*Cvičení k modulu*
  - 1. První cvičení Dentist+
  - 2. Druhé cvičení Dentist+
  - 3. Třetí cvičení Dentist+
  - 4. Čtvrté cvičení Dentist+

E-learningová podpora a vzdělávací materiály byly vytvořeny z prostředků Evropského sociálního fondu pro podporu výuky předmětu "Programové vybavení ordinace zubního lékaře (LBF/ZUB21)"

Pro jednotlivé moduly byly zpracovány následující komponenty:

1. Distanční učebnice
2. Zadání cvičení
3. Postup řešení
4. Úkoly k samostatné práci
5. Pomocné soubory a přílohy
6. Výukové animace
7. Autokorekční testy

**Aktuální informace:**

- Odkaz na systém STAG

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Figure 2: Overview of directions for tutorials at the e-learning site




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### E-learningová podpora cvičení: 1. Konstrukce jednoduché četnostní tabulky

Modul		Všechna cvičení k modulu	
Název:	Zaklady biomedicínské statistiky	Název:	Konstrukce jednoduché četnostní tabulky
Popis:	Tento text si klade za cíl vysvětlit vám některé střední pojmy ze statistiky a ukázat vám možné využití metod statistického popisu (deskripce) a statistické indukce na datech z oboru zubního lékařství.	Popis:	Konstrukce jednoduché četnostní tabulky - Metody deskriptivní statistiky v programu Excel 2007
Učebnice:	<a href="#">Zobrazit učebnici</a>	Další cvičení modulu:	<ul style="list-style-type: none"> <li>1. Konstrukce jednoduché četnostní tabulky</li> <li>2. Konstrukce četnostní tabulky pro dva kvalitativní znaky</li> <li>3. Tvorba koláčového grafu</li> <li>4. Tvorba sloupčového grafu</li> <li>7. Chi-kvadrát test</li> <li>5. Dvouvýběrový t-test</li> </ul>

Zvolte jednu z možností: ☒ Zadání ☐ Řešení ☐ Úkoly ☐ Test ☐ Evaluace

Zadání cvičení ... [zobrazit v okně](#)

Z dat uložených v souboru **Popisná statistika\_Zubní lékařství.xlsx**, na listu „úrazy dočasných zubů u dětí“ zjistíte:

- 1) Počet a procento chlapců a dívek v souboru (sloupec **Pohlaví**),
- 2) Počet a procento úrazů doma a venku (sloupec **Místo úrazu**),
- 3) Počet a procento úrazů podle mechanismu úrazu (sloupec **Mechanismus úrazu**),
- 4) Počet a procento dětí podle počtu postižených zubů (sloupec **Počet postižených zubů**).


**Teorie**

Četnostní tabulky jsou základním nástrojem pro popis distribuce (rozdělení) četností naměřených hodnot daného kategoriálního znaku v jednotlivých kategoriích. V programu MS Excel lze četnostní tabulky tvořit pomocí nástroje **Kontingenční tabulka**.


**Popis a umístění souboru s daty**

Datový soubor **Popisná statistika Zubní lékařství.xlsx** je uložen na síťovém disku F:\, ve složce „SOFTWARE (biostatistika) data Zubní lékařství 3r“.. Složka bude přístupná pouze po přihlášení se do sítě (viz login name + password v okně T. online).

**Materiály ke cvičení**




Demonstrační animace




Popisná statistika\_Zubní lékařství.xlsx  
Excelový sešit **Popisná statistika\_Zubní lékařství.xlsx** obsahuje 4 datové listy:  
List „úrazy dočasných zubů u dětí“  
Na listu jsou uložena data zaznamenaná v zubní ambulanci při ošetřování dětí po


Figure 3: Instructions for tutorials at the e-learning site




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Účel: 1. 1. 2007 - 31. 12. 2010

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### E-learningová podpora cvičení: 7. Chi-kvadrát test

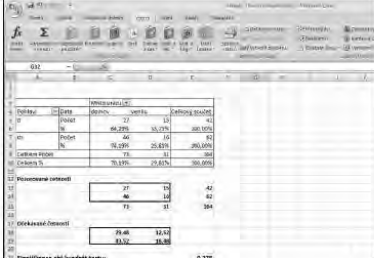
Modul		Všechna cvičení k modulu	
Název:	Základy biomedicínské statistiky	Název:	Chi-kvadrát test
Popis:	Tento text si kladu za cíl vysvětlit Vám některé stěžejní pojmy ze statistiky a ukázat Vám možné využití metod statistického popisu (deskripce) a statistické indukce na datech z oboru zubního lékařství.	Popis:	
Učebnice:	<a href="#">Zobrazit učebnici</a>	Další cvičení modulu:	<ul style="list-style-type: none"> <li>1. Konstrukce jednoduché četnostní tabulky</li> <li>2. Konstrukce četnostní tabulky pro dva kvalitativní znaky</li> <li>3. Tvorba koláčového grafu</li> <li>4. Tvorba sloupčového grafu</li> <li>7. Chi-kvadrát test</li> </ul>

Zvolte jednu z možností: ☐ Zadání ☒ Řešení ☐ Úkoly ☐ Test ☐ Evaluace

Řešení cvičení ... [zobrazit v okně](#)







4 / 6

78,2%



Hledat:



**Materiály ke cvičení**

K modulu nejsou připojeny poznámky


Figure 4: Solution to an exercise at the e-learning portal



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**E-learningová podpora cvičení: 7. Chi-kvadrát test**

Modul		Všechna cvičení k modulu	
Název:	Základy biomedicínské statistiky	Název:	Chi-kvadrát test
Popis:	Tento text si klade za cíl vysvětlit Vám některé stěžejní pojmy ze statistiky a ukázat Vám možné využití metod statistického popisu (deskripce) a statistické indukce na datech z oboru zubního lékařství.	Popis:	
Učebnice:	<a href="#">Zobrazit učebnici</a>	Další cvičení modulu:	<ul style="list-style-type: none"> <li>1. Konstrukce jednoduché četnostní tabulky</li> <li>2. Konstrukce četnostní tabulky pro dva kvalitativní znaky</li> <li>3. Tvorba koláčového grafu</li> <li>4. Tvorba sloupcového grafu</li> <li>7. Chi-kvadrát test</li> <li>5. Dvouvýběrový t-test</li> </ul>

Zvolte jednu z možností: ☐ Zadání ☐ Řešení ☐ Úkoly ☒ Test ☐ Evaluace

Počet chybných odpovědí: 0 Úspěšnost: --%

Jaká statistická metoda je vhodná pro ověření závislosti dvou kvalitativních znaků?

☒ Párový t-test  
☐ Dvouvýběrový t-test  
☐ Chi-kvadrát test

---

Jaká statistická metoda je vhodná pro zjištění efektu léčby? K dispozici máte data sledované kvantitativní veličiny, která má normální rozložení, naměřené před léčbou a po léčbě.

☐ Chi-kvadrát test  
☐ Párový t-test  
☐ Dvouvýběrový t-test

---

Jaká statistická metoda je vhodná pro porovnání dvou populací nemocných, kteří jsou léčeni různými metodami? K dispozici máte data sledované kvantitativní veličiny, která má normální rozložení, naměřené ve dvou výběrových souborech?

☐ Párový t-test  
☐ Dvouvýběrový t-test  
☐ Chi-kvadrát test

---

**Materiály ke cvičení**



*K modulu nejsou připojeny poznámky*

Figure 5: A test at the e-learning portal

## 15

# COMPUTER-BASED KNOWLEDGE EVALUATION IN HEALTH WORKERS EDUCATION

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<sup>2</sup> Institute of Biostatistics and Analyses, Masaryk University

## Abstract

Modern information and communication technologies are common, sometimes even essential complement of education at universities. Using these tools in the knowledge evaluation process is perceived by various institutions differently. Learning approaches and methodologies offer a variety of perspectives on this issue. Many learning management system are used for electronic examination across the MEFANET (MEDical FACulties NETwork). This contribution focuses on theoretical background, which is crucial for preparation of the high quality evaluation materials. The design concept of evaluation, building methods of various test questions and analysis methods are discussed in detail. Risk areas and the most common pitfalls in the use of electronic examination testing, as well as the benefit of all stakeholders (students, teachers, educational institutions, clinical practice, etc.) are further mentioned. Finally, questions related to the classification of tests within each part of the educational process are discussed. Accented are requirements for different purposes of using the electronic testing agenda (assessment of knowledge, ability of critical thinking, independent work in Problem Based Learning, etc.).

## Keywords

computer-based assessment, e-learning, electronic examination, knowledge evaluation, methodology

## Introduction

It is well known that new information and communication technologies significantly alter the educational practices and enhance the learning procedures. Distance learning or electronic education has become a very popular way of educations, Conventional education methods used for lectures and examinations had been adopted to be applicable to the distance learning <sup>[1]</sup>. The whole process of computer-based knowledge evaluation is essential part of modern e-learning approach and helps teachers to enhance learning practices by weaknesses detecting that students might have. Computer-aided testing systems and methods might contribute to student assessment procedures through numerous ways, for example the simplification of the logistics of the examina-

tion process and the ability to provide self-examination material that can be used on a distance-based learning framework by the student <sup>[2]</sup>.

E-learning, in Anglo-Saxon literature, known as elearning is gradually taking hold in the modern approach to education and health professionals. As stated A. Pokorná <sup>[3]</sup>, with the ever increasing demands and increasing pressure on the level of knowledge and skills of nursing and medical students comes to widening the aspect of time constraints on training for clinical practice. E-learning is characterized as learning through computer connected to the web using the LMS environment <sup>[4-6]</sup>. Thorough the online education we could share the study materials in different way (e.g. simple text, photographs, video etc.), present additional information

(e.g. links to the scientific webpages), prepare discussion forum and of course test the knowledge of students.

## Test classification

There is a wide range of the assessment classifications, which are based on various criteria. The modern knowledge evaluation is often used in combination with ICT tools such as web-oriented applications or sophisticated learning management systems (such as Moodle, Breeze etc.) According to the purpose assessment could be divided into formative and summative categories. Formative approach helps us shape or form an understanding of students' reading development and learning across lectures and provides students' experiences and attitudes. For example teachers have created opinion polls to find out students' feedback. Summative approach provides a summary of students' achievement and helps us take measure students' knowledge in relation to curriculum objectives [7]. For example consider a series of drill-oriented continual exercises during the course, submission time-limited tests after a tuition or high-stakes tests at the end of a course. It is also possible to publish online demo test and acquaint students with an assessment environment. Today teachers have a lot of opportunities how to integrate computers into the assessment agenda and make whole evaluation process more comfortable and efficient. In general, computer-based knowledge evaluation could be used as pre- and post-test. It means that you can use it before the tuition or at the end of courses or seminars. In some cases we can use it also as follow-up test but it is not so common in professional pre-gradual education.

## Design concept

For preparation process of e-learning courses and especially for the test preparation we have some special requirements. Concerning the evaluation knowledge there are some general suggestions for the best preparation of the online testing:

a) **The authors of the tests (teachers or tutors) should create questions that are focused on the primary course objectives.** The best way how to start is to try

to develop at least one question that tests participants for each course objective. This will ensure that teacher is asking participants to demonstrate their knowledge of what course developers determined are the most important concepts to learn across the entire course.

- Go one step further and ask yourself
- What ten crucial things in this course cover what a health professional needs to know about care?
- Then create your questions from the list of concepts, facts, or skills.

- b) **Only develop questions to which there were clear answers provided during the course.** Teachers should not test participants on concepts or knowledge that were not sufficiently covered in the course and create questions that don't demand the memorization of extraneous (i.e., picky) detail. Students should not be tested on whether they remember a particular word or phrase but rather on whether they have learned important concepts and facts related to the subject matter. The level of importance should be chosen very carefully.
- c) **The best tests are developed if the students can fill it in 10–30 minutes.** Of course completing a pre and post-test can take time away from covering material in the course or subject. Pre- and post-tests are not supposed to be exhaustive of the material addressed in the course but be a sample of the most important concepts and skills covered. We can say that the knowledge test that would take an average participant approximately 15 minutes to complete and if you use multiple-choice and true/false questions that could be 15–20 minutes. In case of using answers or essay questions, you should allow for 25 minutes.
- d) **The teacher should use different types of questions.** Variety of knowledge questions can help make a test more rigorous and interesting and it helps students to be more motivated and active. It is important to have a balanced mix of True/False and Multiple Choice questions.
- e) When teachers (tutor) **create multiple choice questions** they should develop responses that are substantively dis-



tinct from one another. The developing of “incorrect” responses that are potentially plausible but clearly wrong is not effective and made students unsatisfied. Students should not use more than one correct answer (e.g. none of the above is correct or **A** and **D** is correct). What is also important to use more than only three responses. The majority of information should be in the question, not the answers. It is more confusing when the answer is too long and students have to read a lot. Tutors has to review questions and responses for the usability and made them as understandable as possible (mark and indicate required response – chose **right answer** or mark **incorrect examinational methods** or you **should not mark** etc.).

- f) When teachers are **creating the true/false questions** they should construct questions that are simply worded, to the point, and unambiguous. Tutors have to avoid strange, unfamiliar or unheard words. Also vocabulary that can be interpreted in different ways makes the questions much more difficult for students to answer. In health-care workers education, have to be strictly adduced, if students should use Latin or not. Teacher should avoid using of conjunctions such as **and**, **but**, **except**, and **or**. These words imply a second idea or concept and can be confusing when students are answering.
- g) Tutors can also **create open ended questions**. However it is sometimes too difficult to evaluate the answers from many students. It is useful if tutor want to assess the ability of students to write some scientific words (e.g. name of organs in Latin or English). For the longer answer it is not so good especially if you have big students group. For the evaluation of longer answers in pen ended questions teachers have to have strict criterion. There is another way how to use open ended question – using peer review among the stu-

dents and evaluate the argumentation of their statements.

What is the most important thing if teacher – tutor prepare the online testing... that even after the long time from the preparation he is still able to interpret the goal of each questions, understand the content of the questions and each expected answers.

## Analysis of evaluation agenda

This chapter introduces various analysis methods of didactic tests. Below two statistical measurements are described. The first one is focused on the difficulty of test questions and second describes how to recognize the sensitivity of the questions.

### Difficulty of test questions

The difficulty level belongs to basic statistic characteristics. It is calculated from the ratio of students who provided correct/incorrect answers (solution) of a task<sup>[2]</sup>. The primary motivation lies in the identification of easy and difficult test questions. A knowledge test, which contains too many easy and too many difficult items, can result in skewed mark distribution. Difficulty analysis enables teachers to identify insufficient items and consequently edit them or remove them from the question database. Questions can be also arranged in order of difficulty and then teacher can strictly define question list of the test (from less difficult items to more difficult items).

The key role represents the difficulty question value, which shows the proportion between the number of false responses and the number of all responses.

$$Q = 100 * \frac{n_w}{n} \quad (1)$$

where  $Q$  is difficulty question value,  $n_w$  is number of incorrect answers to the given question and  $n$  is number of all answers to the given question. The calculation has to be executed for all test items.

Table 1: Recommended values of the difficulty level

Difficulty question value	$Q < 20$	$20 \leq Q \leq 80$	$80 < Q$
Difficulty level	easy	optimal	difficult

Table 2: The example of difficulty and sensitivity analysis of real evaluation agenda								
	question id	q01	q02	q03	q04	q05	q06	q07
Difficulty	total number of answers	10	6	5	7	16	7	5
	correct answer	9	5	2	5	15	4	3
	incorrect answer	1	1	3	2	1	3	2
	difficulty question value	10,0	16,7	60,0	28,6	6,3	42,9	40,0
	difficulty level	easy	easy	optimal	optimal	easy	optimal	optimal
Sensitivity	correct answers (U)	5	1	2	3	7	2	1
	correct answers (L)	4	4	1	2	8	2	2
	discrimination index	0,2	-1,0	0,4	0,3	-0,1	0,0	-0,4
	result	×	×	ok	ok	×	×	×

Items having difficulty level lower than 20 (too easy) or higher than 80 (too difficult) are not suitable and have to be controlled by item writers (see Table 1). The whole analysis is depended upon only correctness answers attribute.

Sensitivity of test questions

Discrimination index represents one of the statistic techniques for the sensitivity calculation. It is usually designed by the abbreviation ULI (upper-lower-index) and show the difference between upper and lower scores answering the given item correctly. Questions of high sensitivity are successfully solved by good students and unsuccessfully solved by weak students. The higher coefficient value informs us /provides information/ about distinguishes between students with good and bad knowledge [2, 8]. Lower (L) and upper (U) are special groups of respondents, which are decided by dividing the arranged total scores into two subsets – weak students <0%–50%> and good students (50%–100%>.

$$d = \frac{n_U - n_L}{0,5 * n} \tag{2}$$

Where d is discrimination index,  $n_U$  is the number of correct answers to the given question responded by good students (belongs to the upper group),  $n_L$  is the number of correct answers to the given question responded by weak students (belongs to the lower group)

and n is the number of all answers to the given question. The calculation has to be executed for all test items. The recommended ULI value is more than or equal to 0.3.

There are also available more complicated and more time-consuming sensitivity analysis methods such as the tetrachoric correlation or the point biserial correlation, which are more confidential than the discrimination index.

Conclusion

Assessment in education is a complex process with deep moral implications having as ethical consequences the achievement of classifications and selections that will affect the professional and personal development. This represents much more than the measurement of acquired knowledge and marking, having effects in social and individual live [9]. The online testing has not rich history in health workers education but this is big opportunity for the future also with increasing number of students and lack of time. However teachers should know how to create effective online test and have to aware of the risk which are common in not personal contact. The success of efforts in this area depends on the prediction and adaptation of traditional education with a critical assessment of the involvement of online education and e-learning as a new teaching and evaluative methods.

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# E-LEARNING IN OPTOMETRY, STANDARD OF TREATMENT IN PRACTICE

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## Abstract

E-learning in optometry represents a new effective way of education. Optometrists are full qualified experts in field of refractive errors and corrective aids. E-learning cannot replace personal contact with pedagogues but can enrich lessons with complex information about client and imitating a real practice. Clinical standards with quality indicators can improve label of understanding but also prepare graduate to everyday activity.

## Keywords

e-learning, standard of treatment, everyday practice

## Introduction

Classroom lectures, paper exams and face-to-face communication are used to accomplish the cognitive objectives in most education programs. However, in recent years, education has reached beyond the classroom setting to a wider student audience that is not able to attend the on-campus classroom. Another example is illness of students. Online education connects instructors and students with resources, virtual communication and remote activities using a course management system as the primary means of instruction. Transitioning from on-campus to online teaching brings about some challenges and surprises. This article will focus on the ways in which faculty must adjust their teaching in order to effectively facilitate learning online. The connection and feeling of being part of a learning community is somewhat lacking in online education and it is not unusual for an online student to feel isolated. Creating a sense of social presence creates a level of comfort and enhances interactions between students and the instructor, which makes the learning environment fulfilling for online learners and instructors.

Optometry is relative new health occupation in Czech Republic. The aim is biometry of the eye globe, examination of subjective

and objective refraction, binocular balance, and selection of appropriate refractive aid, glasses or contact lenses and prescription of spectacles.

Assessment represents complex of separate procedures which are necessary to keep. Standards of correction rules are incorporated into the training.

Didactic process can be divided into single phase: patient with refractive error, pick up anamnesis' data and clinical signs, basic examination, additional examination, determination of refractive error and resulting correction. The prescribing rules are intended to help patients easily adapt to their new spectacles and so avoid dissatisfaction. Some other errors are such as those due to dispensing errors, ocular pathology, transcription errors and communication problems.

Very important is family history: cataract, glaucoma, high myopia, amblyopia, tumors, keratoconus.

Essentially case history: asthenopia, double vision in near action (hypermetropia), worse vision at dimness- myopia, worse vision to far, worse vision to casual near distance: progressive myopia. We can simulate clinical symptoms by corrective glasses. Very important is occupational history.

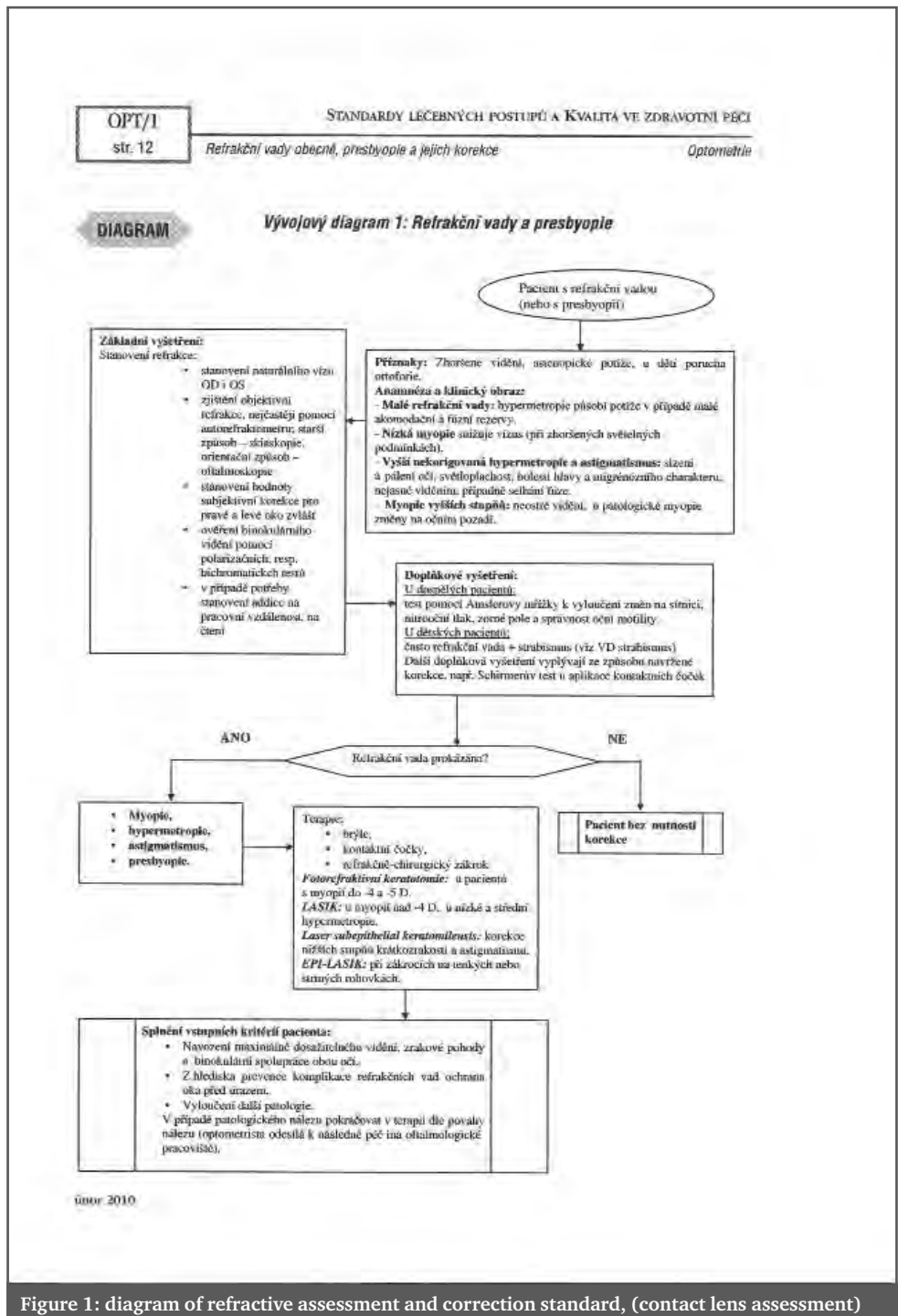


Figure 1: diagram of refractive assessment and correction standard, (contact lens assessment)

The basic examination: natural vision, subjective and objective assessment the both eye separately, students must follow rules about optimal correction, after that they check binocular cooperation by polarization tests or dichromatic tests. The last stage is determi-

nation of addition for working or reading distance.

Additional tests are indicated in adult – measurement of intraocular pressure by non-contact methods, examination of visual fields, assessment of motility of both eyes,



Figure 2: sharp picture in emmetropia



Figure 3: simulation of myopia by plus lenses

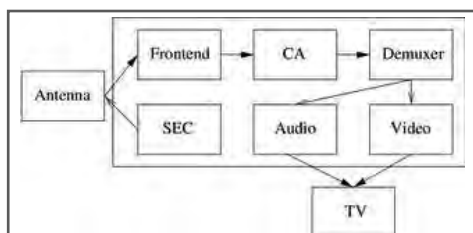


Figure 4: near vision in normal condition

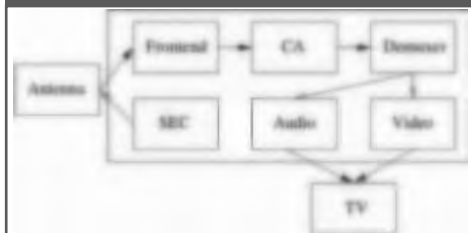


Figure 5: presbyopia, which is simulating by minus glasses

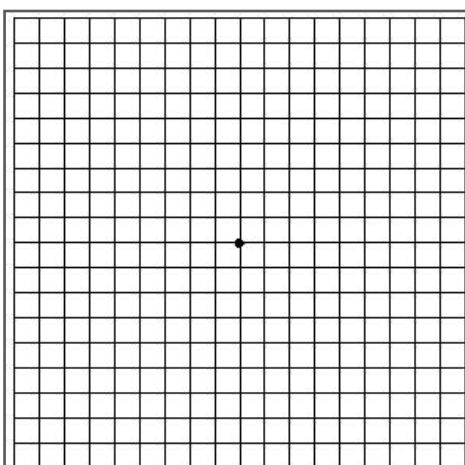


Figure 6: Amsler grid



Figure 7: near vision in macular degeneration

test by means of Amsler grid to exclude central scotoma in macula disease.

In children we must examine strabismus by means of simple cover test.

In case of contact lens application we must assess quality of lachrymal film by Schirmer's test and patency of lachrymal ducts in chronic conductivities and blefaritis. Stage of correction includes application of converging and diverging glasses, toric glasses and contact lenses. The course includes information about refractive sur-

geries – by excimer laser, or microsurgery and refractive intraocular lens exchange. In case of pathological findings optometrist send patients to eye doctors. Every stage of refraction we can simulate by appropriate multimedia technique. The use of prescribing rules may even avoid the consequences of an incorrect refraction in some cases. The final prescription may not simply be the refraction result. By implication the prescription may need to be modified to help patient adaptation and comfort.

## Summary

E-learning brings new possibilities in the practical courses of optometry. Algorithms of standard examination protect clients and examiner from mistakes and corrective aid intolerances. The standards of refractive errors correction carry a simple algorithm instruction but students must follow the rules of correction. E-learning materials can simulate usual condition in normal practise.

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# 3D CONTENT IMPLEMENTATION AND VISUALISATION IN THE PROCESS OF SMART ON-LINE EXAMINATION

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## Abstract

Practical use of the web 2.0 on-line eLearning and examination system, described in previous Mefanet reports, has led, due to its crowdsourcing features, to a wide database of multiple-choice questions. However the “question” is not exactly the best expression for the elementary particle of the examination system. Under “question” is understood a brief and logically compact module that consist from header (title/heading of the question) and options (answers) which could be only correct or incorrect. The question could be text, picture, animation, video or their combination. The same works for answers. Of course the use of multimedia is more popular than the pure text and often has higher educational effect. Especially in clinical subjects, the use of clinical photos and videos has higher clinical value. Implementation of 3D stereoscopic digital clinical photography and stereoscopic 3D clinical video led to a new challenge. The 5 years of experience with stereoscopic 3D photography and videos provided sufficient amount of 3D content (stereoscopic photographs and videos including macro shots). Starting with stereoscopic photos and videos by digital SLR – Nikon D90 with 3D macro lens in 2009 and with 3D Panasonic camcorder since 2010 allowed implementation of the 3D content into the system. The methods of visualization vary depending on the viewing methods ranging from anaglyph to active shutters interpretation. Significant improvement was gained by noncommercial implementation of YouTube services, uploading the stereoscopic videos on YouTube servers with “yt3d:enable=true” tag allowing stereoscopic features and so lighten the bandwidth load on our server.

## Keywords

stereoscopic photography, stereoscopic video, 3D medical testing, online examination, 3D eLearning, virtual patient, 3D visualization,

## Introduction

Stereoscopy, sometimes also called stereoscopic or 3D imaging, refers to a process of creating, enhancing or visualizing the illusion of depth in an image by presenting two images separately to the left and right eye of the viewer. Both of these 2D images are then combined in the brain to give the perception of 3D depth.

Stereoscopy creates the illusion of three-dimensional depth from images on a two-

dimensional plane that we also use in various forms during examination. For example the paper sheet or computer display during on-line examination. Human vision uses several cues to determine relative depths in a perceived scene. Some of these cues are:

- Stereopsis
- Accommodation of the eyeball (*eyeball focus*)
- Occlusion of one object by another



- Subtended visual angle of an object of known size
- Linear perspective (*convergence of parallel edges*)
- Vertical position (*objects higher in the scene generally tend to be perceived as further away*)
- Haze and desaturation
- Change in size of textured pattern detail

All the above cues, with the exception of the first two, are present in traditional two-dimensional images such as paintings, pho-

tographs, and television. Stereoscopy is the enhancement of the illusion of depth in a photograph, movie, or other two-dimensional image by presenting a slightly different image to each eye, and thereby adding the first of these cues (stereopsis) as well. It is important to note that the second cue is still not satisfied and therefore the illusion of depth is incomplete and sometime cause dizziness.

Stereoscopy is not a new technology; it was known and quite popular already in the middle of the 19<sup>th</sup> century (figures 1, 2 and 3).

With the rapid advancement of information technology during the recent decades, many higher education institutes are incorporating more and more IT into their education activities in order to improve their education quality and effectiveness. It is essential to understand eLearning as crucial tool in academic education, not only as a bonus and prestigious feature as it was couple decades ago. It is also essential to name responsible authorities for eLearning implementation into the university curriculum and choose the authorities aware of current trends in the IT. In rare cases those respectable university authorities occupying the posts of “eLearning decision-makers” are metaphorically lost in cyberspace and afraid of revealing their poor understanding of the current powers of Internet. Fear from what they don’t understand often leads to attenuation of various projects originating on their university and usually leads to reliance on foreign solutions. Such affected universities are



Figure 1: Vintage stereoscopic photography in anaglyph format.



Figure 2: Vintage photograph in stereoscopic parallel format.



Figure 3: Vintage stereoscopic viewer from 19<sup>th</sup> century.

usually not able to keep up with the growing demand and expectations of their students, and the rapidly evolving society. Under these circumstances, the term e-Learning is sometime rather a fashionable term, only a buzzword for these authorities and as a widely used term it helps them to sound wise and oriented. Such handicapped underdevelopment of university in the IT field during these years will have terrible and long-term effect on the prestige and quality of the particular university and vice-versa. By e-Learning, multimedia technologies and the internet are used to improve the quality of learning by facilitating access to resources and services. Furthermore, e-Learning also represents the facilitated exchange of ideas and collaboration (Pang, 2006).

In this paper, is introduced a method of implementation of 3D content into existing WEB 2.0 examination system. Use of stereoscopic images and videos in the web based e-Learning system was compared to 2D video/picture tests. New 3D features of YouTube services were used to implement stereoscopic video into the on-line test. This

allowed uploading only one version of stereoscopic video and leaving the users' choice to define the preferred method of pseudo3D interpretation. This could be, according to 3D YouTube menu, anaglyph or parallel format (Fig. 6.).

## Materials and methods

The 5 year experience with stereoscopic 3D photography and videos provided sufficient amount of 3D content (stereoscopic photographs and videos including macro shots). Starting with stereoscopic photos and videos by digital SLR – Nikon D90 (Figure 7) with 3D macro lens (Figure 8a) since 2009. This digital camera is able to shoot also video which we also used. Nikon cameras are constructed to share many functions with the lens and so using primitive 3D macro lens (Figure 8a) was possible only in the manual mode that caused loss of some advanced features of the camera.

Later in 2010 with started to use also 3D Panasonic camcorder (Figure 8b) that provided HD stereoscopic videos. Implementation of the 3D content into the system was



Figure 4: Modern simple stereoscopic viewer from 21<sup>st</sup> century could be compared to picture 3. allowing pseudo3D look at stereo-pair picture without any current hi-tech digital technology.



Figure 5: Anaglyph glasses allowing pseudo3D look at anaglyph picture without any current hi-tech digital technology.

not difficult. The methods of visualization were depending on the viewing methods ranging from anaglyph to active shutters interpretation. Significant improvement was gained by non-commercial implementation of already mentioned YouTube services, by uploading the stereoscopic videos on YouTube servers with “yt3d:enable=true” tag

allowing stereoscopic features and so lighten the bandwidth load on our server ([www.sapienti.ae](http://www.sapienti.ae)).

Example of stereoscopic videos could be found for example here: <http://goo.gl/mv2mX>.

In some clinical videos was the video too shaking however cropping that occurs when

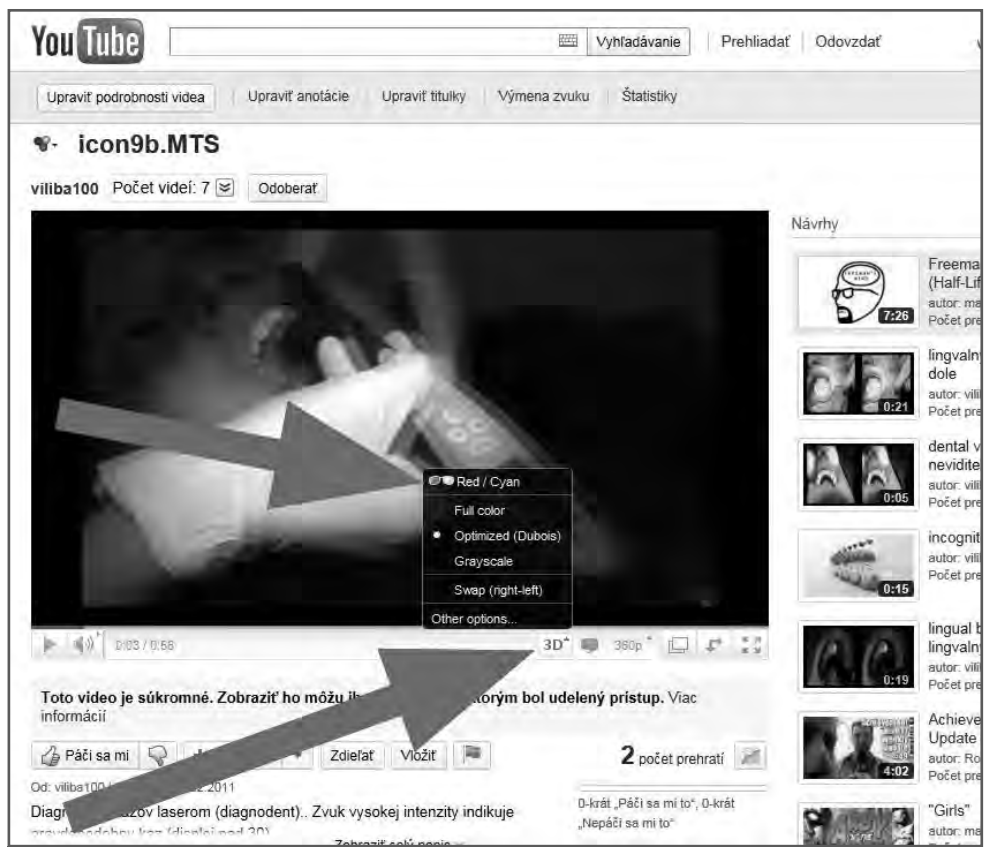


Figure 6: YouTube “3D menu” helping us to implement 3D videos into on-line examination with possibility to define the stereoscopic format later.



Figure 7: Digital SLR – Nikon D90



Figure 8a: Macro 3D lens LOREO.



Figure 8b: 3D camera Panasonic HDC-SDT750

using Google video edit stabilisation (Figure 10.) was destroying the stereoscopic architecture of the video and is not recommended by the authors of this paper. In some monoscopic 2D photographs authors also used software convertor to anaglyph and stereo-pair formats on the basis of depth maps (greyscale bitmaps), which were created from this images.

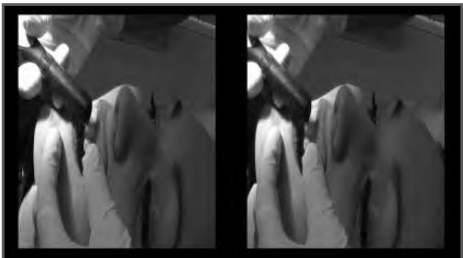


Figure 9: One frame from 3D video recorded by Panasonic 3D camera.

## Results

Smart on-line examination provided with our web 2.0 examination system described earlier, had to face the current developments. In fact it has taken the advantage from current technological developments allowing medical students to use their perception of depth in a limited way. Perception of depth from 2D photographs and 2D videos opens a new dimension of clinical documentation with not clearly researched benefits. Creating anaglyph pictures in pre-questions and questions in the system, to be used with red-cyan glasses was easy and without any obstacles. However to implement stereoscopic picture to be rendered by active shutter glasses depends on browser plugins and also graphic card NVIDIA or AMD/ATI drivers. This was more complicated also because the authors could not create common solution, suitable for each computer, because of different systems of visualisation for active shutter glasses. There is a high probability that in a very near future the situation in interpretation of stereoscopic on-line content will clear out. In the meantime the links to stereoscopic videos uploaded in YouTube showed as the most practical solution (Figure 11).

## Conclusion

Implementation of 3D content into e-learning solutions is a must. Later as the hardware and software cooperation in pseudo3D and true3D on-line content visualisation will establish and unify, the implementation will be much easier. The benefits and potential is promising.

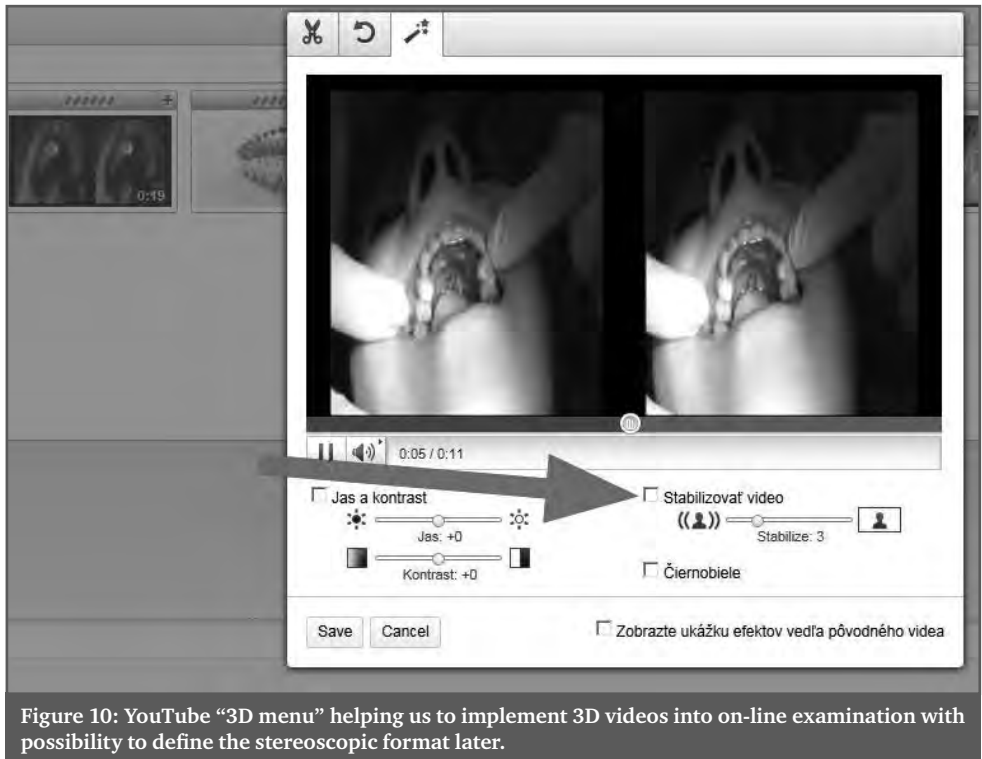


Figure 10: YouTube “3D menu” helping us to implement 3D videos into on-line examination with possibility to define the stereoscopic format later.



Figure 11: A screen from the system (www.sapi-enti.ae) during testing of anaglyph images.

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# **D** | **INFORMATION SYSTEMS AND EDUCATIONAL PORTALS**





# MEFANET AFTER FOUR YEARS OF PROGRESSING: STANDARDIZATION OF EDUCATIONAL WEB PLATFORM AMONG MEDICAL FACULTIES

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## Abstract

The MEFANET project (MEDical FACulties NETwork) has initiated international, effective and open cooperation among all medical faculties in the Czech Republic and Slovakia. One of the elementary goals of the project is to advance medical teaching and learning with the use of modern information and communication technologies. As an instrument for that, MEFANET has decided to develop an original and uniform solution for educational web portals which are used, together with a central gate, to offer and share digital educational content. Recent developments have focused on a new set of tools for multidimensional assessment of published contents quality. The following four dimensions are included: 1) review, 2) typological classification, 3) the level of the target groups, 4) users' self-study score. This 4-D assessment promises wider range of tools for the organization of published contents, as well as the opportunity to present teaching materials provided with expert commentary from selected medical professional societies.

## Keywords

educational network, distance education, educational technology, medical education, e-publishing

## Introduction

Rapid growth of the medical knowledge in our society makes medical school teachers to pass students ever increasing quantities of learning material. Sharing of educational contents with the use of information and communication technology (ICT) and open access to e-learning materials were encouraged in many reports, e.g. [1, 2, 3]. Only selected works [2, 3] show the need for quality control of shared teaching materials and ensuring validity, accuracy and the use of evidence-based practice.

The idea of cooperation of medical faculties on sharing their educational digital contents appeared in 2006 for the first time. Early after that in 2007 all seven Czech medical

faculties as well as all three Slovak medical faculties have formally joined the brand new network, see Figure 1. The MEFANET (MEDical FACulties NETwork) project [4, 5] aims to develop cooperation among the medical faculties as regards the progress in education of medical and health care disciplines using modern ICT by means of a common platform for sharing the educational digital contents. The primary objective of the MEFANET project is to ensure a horizontal accessibility of electronic teaching tools for both teachers and students. The MEFANET project is certainly not meant to affect or control teaching activities at individual faculties: all targets of the MEFANET project fully respect the independence of individual schools.

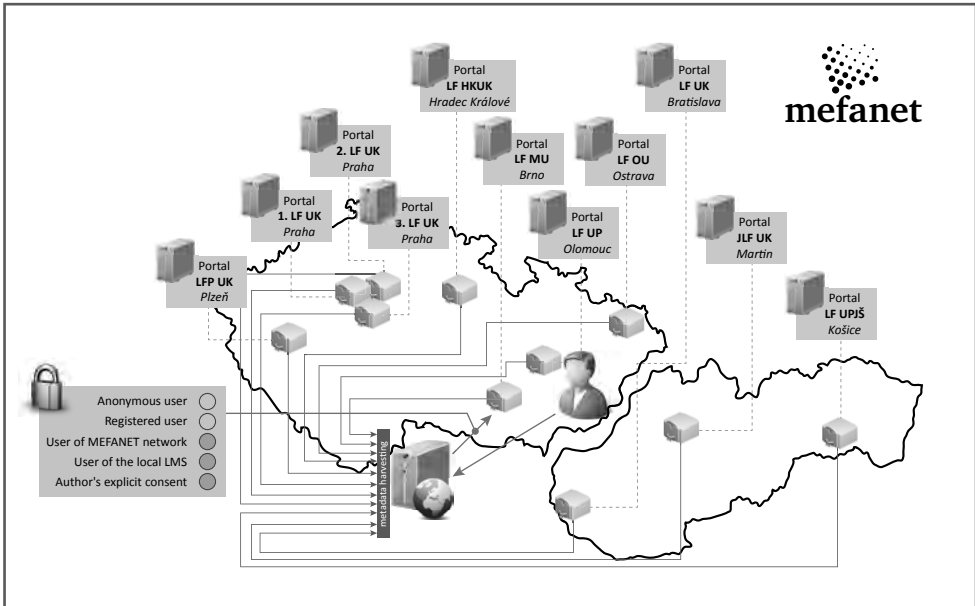


Figure 1: The MEFANET network involves all medical schools in the Czech Republic and Slovakia. They share each other digital teaching materials, using an e-publishing system, which consists of eleven instances of educational web portal and a central gateway. on-line examination with possibility to define the stereoscopic format later.

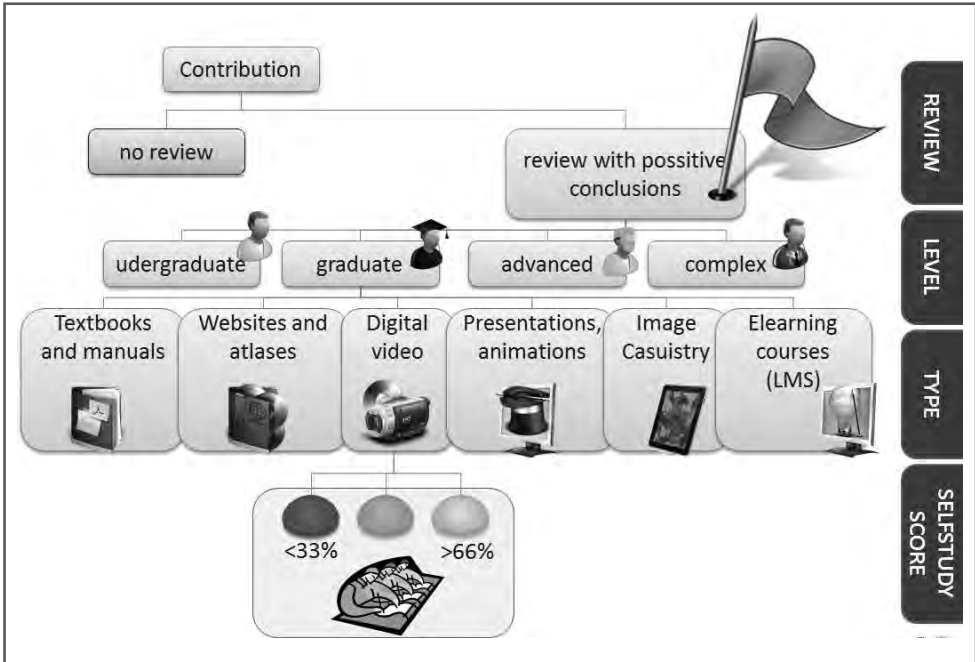


Figure 2: Four-dimensional quality assessment of the contributions involves the following four dimensions: 1. expert review, 2. educational level of target users, 3. classification by type, and 4. selfstudy score.

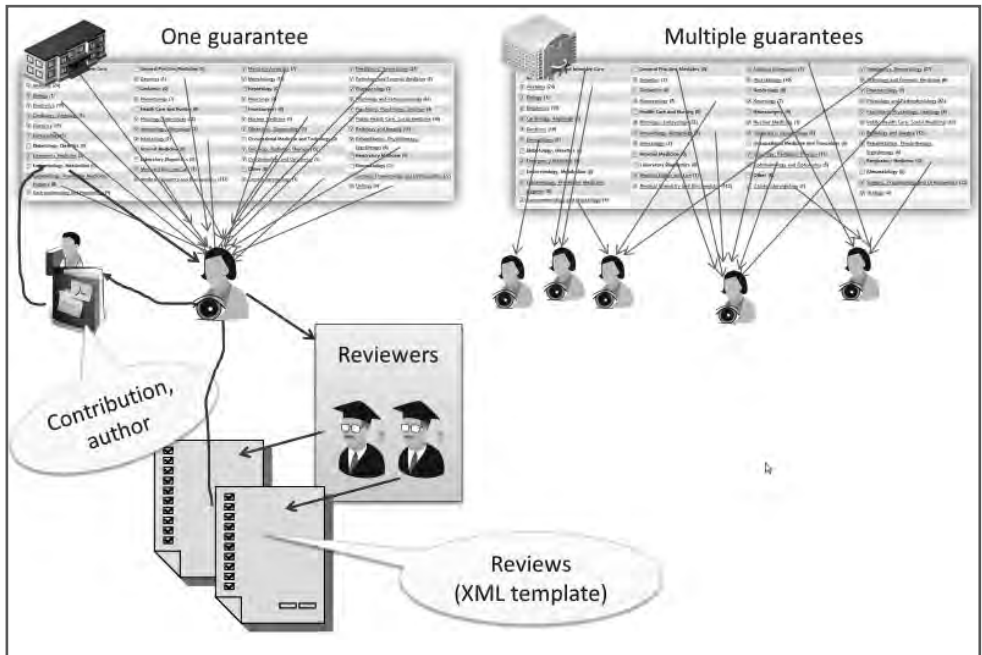


Figure 3: A contribution workflow basic scheme. 1. Author and technical editor finishes the contribution. 2. Guarantee, who is associated with particular medical disciplines, is notified about a new contribution in his/her area of interest. 3. The guarantee alone or with the help of faculty's editorial committee invites two reviewers who prepare their reviews on-line with the use of XML-template-generated forms.

## Common portal platform

There are two particular goals concerning the educational web platform in the MEFANET project: 1. to unify educational web portals of the involved medical schools such that the published teaching materials are accessible horizontally, 2. to build a common central gateway enabling easy and comprehensible content browsing.

The idea of the shared e-publishing system<sup>[6,7]</sup> is based on a set of standalone web portals rather than on a centralized application hosted for all medical schools, what might be an inflexible and more vulnerable alternative solution. Each portal instance represents an independent publication media with its ISSN code and an editorial board. Local metadata describing the digital educational contents are replicated regularly to the central gateway, see Figure 1.

There are three fundamental elements which have to be kept rigid on the parts of the local administrators: 1. Medical disciplines linker, 2. Authentication / authorization framework and 3. Multidimensional quality assessment.

The other features, properties, functionalities can be adapted or localized to meet the needs of the particular schools.

## Medical disciplines linker

The medical disciplines linker represents taxonomy of the contributions. At the beginning single-level or multilevel list of medical specializations were considered as well as the possibility to adapt an existing scheme from the National library of the Czech Republic, which is based on the standard Conspectus method<sup>[8]</sup>. However, the medical disciplines mapping according to the Conspectus method showed to be inapplicable for MEFANET purposes. Thus, an own medical disciplines linker was composed, based on various taxonomies adapted from significant medical publishing houses. It is a single level list of 48 medical specializations. It is the only obligatory structure of a portal instance and any change to it is a subject to approval of the coordinating committee of the MEFANET project.

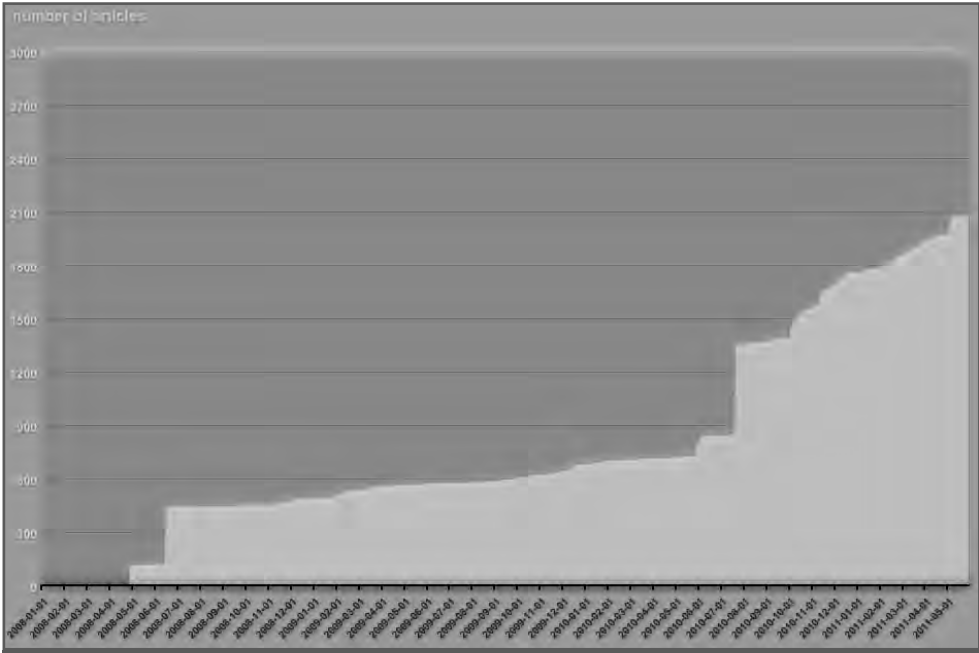


Figure 4: The number of shared contributions in the MEFANET network has been increasing since the launch of the central gateway. It is worth to note that each contribution represents a set of electronic teaching materials with varying degrees of complexity / granularity.

## Authentication / authorization framework

The access to portal instances is not restricted anyhow. All pages and contributions are accessible for anyone. Thus, everyone interested can get an overview of digital educational contents available in the given medical school or even in the whole MEFANET network. The educational contents itself is included in attached files or hypertext links. Each attachment and/or link contains information on a group of users who have access to these materials.

The authors of the teaching materials (i.e. published attachments) can choose from the following user groups, in order to permit or deny access to their materials: 1. non-registered anonymous users, 2. registered anonymous users, who accepts the terms of use within his/her registration, 3. user of MEFANET network, i.e. student or teacher from any Czech or Slovak medical school, 4. user of local university, whose affiliation to that university has been verified at the portal via the local information system of that university, 5. user to whom attachments are

made available only on the author's explicit consent.

Services of the Czech academic identity federation EDUID.CZ<sup>[9]</sup> are used, in order to check affiliations of the users of the portal instances. This federation uses Shibboleth technology which is one of many authentication frameworks allowing sharing web resources among institutions using the SAML (Security Assertion Markup Language) protocol standard. The portal instances behave like service providers in this federation, whereas the information systems of the involved schools behave like identity providers.

## 4-D quality assessment

There are four dimensions which are of crucial importance when evaluating the quality of electronic teaching materials, see Figure 2.

The first of them is an expert review. The review includes binary questions as well as open questions. The structure of the review-form can be localized by modifying an XML template file. The second dimension is represented by the educational level of the tar-

get group of the teaching material, which is a useful piece of information for users as well as for reviewers. Next dimension is represented by a multiple-choice classification according to the types of attachments – the enumerated scale includes static files for web-based learning as well as interactive e-learning courses encapsulated in learn management systems (LMS). The last dimension – a self-study score – shows what users think about usability of a particular contribution for their self-studies.

Values of the first three dimensions of the 4-D assessment of are composed by authors, guarantees and reviewers. Their activities as well as the workflow of a contribution are explained in Figure 3.

## Central gateway

The central gateway is besides eleven portal instances another web-based application which collects all metadata from the web portals in the MEFANET network. A complete image about the available digital contents is constructed in this way. Students and academic staff can search and browse the contributions sorted by medical disciplines, authors, schools or multidimensional quality assessment criteria. For details, see <http://portal.mefanet.cz>.

The data format of a shared contribution is based on XML-based RELAX NG schema language <sup>[10]</sup>. XML documents representing the contributions without their attachments are imported regularly with 24-hour period. The XML validation procedures are based on matching patterns specified in own RELAX NG schema.

## Contents of MEFANET “with a tutor!”

The MEFANET e-publishing system can be understood as very close to the so-called discovery webscale systems which main purpose is to harvest metadata from individual catalogues and to perform deep full-text indexing as well as to provide users a

simple tool for quick and efficient retrieval from a wide set of catalogues or databases of e-resources. We believe that a good implementation of the 4-D assessment will enable us to derive many interesting functionalities for MEFANET platform from selected web-scale discovery systems. In particular, the functionality commonly referred to as facets for search refining is in the viewfinder. With facets’ use the published content will be presented in a more structured form, without creating new demands on users for complex search forms. After what the content is organized, medical professional societies will be addressed to nominate experts or tutors, who will provide additional comments, and thus help users to recognize appropriate sequence of studying the materials.

## Conclusions

The educational web platform for offering and sharing digital teaching materials among all medical schools in the Czech Republic and Slovakia was presented and its fundamental elements were described. The platform is used at ten medical schools in two countries by users in two groups: academic staff – about 3.900 potential users – and students – about 16.500 potential users. The local portal instances do not replace well-established LMS systems at the medical schools. Compared to the LMS, the educational portal platform provides additional e publishing tools with well-defined rules for quality assessment. Further, it allows users federated authentication, and so they do not have to create ten separate user accounts for each portal instance.

High-quality digital educational contents production has become a matter of prestige at medical schools in this region and the volume of teaching materials available is growing rapidly – thanks to the MEFANET project and its platform, see Figure 4. Further development will aim to encourage publication of materials aimed at clinical reasoning based on the concept of virtual patients.

## ACKNOWLEDGEMENT

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## 19

# IMPLEMENTATION OF ELECTRONIC LEARNING PROCESSES IN THE (AIS) ACADEMIC INFORMATION SYSTEM

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## Abstract

Academic information system does not have to be only the formal part of the school attendance, but it could be a significant help to enhancing the studying process. Introducing the active e-learning rather than offering only presentations from the lectures, has become the latest trend. Assignment of homework through the system or showing colleague's test score online could motivate students to stay in touch with the latest knowledge and learn all through the year, and not only with the aim to pass the exam.

Our centralized academic information system (AIS2) was launched on September 1<sup>st</sup> 2009, simultaneously on all 13 faculties of Comenius University. For the first time ever, in the summer term 2009/2010 students had the opportunity to sign in for exams in all departments of the Medical Faculty in Bratislava. Students appreciated this improvement with enthusiasm and are looking forward for the new modules of this system.

Already in the first year of AIS2 operation it became obvious that the study system on Medical Faculty is different and bears certain specific features; what is sufficient for a common faculty may not necessarily be good enough for the Medical Faculty. Students shown to have clear expectations from the electronic academic system. A survey was made with 388 students trying to ascertain their views on academic information system and define their needs.

## Keywords

AIS, AIS2, e- learning, student's inquiry

## Introduction

Our centralized academic information system (AIS2) was launched on September 1<sup>st</sup> 2009 simultaneously on all 13 faculties of Comenius University. It is a comprehensive information system designed primarily to manage all three degrees of university education and to support the science and research. The Center of Applied Computer Science at the University of P. J. Šafárik in Košice is developing the system since 1997. Step by step, it has been implemented in 12 institutions. Since 2005, AIS became a part of the

central development IT project supported by the Ministry of Education, Science, Research and Sport of the Slovak Republic. University of Economics in Bratislava, Academy of Performing Arts in Bratislava and The Academy of Fine Arts and Design in Bratislava also joined the project. A new improved version of the AIS called AIS 2 has been developed. It reflects the latest changes in the applied technologies and enhanced skills of the current computer users. University actively participates in the AIS development through working groups. The final product should be

sufficiently flexible, and applicable to various colleges and universities.

The need for an information system on Comenius University has been clear for some time already. Discussions about its complexity, functions, modules, and the provided educational information took several years. Each Faculty was involved in planning of a new system called Student II. Once the public procurement process failed in 2009, Comenius University entered the IT project supported by the Ministry of Education.

## Experience

The academic information system is always a big help for the Student Affairs Department, as well as for the students and teachers. Already in the first year of AIS2 operation it became obvious that the study system on Medical Faculty is different and bears certain specific features. What is sufficient for a common faculty may not necessarily be good enough for the Medical Faculty.

## Benefits of the information system as such for the student and the teacher:

- Bigger comfort – the possibility of better education through computer and Internet.
- Information system minimizes the Student Affairs Department visits, as most of the operations like signing in for the new academic year may be done electronically.
- It provides students with detailed information on subjects and offers the possibility for electronic registration for exams.
- The student will not have to browse through the yearbook.
- Teacher can see who signed in for the subject.
- Links or electronic information sources can be provided to the student together with information about the conditions for gaining credits and taking exams.
- Teacher may insert all students' evaluations into the system saving thus the time he would spent on filling in the individual Report cards.
- All is available within the web browser interface – no need to install anything.

## The situation on a medical school:

- Signing in for the new academic year can be done electronically, though the student still needs to visit the Student Affairs Department to sign the papers. Electronic signature is not enacted in the Slovak Republic.
- Signing in for subjects is just a formality, in fact students cannot choose subjects. Prerequisites prevent them from doing it.
- Browsing through the yearbook is faster than searching in the Oracle interface.
- Teacher knows well that all 300 students in one year will choose his subject, as it is a prerequisite to further studies.
- AIS does not save teachers time or work with Report cards, because the teacher has to do the same paper work with or without AIS.
- Medical faculties have their clinics in hospitals. Obsolete Internet browser versions installed in hospital computers are preventing teachers from using AIS.

## What is important for the students

Expectations are high, taking into account the public online discussion and endless waiting during the last decades. Many e-learning ideas and improvements are still waiting to be implemented. Some questions about the intellectual property rights or users motivation remained unanswered. For the first time ever, in the summer term 2009/2010 students had the opportunity to sign in for exams in all departments of the Medical Faculty in Bratislava. Students appreciated this improvement with enthusiasm.

The discussion of all possibilities and functions of the AIS shown clearly that there are two functions essential for students. Signing in for exams electronically and the access to educational sources. Academic information system does not have to be only the formal part of the school attendance, but it could be significant help to enhance the studying process. Introducing the active e-learning rather than only offering presentations from the lectures, has become the latest trend. Assign-



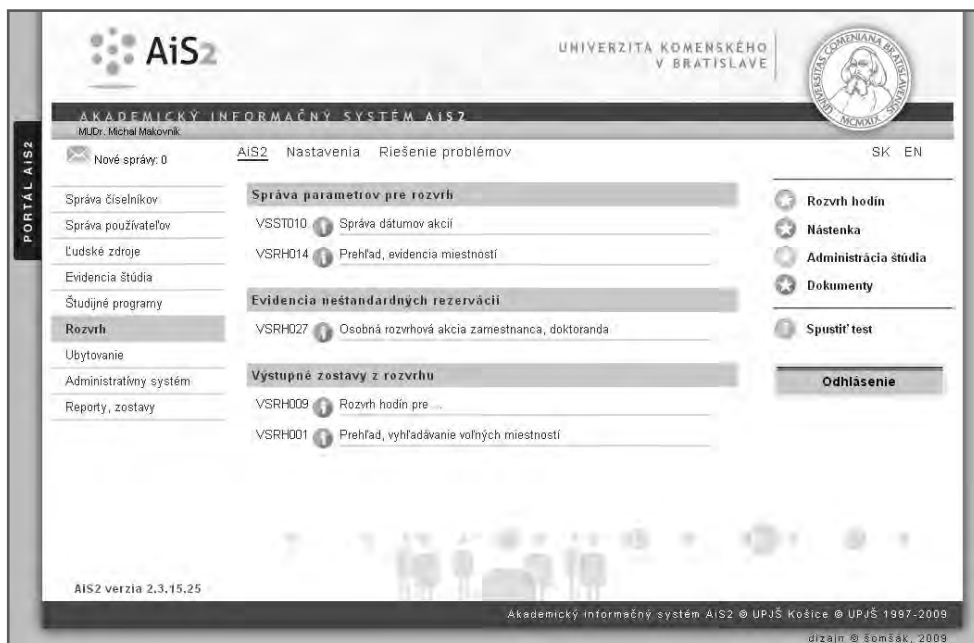


Figure 1: Home screen screenshot from AIS2

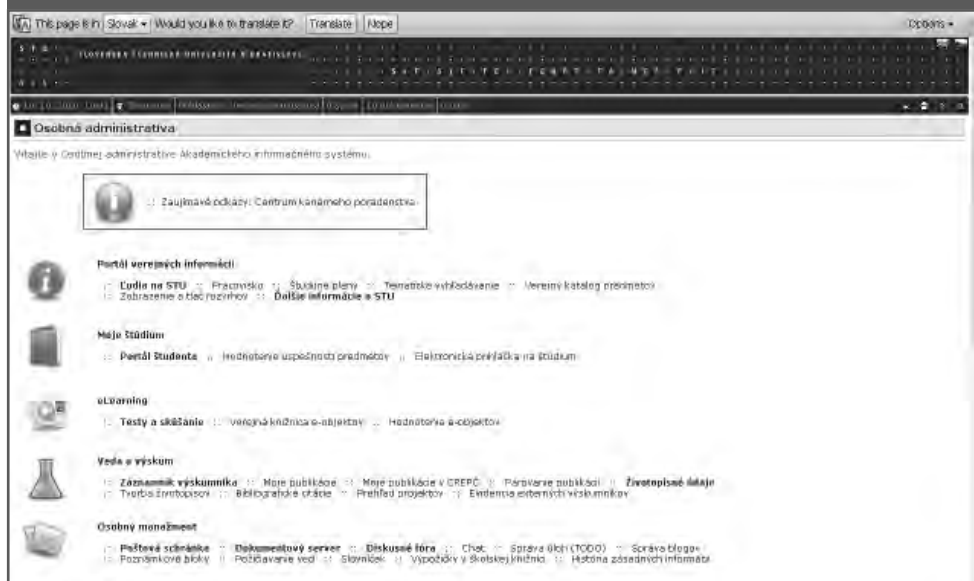


Figure 2: Home screen screenshots from academic information system on FEI

ment of homework through the system or showing test score online could motivate students to stay in touch with the latest knowledge and learn all through the year and not only with the aim to pass the exam. Students shown to have clear expectations from the electronic academic system. They do not view the AIS as electronic study agenda processing for the University, they rather wish easier access to e-content as a part of the

system. A survey was made with students of Medical Faculty of Comenius University and other faculties trying to ascertain their views on the academic information system and define their needs.

388 students participated in the survey, 226 thereof were students from the Medical Faculty of Comenius University (LFUK) and 160 from other universities in Bratislava. The goal of the survey was to find out the ser-

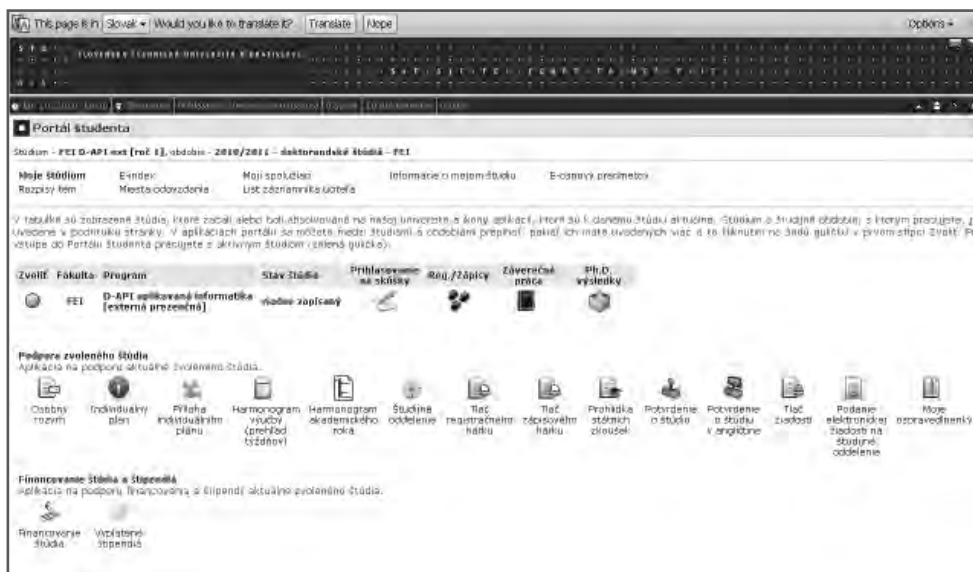


Figure 3: Screenshot showing the work with academic information system on FEI

vices and information sources students are interested in, as well as to establish the differences between LFUK students and students from other faculties, if any.

In the first question, the home screen screenshots from the AIS2 (Figure 1) and the academic information system of Faculty of Electrical Engineering and Information Technology of the Slovak University of Technology (FEI) (Figure 2) were compared. Reactions were almost the same in both groups. Around 70% of the respondents found the AIS2 home screen screenshot better arranged

On the contrary, the screenshot showing the work with academic information system on FEI (Figure 3) was considered to be better arranged as the AIS 2 (Figure 4). 62% of LFUK students and 54% of other student voted for it.

All of the students would like to have the possibility to download PowerPoint presentations from the lectures.

5% would like to have an electronic book for online reading accessible in their academic information system, 20% would like to have it for just downloading and 75% for online reading and downloading.

Only 87% of students would like to have their homework's for the next practice disclosed in AIS.

93% would like to publish the conditions for gaining credits and exams in the AIS.

In the next question, we asked the students if they would like to see the classmate's tests results and vice versa. In the LFUK student group, 5,5% answered Yes; 33% No and 61,5% would like to decide, if they show them or not. In the other group 7% answered yes, 39% no and 54% would like to decide.

55% of the LFUK student group would agree to show the date of the exam they signed in; 8% would not and 37% would like to decide if they disclose it or no. In the other group, 70% would agree to show the date of the exam they signed in; 5% would not and 25% would like to decide.

20% of the LFUK student group would like to have the opportunity evaluate the school employees via the AIS; 17% not and 63% would agree doing it only anonymously. 14% of the other group would like to evaluate the school employees via the AIS; 14% not and 72% would agree doing it only anonymously.

In the case of the AIS technical problems, in the LFUK group 67% would like to solve these via e-mail; 5% through the Student Affairs Department; 28% with a NON-STOP phone line. In the other group, 71,5% would like to solve these issues via e-mail; 6% through the Student Affairs Department; 22,5% with a NON-STOP phone line. Nobody would like to solve the AIS technical problems via a letter communication.

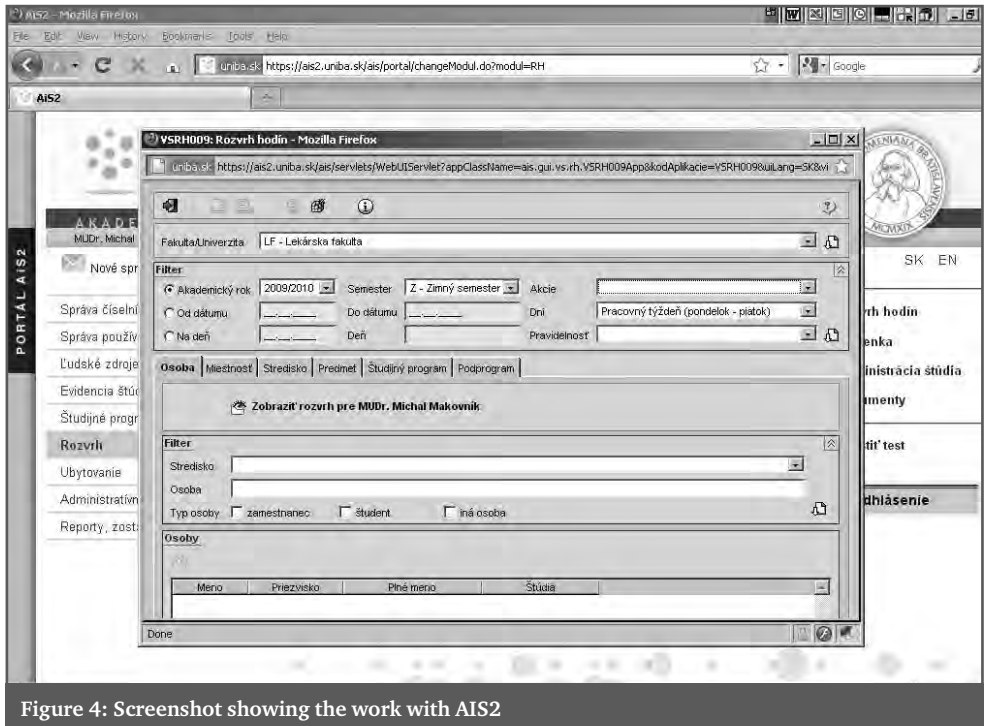


Figure 4: Screenshot showing the work with AIS2

In the LFUK group, 75% of the respondents would be willing to pay for the SMS notification service, (e.g. notification of a free date for exam, information on the test result, notification from the Student Affairs Department). In the other group, only 50% of the respondents would be willing to pay for such a service.

In the LFUK group, 58% would be willing to pay for a special postal service, but only 37% in the other group. The special postal service means that the Student Affairs Department would send the electronically submitted documents via post to the student. (e.g. School attendance Certificate or other documents with signatures and stamps that can not be sent electronically). The student would not need to visit personally the Student Affairs Department during its office hours.

## Conclusion

Students welcomed the AIS with enthusiasm and are looking forward to its new func-

tions. An interesting difference between the LFUK students and students from other faculties can be found in the questioned group. The group of non-medical students seems to be more open in questions of their privacy. Exception may be just the school employee's evaluation.

In general, students want more features in the AIS. More than a half of the students would be willing to pay for special services, such as the SMS notifications or postal service. These optional services could not only enhance the user comfort and the popularity of the AIS, but also reduce the costs. Academic information system does not have to be only the formal part of the school attendance; it could be a significant help to enhancing the studying process. More interactivity and interrelatedness with the e-content is expected.

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# CREATION OF E-LEARNING CONTRIBUTIONS FOR EDUCATIONAL PORTAL IMED – “CYSTICS FIBROSIS”

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## Abstract

Slovak Medical Chamber (SMC) is carrying out the project “Formation and implementation of e-learning portal for medical education” with financial contribution from European Social Fund, since 2009. One aim of the project, which is in process now, is to create the e-learning portal IMED ([www.i-med.sk](http://www.i-med.sk)) and after that continually update its content. To fulfill our goal, we have chosen to use a non-standard procedure – to develop smart user-friendly templates and use them to create and provide papers in digital form. With help of our authoring tool, it will be easy to prepare professional e-learning educational materials, also for the authors with no further experience and IT skills. These templates have been realized according to the analysis of our target group demands – the primary care physicians, considering the requirement of the standardized structure of e-learning papers. The review proceeding is integrated into the template, as it is an important prerequisite to ensure that IMED portal will provide quality and up-to-date medical information. At this time, the programmed authoring tool and its functionality is in process of final testing.

One of the first created papers is “Cystic fibrosis from the perspective of General Practitioner for Children and Adolescents”. Cystic fibrosis (CF) is a serious genetic disease. In recent years clarification of the pathogenesis and elaboration of complex treatment approach significantly prolonged the survival of patients and also improved the life quality of patients suffering from this disease. The aim of the paper “Cystic fibrosis from the perspective General Practitioner for Children and Adolescents” is to bring the latest generally accepted crucial data about cystic fibrosis needed in the General Practitioner for Children and Adolescents practice. The paper focuses on the etiopathogenesis, clinical features, differential diagnosis, disease treatment, and prognosis. Working with a template definitely simplifies the process of creating the paper. It provides quoting standards support, 12 template page formats, and basic tools for creating all parts of the paper (tests, dictionaries, online resources...) etc. Nevertheless it is only a support for the author in providing a formal structure of the paper with all necessary parts. However, the quality of the paper is given by its' content and context.

## Keywords

e-learning, lifelong learning of the primary care physicians, project imed, cystic fibrosis

## Introduction

Since June 2009 Slovak Medical Chamber (SMCh) has been working on the project “Formation and implementation of e-learning portal for medical education”. SMCh was granted the non-repayable contribution by European Social Fund within the “Operational Programme Education”, priority 2 – Further education as a tool for human

resource development, Proceeding 2.2 – Support of systematic education in health care<sup>[1]</sup>.

The main goal of the project is to create an effective tool for systematic education in health care area using a CME (Continuing Medical Education) in digital environment; i.e. to increase availability and flexibility of educational activities for our doctors.

The newly developed educational e-learning portal for doctors IMED<sup>[2]</sup> is available on the following web page: [www.i-med.sk](http://www.i-med.sk). It aims to introduce quality and actual educational materials applicable for doctors of first contact, as well as for specialists in particular medical areas. The portal puts the accent on information applicable in doctors' practise and based on principles of evidence-based medicine. At the same time it will inform about wide area of medical disciplines, latest knowledge in prevention, diagnostics, and therapies. Doctors can test their gained knowledge and earn credits if they fill in self-study tests online on the portal.

The e-learning portal IMED has an ambition to become a modern tool for systematic education and self-study; using latest technologies it aims to become a supplement, not a substitution, to current medical education.

## **Cystic fibrosis from the prospective of General Practitioner for Children and Adolescents**

The e-learning paper "Cystic fibrosis from the prospective of General Practitioner for Children and Adolescents" is elaborated in a way of a well arranged article. It summarizes papers published by our and foreign authors pointing out information applicable in practise of physicians. The paper offers a complex view on the serious, genetic conditioned, and recessive disease which occurs in our region with frequency of 1 disease per 2500 inhabitants<sup>[3]</sup>.

Cystic fibrosis is a disease characterized by generalized exocrine glands dysfunction (disorder of electrolytes transport: Na, Cl) in epithelial cells of respiratory, gastrointestinal, urogenital tract, and sweat glands<sup>[4, 5]</sup>. As a consequence, the affected glands produce a highly viscous secretion which is responsible for plugging glands' ducts and an inflammatory process damaging the parenchymatous organs. Respiratory and gastrointestinal symptoms are the most common and most serious manifestation of the disease. However, the disease may prove isolated signs of disability of other bodies, e.g. edema at hypoproteine-

mia; manifestations of homeostasis disorder; men sterility, and other.

A mandatory screening examination of cystic fibrosis on newborns has been introduced in Slovak Republic since February 2009. The examination is done via establishing the level of immunoreactive trypsin. Subsequently in case of a positive result a targeted examination of chloride in the sweat and determination of genotype follow what provides not only early diagnosis but mainly allows to start early appropriate treatment<sup>[6]</sup>.

Early diagnosis and subsequent referring the patient to specialized units for cystic fibrosis is not only a choice but it is an inevitable approach to patients with this severe disease. Individual parts of the paper are sorted into smaller units: etiopathogenesis; case history and clinical symptoms leading to disease diagnosis; laboratory diagnosis, including prenatal diagnostics; treatment (conservative and surgical transplantation of heart-lungs complex) as well as the prognosis of the disease.

The paper "Cystic fibrosis from the perspective of General Practitioner for Children and Adolescents" aims to bring relevant information about cystic fibrosis pointing out new approaches in diagnosis of the disease, and a well-developed comprehensive approach to treatment under established centers for the cystic fibrosis. As a result, not only the survival of patients was significantly prolonged but also the quality of their lives was improved. Due to the fact cystic fibrosis is not anymore a disease of childhood but also an adult one. The disease obtains an important position in differential diagnostic considerations of doctors.

## **The e-learning paper's structure**

The requirements listed in the brochure "How to write posts on e-learning portal for medical education"<sup>[7]</sup>, which is one of the outputs of the project, were taken into account when creating the paper "Cystic fibrosis from the perspective of General Practitioner for Children and Adolescents".

Pre autorov Moje súbory

**i med** Moderné vzdelávanie pre vedomostnú spoločnosť / Projekt je spolufinancovaný zo zdrojov EÚ

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Dystická fibróza z pohľadu VLDD / Teremová / 2010

Dystická fibróza z pohľadu VLDD

1. Úvod

1.1. Definícia ochorenia CF

1.2. Výskyt CF

1.3. Patofyziológia CF

1.4. Genetika ochorenia CF

1.4.1. Mutácia génu CFTR

1.5. Pôvodová infekcia u pacientov s CF

2. Klinické prejavy ochorenia

2.1. Klinické prejavy CF podľa veku

2.1.1. Novorodenec a dojčenský vek

2.1.2. Staršie deti

2.2. Klinické prejavy CF podľa lokalizácie

2.2.1. GIT prejavy

2.2.2. Respiračné prejavy CF

3. Diagnóza CF

3.1. Laboratórne a pomocné vyšetrenia

3.2. Diferenciálna diagnostika

4. Ústredie

4.1. Prevencia a liečba infekcie a zápalového procesu pľúc

4.2. Zabezpečenie čistoty dýchacích ciest

4.3. Nutričná podpora pacienta

4.4. Komplikácie

5. Prevencia ochorenia

6. Záver

Literatúra

## 2. Klinické prejavy ochorenia

- sú veľmi rôznorodé v závislosti od postihnutých orgánov - stúpa počet pacientov s dominujúcimi prejavmi postihnutia GITu.

Pri závažných formách CF sa niektoré prejavy objavujú už v novorodeneckom veku, iné sa vyvíjajú neskôr, postupne. Respiračné a gastrointestinálne príznaky sú najčastejším a aj najzávažnejším prejavom ochorenia (Obr. 7). Menej závažné formy CF sa často diagnostikujú až v puberte, resp. v dospelosti.

Obr. 7. Orgány ovplyvnené cystickou fibrózou \*

\* Rosalyn, Carson-DeWitt: Beliefnet, Cystic Fibrosis. [online] Publikované 2007-11-01. [aktualizované 2007-11-01], [citované 2010-10-15]. Dostupné z <<http://www.beliefnet.com/healthandhealing/getcontent.aspx?cid=11918>>.

Redakčná rada Recenzent Didaktik

Práve píšete správu pre redakčnú radu

Odošli

Zatiaž neexistuje žiadny záznam pre túto sekciu.

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Figure 1: The chapter 2 overview. The clinical symptoms of disease in the authoring tool.

A 3000-character abstract was created along with the paper aim description in 1500 characters; 6 key words and their explanation in the glossary prepared on the i-MED portal.

The principal part of the paper is divided into smaller parts; it has 32 online pages and it contains all necessary information to pass a credit test from the particular area described in the paper. The main part includes 14 pictures, 1 chart, and 12 feedback questions.

The whole text is much more complex. Extras such as classifications or extensions to the paper are in a form of attachments available after clicking the “More about...” button.

Apart from the bibliography used in the paper itself, in the list of bibliography there are listed 18 recommended online sources about the topic.

An educational test with 15 questions, which is freely available for unlimited accesses, is also a part of the paper. A learning doctor can log in to the portal using the ID code and password provided by the SMCh. Then he or she has the opportunity to receive feedback on whether he/she has understood the topic correctly. 10 out of 15 questions are then used in the credit test. Once the portal is fully launched, the test will enable learning doctors to earn credits upon correctly answered test questions / tasks. Credits will then be automatically added to his account registered at the SMCh. The credit test to a paper can be performed only once by each doctor.

## Working with the template

To prepare papers on the web portal [www.i-med.sk](http://www.i-med.sk), there are several templates available. The templates act as a support to create papers – the authoring tool for authors with no further experience in creating professional e-learning educational materials. The author has very intuitive and easy-to-use tool to prepare quality materials with good technical background. The author has also the option to become familiar with this authoring tool and its environment with help of the Methodological guide for authors “How to prepare the educational materials for i-med.sk”. It is accessible on URL <http://www.i-med.sk/prirucka/>.

This guide leads the author step by step through the whole process of using the template.

**Help in three forms** – text, audio or video, leads the author throughout the whole work in the template. The template uses standardized elements, so that the author can simply and easily get around with the template in each section. Uniform icons are used in the template for editing, formatting the content and its structure, icons for selecting the type of citation, as well as the status icons showing the paper’s state in the review proceeding.

**Inserting the educational text** is enabled thanks to 12 pages with predefined format with different layout (title, text, image, table, and question/task). It is possible to insert predefined titles, which are editable and are displayed together with corresponding icons. It is also possible to move and delete individual pages of the educational text, except for the first initial page and the last page (bibliography) – these are fixed. All inserted elements can be edited or deleted if necessary (Figure 1).

For the author, the major simplification is that all kinds of the paper’s text (abstract, objectives, educational texts...) can be edited directly in this authoring tool or inserted from pre-prepared materials in MS Word, ppt, pdf... by using the copy/paste function. The formatting of the text does not matter, because the template changes all according to selected design.

**Citation module.** Another helpful tool for authors in the template is the citation module – the author can insert the citation in section “Citations”, by filling in the form for chosen entry. This citation is then automatically processed by the system according to standards ISO 690. The created citations may be inserted into the educational text at any time and as many times as needed by clicking the icon “Citation”.

**“My files”.** Each author has his/her own data storage place “My files”, where various types of files can be loaded up to the size 70 MB per each file (larger files are added on the portal by the administrator). Any file uploaded by one author can be used then in

The screenshot shows a Moodle LMS interface. At the top, there is a navigation bar with links: Redakčná rada, Aktuality, O nás, Partneri, Pomocník, Kontakt, Pre autorov, and Pre recenzentov. Below this is a header section with the 'i|med' logo, a tagline 'Moderné vzdelávanie pre vedomostnú spoločnosť / Projekt je spolufinancovaný zo zdrojov EÚ', and logos for the Slovak Republic and the European Union. The main content area is titled 'Cystická fibróza z pohľadu VLDD' by MUDr. Zuzana Teremová. It includes her contact information and a list of keywords: cystická fibróza, mukoviscidóza, CFTR, potrný test, chloridový kanál, pankreatofibróza. Below this is a list of resources numbered 1 to 6: 1. Štruktúrovaný abstrakt (Structured abstract), 2. Vzdelávací text (Educational text), 3. Otvorený test (Open test), 4. Kreditový test (Credit test), 5. Audio, Video, and 6. Viac o ... (More about ...). The left sidebar shows a list of medical specialties, and the right sidebar shows a rating system and administrative options.

Figure 2: The user's overview of the published paper "Cystic fibrosis from the prospective of General Practitioner for Children and Adolescents" in Moodle environment.

all his/her papers, if he/she decides to continue to work with the template and prepare more papers.

**Pictures.** Even the work with pictures is easier using the template as they can be loaded to the data storage place "My files" in jpg, gif,

png and bmp format. The pictures are then inserted on the page by clicking the "Insert picture" icon. The pictures are automatically numbered according to their position in the paper (Fig. 1, Fig. 2...). The pictures can be used repeatedly and their title can be set



**i-med** Moderné vzdelávanie pre vedomostnú spoločnosť / Projekt je spolufinancovaný zo zdrojov EÚ

**1.4. Genetika ochorenia CF**

**Dedičnosť cystickej fibrózy (CF)**

CF je geneticky podmienené ochorenie autozomálne recesívne viazané (Obr. 3), s uplatňovaním génových modulatorov.

Najčastejšou genetickou mutáciou v Európe je **delecia tripletu báz CTT v exone 10**. Následkom toho je chýbanie aminokyseliny fenylalanínu v pozícii delta F 508. Vyskytuje sa v 66 % u pacientov s CF. Priebeh ochorenia ovplyvňujú aj environmentálne faktory – rodinné prostredie a spôsob domácej starostlivosti, rehabilitácie, medicínske liečebné postupy.

**Obr. 3. Genetický strom \***

**Ktoré z nasledujúcich konštatovaní je vhodné adresovať rodičom s dieťaťom s CF, ktorí plánujú mať druhé dieťa?**

- Odporučiť genetické poradenstvo
- Je 50 % pravdepodobnosť, že dieťa bude normálne
- Je 50 % pravdepodobnosť, že dieťa bude postihnuté s CF
- Je 25 % pravdepodobnosť, že dieťa bude len nosičom

**Ukáž odpoveď**

\* The Worlds of , David Darling: Cystic fibrosis. [online] Publikované 2010-10-15. [aktualizované 2010-10-15], [citované 2010-10-15]. Dostupné z <[http://www.daviddarling.info/encyclopedia/C/cystic\\_fibrosis.html](http://www.daviddarling.info/encyclopedia/C/cystic_fibrosis.html)>.

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Figure 3: The user's overview of the chapter 1.4. The cystic fibrosis disease genetics.

each time when inserted. The size of inserted picture is limited to max. 1280 × 1024 px, which represents about 33 × 27 cm.

The author does not have to worry about the correct size of picture inserted on the page. The template will automatically adjust the image size regarding the chosen page format. If the image size is smaller than predefined, the picture is displayed in original size. After clicking on the picture it is opened in new window in its original size. If it is necessary to use picture with larger size, the author can ask the portal administrator to add this picture.

**Automat in action.** Everything what can be done automatically is set by the system – for example all citations inserted by the author into the text are automatically displayed in the list of citations according to standards ISO 690 and are alphabetically ordered. The pictures and tables are also numbered automatically. All data on the IMED portal inserted by one author can be automatically loaded anywhere it is needed and they are available at any time.

**Test questions, Online resources to current topic and Dictionary entries** are inserted by author with a help of separate

modules, which are directly linked with the Moodle learning environment<sup>[8]</sup>. After filling in all items in the template the data are implemented directly to Moodle and the full paper is displayed (Figure 2).

**Paper's design.** The authoring tool is created so that the author has the basic idea of how the paper will look like after exporting to Moodle during the whole editing process. The difference between edited and exported paper is only in displaying/not displaying editing icons (Figure 3). This approach clearly makes the author's orientation easier during the paper's preparation process.

**Review proceeding.** After logging in to the portal, the author enters the section "For authors" where author can complete the form "Request to prepare the paper" and send it to the editorial council. As soon as the paper's issue is approved, the author can write the abstract, which again has to be approved by the reviewer for corresponding specialization and then the paper is fully opened for editing (Figure 1). The author has the option to communicate with member of editorial council and with reviewer or didactic via message panel located directly below each inserted page of the paper (Figure 1, below). These two loops of review proceeding may be skipped by using the quick review proceeding. Only the final step remains, when the completed paper is given to review. Programming of review proceeding is currently in the finalization process.

## Summary

The first time we have comprehensively used all the options of the authoring tool developed for the IMED portal was as we were

preparing the prototype paper "Cystic fibrosis from the prospective of General Practitioner for Children and Adolescents". The first touch with the template is difficult for everyone. Despite the "user friendly" concept, the author has to get familiar with the environment and all new features. But with every new page of prepared paper, the work gets easier and even more creative. We were inspired to use all the features of the template to make the paper more catching and inspiring to further study. Of course only the practice will show how frequently the new form of education will be used.

Work with the template clearly simplifies the process of preparing a paper, providing the author with general support and effective tool for creating courses. However it is only a backbone ensuring the formal level of the paper. The quality of the e-learning paper is always determined by the content and context created by the author.

The e-learning paper "Cystic fibrosis from the prospective of General Practitioner for Children and Adolescents" as well as the developed authoring tool for preparing papers on the IMED portal are just some of the outputs of the project "Formation and implementation of e-learning portal for medical education".

The presented template as a supporting tool will be used by authors who prepare papers for the IMED portal. It will become a part of mosaic of tools helping to fulfill the ambition of the IMED portal. The IMED portal has the intention to provide quality and up-to-date medical information with use of the latest digital technologies.

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# E-LEARNING IN BURN SURGERY

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## Abstract

We have created a full-fledged e-learning portal based on the application LMS (Learning Management Systems) which integrates various on-line tools for documentation and administration of learning programs. We have chosen well-known open source Content Management System WordPress to meet the target. This management system enables even less skilled users to publish and edit articles which are essential for the sustainability of this project. We have established our own domain called epomed.cz. Its name is formed from the initial letters of the Czech name of our project – E-learning of Burn Surgery. We have created a template based on our own graphic design. The template was subsequently filled up with its content. The portal is divided into an educational, testing and auxiliary section. The educational section includes educational texts, charts, graphs, photographs and case reports. The testing section serves visitors for examination of acquired knowledge. The auxiliary section contains an index of medical terms referring to burn surgery, and a forum where users can publish their queries and remarks. The strong point of this project which we plan to develop further rests on a use of modern technologies, simple maintenance and easy extensibility. We intend to develop this portal towards integration with other portals and translate it into English.

## Keywords

e-learning, burns, epomed, learning management system, LMS

## Introduction

Epomed.cz is an educational multimedial on-line portal designated for medical students and health care professionals. This e-learning project supports a modern way

of on-line education at Faculty of Military Medicine in Hradec Kralove, University of Defence and Medical Faculty in Hradec Kralove, Charles University in Prague.



Figure 1: An appearance of administration environment (Back End).

**epomed.cz**  
e-learning popáleninové medicíny

Výuka Kazuistiky Testy Rejstřík Fórum

Přihlásit se

## Vítejte na e-learningovém portálu popáleninové medicíny epomed.cz.

Nacházíte se na stránkách věnovaných popáleninové medicíně. Informace, které zde naleznete, jsou určeny odborné veřejnosti – zdravotníkům, lékařům a studentům medicíny.

Pokud **nejste** lékař, zdravotník nebo student medicíny, **opusťte** prosím tyto stránky!

Tento projekt vzniká na **podporu e-learningu** jako **moderního způsobu individuální výuky přes internet** na **Fakultě vojenského zdravotnictví Univerzity obrany v Hradci Králové** a **Lékařské fakultě Univerzity Karlovy v Hradci Králové**.

Portál je rozdělen na **výukovou část**, **testovací část** a **pomocnou část**. Výuková část zahrnuje výukové texty vč. tabulek, grafů a fotodokumentace, a řadu kazuistik. V testovací části si můžete ověřit vaše znalosti. V pomocné části jsme pro vás připravili **Rejstřík medicínských pojmů** vztahných k popáleninové medicíně; a dále **Fórum**, kde nám můžete sdílet vaše dotazy a postřehy.

**Začněte s výukou popáleninové medicíny.**  
Znalosti si upevníte v rubrice Kazuistiky a ověříte v Testech.

**ZAČÍT S VÝUKOU**

podporou Fakulty vojenského zdravotnictví UO v Hradci Králové

Epomed.cz Autorské právo Editovat stránku Vytvoření odpovědi

Stránky podléhají licenci Creative Commons Uveďte autora – Neužívejte komerčně 3.0 Česko

Používáme Český WordPress

Figure 2: Homepage of Epomed.cz with basic information and a caution.

## Astrupovo vyšetření

**Astrupovo vyšetření** je vyšetření **acidobazické rovnováhy** (ABR) dříve vyšetření krevních plynů. Provádí se z arteriální krve (např. z arterie radiální), méně často z kapilární krve nebo z centrální venózní krve.

Zjišťujeme pH, parciální tlak oxidu uhličitého ( $p\text{CO}_2$ ) a kyslíku ( $p\text{O}_2$ ), celkový hemoglobin (Hb) a procento okysličené krve ( $\text{SO}_2$ ). Dále je možné vyšetřit jednotlivé frakce hemoglobinu ( $\text{O}_2\text{Hb}$ ,  $\text{COHb}$ ,  $\text{MHb}$  at.) a dopočítat další hodnoty ABR: množství aktuálního bikarbonátu ( $\text{HCO}_3^-$ ) a standardního bikarbonátu (SBC) a **Base Excess** (BE).

**Tab. Parametry a jejich hodnoty při Astrupově vyšetření acidobazické rovnováhy<sup>1</sup>**

Parametr	Normální hodnoty
pH	7.40 ± 0.04
$p\text{CO}_2$	3.15 ± 0.50 kPa
$p\text{O}_2$	9.3–15.5 kPa
$\text{HCO}_3^-$	24 ± 2 kPa
SBC	24 ± 2 kPa
BE	0 ± 2.5 mEq/L

<sup>1</sup> Hodnoty převzaty cit. <http://www.fjib.com.cz/stroka/astrochemtest3.htm> [cit. 10.08.2010].

Figure 3: Print-out of index term, specifically blood gases examination (Astrup's analysis)

## Objectives

The main task was a production of a full-fledged e-learning portal based on the application called Learning Management Systems (LMS) which integrates various on-line

tools for documentation and administration of learning programs. In our case we use a forum, case studies section and testing section. We have chosen well-known open source CMS WordPress to meet the target.

This management system enables even less skilled users to publish and edit articles. This is important to the sustainability of this project. WordPress comprises of Back End, section used for administration, and Front End, section accessible by external visitors.

Articles editing is intuitive and an application environment is similar to widely used text editors. Item Media allows users to operate audiovisual content in our case administration of pictures and schemes. Item Comments permits administrators to moderate discussions. A new comment made by a new contributor is at first approved by editors, following comments made by the same contributor are approved automatically. Item Pages allows editing of a main menu.

Back End supports assigning of diverse competences, permissions or roles to various users. Basic roles are Administrator (unlimited authority), Editor (allowed to edit portal contents, not allowed to edit portal appearance and functions) and Author (allowed to edit his or her own articles only).

## Development

The first step we took to accomplish our intention was founding our own domain epomed.cz. In the second stage we have created graphic template of the portal which was subsequently filled up with its content. The third stage is about publishing the web via presentation at professional conferences, sending e-mails to medical students and Mefanet registration as well.

The portal is divided into an educational, testing and auxiliary section. Its main page contains a warning that the portal is designated for health care professionals exclusively.

The portal heading contains a logo and a main menu. Users can use the main menu to access all three portal parts. Moreover it allows editors and administrators to sign in. There is located a large link to the educational section under an introductory content to simplify navigation. At the very bottom of the browser window there are situated links to author information, licence policy and a disclaimer.

The educational part contains educational texts including charts, graphs and pictures. Chapters are well arranged and divided into

subheads and paragraphs. Visitors will learn basic information in every chapter to understand introduced themes. We have also attached charts with laboratory values used in burn surgery. Texts deal with epidemiology, pathophysiology, symptoms and signs, treatment and rehabilitation of thermal injuries.

Chapter Epidemiology quotes statistic information concerning thermal injuries frequency in the Czech Republic, figures concerning patients admitted into a hospital, etiology of burns, and define dominant mechanism of injury divided by age.

Chapter Pathophysiology explains a relationship between a velocity of burn formation and a surface temperature of the harmful object. It underlines the importance of intact microcirculation to a development of injury. Furthermore we describe basic pathophysiological mechanisms which participate in a development of the burn oedema and its consequences.

The most extensive chapter Assessment of burns severity contains de-tailed information on major factors determining a burns severity, i. e. mechanism of injury, extent, localisation, depth, age and medical history. Text also contains graphic version of The Rule of Nine and Lund and Browder chart for calculating the percentage of total body surface area burnt. Burns are divided into four degrees and the whole section is enhanced by a simple chart containing characteristics of various degrees of burns. This chapter also includes a number of photographs showing burns of different severity. Finally, we quote a chart with burn severity evaluation according to an age of patients.

Chapter Burn shock introduces list of changes that accompany a burn shock, i.e. metabolic changes and changes of acid base balance and description of burn shock biochemistry. We have attached a chart with biochemical parameters studied in such patients. We also provide basic information on serious states, such as ARDS or renal failure.

Chapter Symptoms and Signs concentrates on a description of states we encounter in a clinical state assessment. The summary of these states provides a chart. Symptoms and signs are described in particular subheads.

Chapter First Aid is divided into a prehospital and hospital aid. In the article Prehospital Aid readers will find a brief description of general rules of a basic first aid. In the article devoted to a hospital aid readers will find more elaborate description of rules important to health care professionals. Rules are written down in a chronological sequence.

In the last chapter Outpatient Care you will find a specification of a primary burn care and a follow-up including care after reepithelialisation. We have also attached phone numbers of Czech burn centres where one can consult a procedure in individual cases. The educational section is followed by case studies. We present two interesting case studies. They come from two different age groups. The first case study describes a 64-year-old man who burned himself badly with a sixty litres of boiling water. The second case is one-month-old suckling whose baby carriage burst into flames.

The testing section serves visitors as an examinational tool. To check acquired knowledge and skills we offer a set of twenty questions which are put together according to our educational texts. Visitors choose one correct answer out of four presented choices. After completion of the test a result and a verbal rating based on a score are displayed. Simultaneously a list of testing questions including answers is displayed under the evaluation. Correct answers are marked with a green tick whereas incorrect answers are marked with a red cross.

The auxiliary section comes with an index. The index includes medical terms related to burn surgery. In case readers encounter an unfamiliar name or abbreviation they can just enter this word to a search box and find what it means. Another option is to find a desired word on their own in the index below. If readers still cannot find what they are looking for they can seek help from a Forum. The Forum is also used for publish-

ing questions and observations and for communication between editors and visitors.

## Promotion

Since September 2010 when portal Epomed.cz was launched till the end of March 2011 almost five thousand readers have visited the portal according to Google Analytics. These visitors have displayed altogether 14,000 pages. We intend to keep this project running by accomplishing following steps.

We tend to initiate evidence and management of students to allow them continuously watch their test results and education progress, to communicate under their names in a newsgroup or to send a message to a lecturer.

Establishment of a personalization brings significant advantages. Users with a Teacher's role will be allowed to obtain a desired web content in the format suitable for projection. With a massive expansion of electronic book readers (e-readers) a need of optimization for this device has emerged as well. Both issues will be solved by a new display panel. The display panel can be used for printing an article, saving files as a pdf or mobi file (e-book format) or switching to a presentation mode.

## Conclusion

One of advantages of our project is a possibility of modifying its content and hence keeping all information up-to-date and possibility of extending it by adding new chapters and features. Other advantages are inexpensive foundation and maintenance, easy maintenance and a use of modern technologies. One of disadvantages is a low number of editors and developers. Further ahead we plan to integrate our portal with other portals and translate it into English. By fulfilling these steps we want to avoid interruption of development and loss of visitors in the favour of competitive websites.

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# MEFANET report 04

## Efficient multimedia teaching tools in medical education

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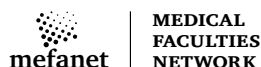
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