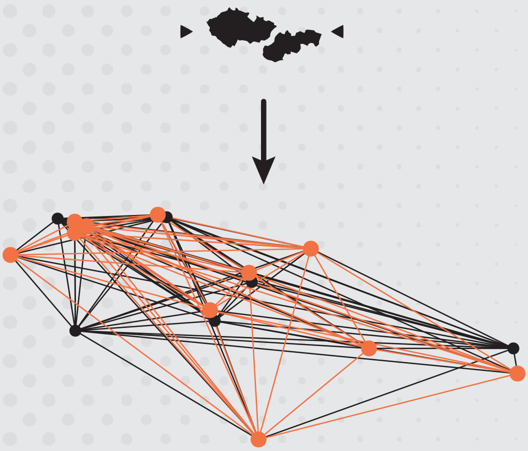
COMPUTER APPLICATIONS, SYSTEMS AND NETWORKS FOR MEDICAL EDUCATION

MEFANET: Czech and Slovak Medical Faculties Network

DANIEL SCHWARZ & LADISLAV DUŠEK



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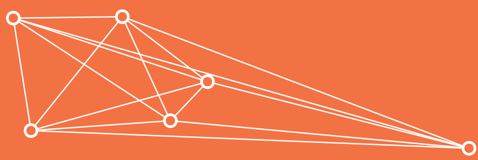

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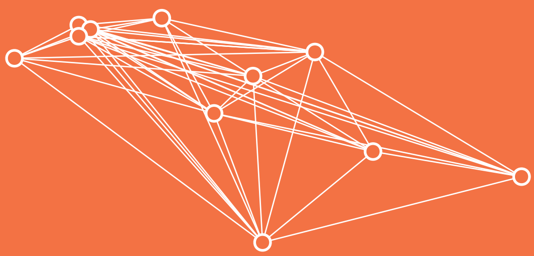

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COMPUTER APPLICATIONS, SYSTEMS AND NETWORKS FOR MEDICAL EDUCATION

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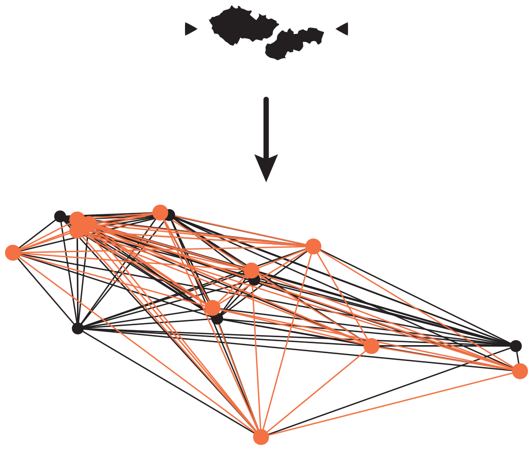

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MEFANET: Czech and Slovak Medical Faculties Network

DANIEL SCHWARZ & LADISLAV DUŠEK

Brno 2014

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Computer applications, systems and networks for medical education

Published by Masaryk University, Institute of Biostatistics and Analyses,
Kamenice 126/3, 625 00 Brno, Czech Republic
Published by Facta Medica, Ltd.,
Srbská 2186/19, 612 00 Brno, Czech Republic

Proofreading by Panorama I.L.A., s.r.o.

Printed by Tiskárna Helbich, JSC, Valchařská 36, 614 00 Brno, Czech Republic

First edition
232 pages

WWW.MEFANET.CZ
WWW.IBA.MUNI.CZ
WWW.FA-MA.CZ

ISBN 978-80-904731-9-5 (Facta Medica)
ISBN 978-80-210-7859-8 (Masarykova univerzita. Brno)

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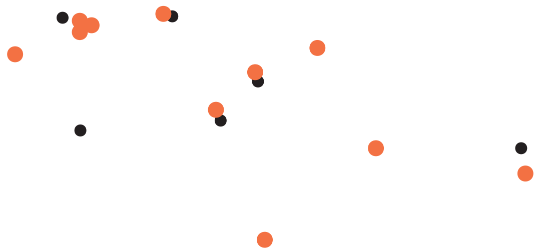

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PREFACE & ACKNOWLEDGEMENTS

Back in 2006, when we initiated regular workshops on information and communication technology applications for medical education at the Faculty of Medicine of Masaryk University (Brno, Czech Republic), we had the good fortune of collaborating with highly dedicated groups of individuals from nine other medical faculties in the Czech Republic and Slovakia. In this manner, MEFANET (Medical Faculties NETwork) evolved from its humble beginning in 2006 and 2007 onto the international network platform. Today, all of the eleven medical faculties in both countries are domained in the network and an additional four faculties—focused on ±health care and biomedical sciences—have recently joined MEFANET. The present-day MEFANET organizes its own annual conference, publishes a scientific journal and collaborates with other bodies throughout Europe. Cooperation in the network is contractually guaranteed—the cooperation agreement was signed by the deans of all medical faculties in 2009.

This book is motivated by the perceived need for an overview of how various information systems and platforms have been designed, implemented and used by the MEFANET community in order to support medical and health care education with modern information and communication technologies. We hope that this effort will help in promoting increased collaboration between medical experts, educators and computer scientists, with the aim of effective and efficient utilization of the technology in the diverse teaching and learning processes.

The book is divided into four sections. After the first section (introductory PART A), PART B brings the state-of-the art overview of e-learning and medical simulation interventions specifically conceived for medical education. We begin with a general introduction to e-learning and to the recent shift in paradigm concerning medical education. CHAPTER B2 reviews the recent literature on the history, motivation, classification and evidence of use of simulation modalities with various levels of fidelity and authenticity. CHAPTER B3 is devoted to the methods of quality assessment in the field of digital education content. CHAPTERS B4 and B5 cover topics that might seem, at first glance, to digress from medical education: identity federations and intellectual property rights. We have, however, included them into this book, in order to collect answers to many questions that we heard from medical experts and educators at various forums, whether of informatics or legal nature. The second part of the book discusses the issues raised in the introductory chapters from the MEFANET's point of view. In CHAPTER C1, we describe the MEFANET e-publishing system and its information discovery services. CHAPTER C2 introduces the serious games component of the MEFANET platform—designed for indexing metadata about simulation-based learning objects, also known as electronic virtual patients or virtual clinical cases. CHAPTERS C3 and C4 cover topics associated with authoring e-learning material incorporating learn management systems and 'wiki way'. Finally, CHAPTER C5 describes an original approach to standardizing and harmonizing medical curriculum in a way that it is well-structured, without gaps and overlaps. The last section, PART D, of this book contains the profiles of each faculty involved in MEFANET and interesting views on MEFANET's activities from particular personalities.

It would not have been possible to complete the book without the great support of all authors and co-authors of the individual chapters as well as of their reviewers. We would like to express our sincere thanks to all those who are not indifferent to MEFANET and to this book. Further gratitude is also extended to all deans of the participating faculties, and to their scientific boards, for the highly valuable support that keeps the MEFANET network on the path of sustained growth. It is our sincere hope that this book will be a valuable resource for the MEFANET community and will inspire further research and development in the vibrant area of medical education science.

November 2014, Brno

Daniel Schwarz

Ladislav Dušek

WORDS FROM HONORARY ADVISORS

TERRY POULTON, MD, PHD

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MEFANET is unique. It is an invaluable active sharing network involving all the medical teaching institutions from 2 separate countries, and there is probably no other network with that level of ambition across Eurasia. The fact that it has survived without external funding is in itself a great achievement; that it continues to grow, is an extraordinary testament to the single-minded determination of its Coordinating Committee, and in particular its leaders Daniel Schwarz and Ladislav Dušek.

Simultaneously, MEFANET addresses another worldwide challenge, that of 'cultural preservation'. It is essential that pedagogically useful materials are available to fit the specific needs, cultural requirements, medical practices and languages of a country, so that we are not reduced to a one-fits-all style of education, based on the languages and medical practices of a very small number of countries.

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- Assistant Professor in Medical Education Informatics: Medical School, Aristotle University of Thessaloniki, Greece.
- Co-ordinator of EU projects mEducator, ePBLnet, LLM, Childrenhealth (www.meducator.net; www.epblnet.eu, www.longlastingmemories.eu, www.childrenhealth.eu).

It is a pleasure to be in the honorary position to speak about a book by and for MEFANET, the Czech and Slovak Medical Faculties Network, whose basic goal is to advance medical teaching and learning by means of modern information and communication technologies.

The latter have swiveled for quite a few years now around the term of e-learning but have undoubtedly driven several paradigm shifts in medical education. What is of pivotal importance in all these developments is that they should be considered in tandem with pedagogy, in a multidisciplinary approach and with a well-designed education research perspective. *This is what I liked most in this comprehensive book* on Computer Applications, Systems and Networks for Medical Education by Schwarz and Dušek.

In addition, the overall aim in contemporary medical education is to improve and enhance the experience of medical learners by empowering them with knowledge and skills to navigate and meaningfully interact with open education resources as well as with other learners. In this direction, one not only needs innovative tools, platforms and services for medical teaching and learning, curriculum management and student encouragement, which are very well described in this book. There are important underlying issues like quality assessment and authentication that abide by numerous practical but also legal and ethical aspects. *Editors of this book, as experts in the domain, are well aware of this notion and have shed suitable bundles of light in each of these perspectives. The final result? A wonderful book, covering in a global way how to contemporarily and technologically lead medical education. Congratulations to all contributors!*

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Medical education of the today's world must face and ultimately respond to internal and external challenges manifested at multiple levels ranging from medical educators to societal changes. The exponential growth in medical knowledge is probably best paralleled by advances in information and communication technologies. This book successfully accomplishes the aim to bridge the gap between these fields, while providing essential tools for addressing the current challenges in medical education worldwide. The reader is first provided with an in-depth overview of the state-of-the art in e-learning and e-publishing approaches in medical and health care fields, with special attention given to simulation technologies. Issues frequently overlooked by overly eager implementers of these new technologies, such as quality assessment and authentication for e-published materials and applications in medicine, are extensively reviewed. Nevertheless, this book is not only an excellent product of theoretical analysis: it further provides detailed insight into the success story of MEFANET. The reader has the opportunity to critically follow the development and implementation of the MEFANET e-publishing system, with special emphasis on emerging MEFANET-related education technologies and approaches, such as the case-based learning tools or Wiki and Moodle implementations. I believe that this book authored and edited by Daniel Schwarz and Ladislav Dušek, the architects of MEFANET, represents in fact a standard of good practice for the integration of information and communication technologies with medical education while also providing a framework for inter-institutional collaborative endeavours.

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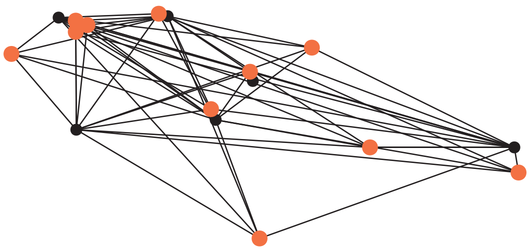

‣ B1 ◂

REVEALING THE IMPACT OF E-LEARNING INTERVENTION ON MEDICAL EDUCATION

DANIEL SCHWARZ, JARMILA POTOMKOVÁ

'Live as if you were to die tomorrow. Learn as if you were to live forever.'
MAHATMA GANDHI

Summary. The chapter gives a general introduction to e-learning and to the recent shift in paradigm concerning medical education. Through several examples of famous visionaries, projects and networks focused on technology-enhanced learning and teaching, it is shown here that if delivered appropriately, e-learning can be an effective and rich learning experience for the student with concurrent more productive and rewarding role for the teacher. Besides the voluntary groups and networks focused on sharing and repurposing medical education content, special attention is given to the aspect of virtual universities and online degrees.

/ **Keywords:**

- computer assisted instruction and learning
- programmed instruction
- e-learning
- computers in medical education
- content indexing, sharing and repurposing
- virtual universities

/ **Reviewer:**

- VLADIMÍR MIHÁL

VISIONARIES OF E-LEARNING IN MEDICAL EDUCATION

Although the advent of e-learning is often associated with the Internet boom and global increase in personal computers, its origins can be traced back to as early as the behaviourist[1] B.F. Skinner, who in 1958 came up with the theory of Programmed Instruction [2]. According to Skinner, the purpose of programmed instruction is to *'manage human learning under controlled conditions'* [3]. It advocates a type of progressive instructional method based on the principle of operant conditioning, which emphasizes the concepts of reinforcement and chaining. Furthermore, programmed instruction is not merely a self-directed instructional method. It emphasizes the preparation of teaching material in advance in order to facilitate instruction [4]. The core concepts of programmed instruction or learning are: (i) it delivers information in small bites; (ii) it is self-paced by the learner; and (iii) it provides immediate feedback, both positive and negative, to the learner [5]. It was popular in the late 1960s and through the 1970s, but pedagogical interest began to wane in the early 1980s in the face of difficulties in implementation and the lack of comprehension of the limitations on the part of practitioners. Programmed learning remains popular in self-teaching textbooks [6] and some of the principles are being applied in computer assisted instruction (CAI). Computers can be used to present education material and help students learn through a variety of techniques such as quizzes, simulations or tests. E-learning needs to be understood in a broader sense than computer assisted instruction or computer assisted learning, as it can also include web-based learning, virtual classrooms, digital collaboration, audio and video recordings, satellite or land-based broadcasts, and even telephones.

In May 1989, G.O. Barnett from Harvard Medical School presented the second American College of Medical Informatics a distinguished lecture at the American Association for Medical Systems and Informatics Congress. The lecture focused on the use of computer technology in medical education and later, it appeared as a viewpoint [7]. The lecture was framed into the metaphor that medical education is in a diseased state and the point was to describe the signs and symptoms, the aetiology, the complications, the possible treatment options and the expected outcome. G.O. Barnett opened his lecture by reviewing the symptoms: *'Let us consider the diagnosis of the disease condition of medical education by first reviewing the signs and symptoms. One of the most apparent symptoms is that medical students are rejecting the current lecture-based method of education. Prior to the curriculum reforms at Harvard Medical School known as*

1 Behaviorist theories of learning aims to shape behavior into predetermined patterns by strengthening stimulus-response bonds [1].

the New Pathway, the three to five lectures each day were very poorly attended, and those students who did attend exhibited evidence of severe sleep deprivation. Most medical students have a liberal arts background, which means they are used to a large amount of independent study. The students felt that the passive didactic education strategy was neither appropriate nor acceptable and therefore, deemed that the lectures were not worthy of their participation.' [7] One of the symptoms was identified as poor integration of the basic science content from the first two years with material included in the last years focusing on clinical medicine. The aetiology of the diseased state of medical education was stated as comprising of five main components: (i) information explosion in medical knowledge that placing highly challenging time demands on the curriculum; (ii) strongly tradition-oriented environment that was very resistant to change; (iii) the departmental organization of medical curriculum where any modification was a process of negotiation; (iv) the changing nature of medical practice with rapid metamorphosis of hospital-based practice to ambulatory practice and decrease in faculty time available for teaching medical students in the classic apprenticeship mode in a hospital environment; (v) failure to appreciate that medical students are adults and learn more effectively when considered as adults. The treatment of the disease in medical education proposed by Barnett required a number of changes in the curriculum and in the priorities of medical schools, including long-term financial support for the development of information technology applications in medical education. The following three IT applications were proposed as important elements of the proposed treatment plan: (i) computer-assisted access to bibliographic literature; (ii) computer-based compendium of medical content, comprehensively indexed by medical concepts relevant to specific medical problems; (iii) computer-based simulations—as one can best learn to solve problems by problem solving and not by passive activities such as lectures or reading. From today's perspective, G.O. Barnett envisioned the use of evidence-based medicine, courseware or learn management systems, and virtual patients more than 25 years before this book was written—when Internet was only in its infancy.

Today almost every medical student spends part of the day online searching, using Google or some other engine for information on a topic, communicating with a colleague or teacher, or studying a unit, module or an electronic course developed in their institution or elsewhere. E-learning has grown in popularity because of its convenience and flexibility and because of the increasing availability of computers and the students' familiarity with them. A legitimate aspiration of e-learning is to make existing approaches to teaching and learning more effective and efficient. If this is to be achieved, e-learning implementation has to be monitored and managed by staff with the necessary education, technology and content expertize. There is no doubt, that if delivered appropriately, e-learning can be effective and can enrich the learning experience for the student while, at the same time, allowing the teacher to take on more productive and rewarding roles [8]. Implications of the new learning technologies are profound. E-learning provides a bridge between the cutting edge of education and training and outdated procedures embedded in institutions and professional organizations. There are important implications too for globalization in medical education, for interdisciplinary education, and for continuous education from undergraduate to postgraduate and further to continuing education [9].

MEDICAL EDUCATION CONTENT: SHARING AND REPURPOSING

To date, Internet has quickly spread into a very large scale hypertext information space where different types of users can search and find information in various domains. Access is now available to a wealth of free online education materials in the education/instructional domain. Tutors can use these resources in their teaching and students can use them to support their learning. A student is likely to first browse the web looking for relevant open-access resources. This scenario is true across all subject domains—the Internet has become an important tool within education [10]. Using the Internet is the norm for today's university students and several reasons exist justifying the use of this phenomenon as a source of learning. According to M. Geueke et al. [11], the Internet promises many advantages: access from all over the world with low-cost technical infrastructure; independence from proprietary hardware and software solutions by means of a common browser as the front-end; independence from time restrictions as material is available 24 hours a day, 7 days a week without any technical necessity for downtime.

Despite numerous efforts put forward in the area of health education content development, description, and sharing, only recently solutions have been put forward that are clear and standards-based for seamless sharing of health education content covering contemporary approaches like games and scenario-based learning. For example, the best practice network mEducator [12], one of the recently completed successful projects in this domain, has developed and compared two alternative and contemporary approaches, including technological frameworks, for achieving content sharing, namely: mEducator 2.0, based on Web 2.0 technologies and mashups and mEducator 3.0, based on semantic web technologies and linked data. The mEducator project has managed to provide mechanisms for multi-type content publishing, discovery and retrieval. The project analyzed the policies and mechanisms for content evaluation, rating, and renewal and repurposing, elaborated on intellectual property rights for education material and tested the impact of true interoperability, repurposing, enrichment, and embedding of a variety of highly attractive and up-to-date learning resources. The mEducator provided recommendations on how to implement interoperable education content discovery and retrieval networks, implemented and extended the specifications and standards on a critical mass of medical education content types and provided recommendations for standards adoption and promotion across the world [13,14].

MEFANET [15] has established itself as the standard setting body for medical educators in the Czech Republic and Slovakia—two independent countries that once comprised a federation, having similar languages and still managing to retain the same curricular structure for medical education. One of the basic goals of the network is to advance medical teaching and learning with the use of modern information and communication technologies. As an instrument, MEFANET has decided to develop an original and uniform solution for education web portals that are used, together with a central gateway, to offer and share digital education content. Students—about 16 500 potential users and academic staff—about 3900 potential users from all Czech and Slovak medical faculties—can find their e-learning materials at eleven standalone faculties' instances of education portal with the use of the indexing and searching engine MEFANET Central Gateway [16]. High-quality digital education contents production has become a matter of prestige at medical schools in the Czech Republic and Slovakia, and the volume of teaching and learning materials available is growing rapidly—thanks to the MEFANET project and its e-publishing platform [17], which has been continuously developed and adopted to the needs of the MEFANET community since 2007. The fundamental elements and extensions of the e-publishing platform are described in detail in CHAPTER C1.

PARADIGM SHIFT IN MEDICAL EDUCATION

Medicine has the reputation of being a conservative discipline. A characterization like this does not refer to the disciplinary content that has always been on the forefront of scientific innovation. It refers to how learning and teaching is supported via policies and education practices, and this is clearly reflected in recent research. Medical education has been constantly evolving by gradually, but significantly, shifting from traditional methods (textbooks, lectures, bedside teaching) to more comprehensive approach, which also employs modern ICT tools (e-learning, interactive algorithms, computer simulations, virtual patients). Such approach has been demonstrated to enhance and improve the learning skills of medical students and residents in comparison to traditional methods [18–21]. Several ancillary factors in medicine and medical education have also contributed significantly to these trends; in particular, the rapid development of new technologies and the generally preferred shorter hospital stays, which reduces student exposure to a given case or diagnosis. Bedside teaching with evidence-based practice elements, supported by e-learning activities, were demonstrated to play an important role in modern medical education [22]. Students do not see e-learning as replacing traditional instructor-led training but as a complement to it, forming part of a blended-learning[2] strategy [24]. Economic efficiencies of web-based education and traditional face-to-face education approaches were compared under randomized controlled trial conditions in Maloney et al. [25] and it was shown that the web-based education approach was clearly more efficient from the perspective of the education provider.

Although most of the modern interactive tools are intended for extending and supplementing the traditional methods rather than replacing them, they have undoubtedly brought a number of advantages, such as equal and easy access for students to all diagnoses, simulation of a variety of real-life situations, comprehensive interdisciplinary learning, and higher level of comfort for hospitalized patients. Simulation-based learning also provides the unique opportunity of practicing knowledge application in manner that mimics real-time patient care and concurrently, poses no risk to the patient [26,27]. On the other hand, developing simulations and e-learning materials requires investment of the time of skilled professionals (physicians, teachers, programmers) and it is, therefore, inherent to ensure that the time and resources expended is duly justified by the education impact [28]. Furthermore, the developed tools are often accepted uncritically and with emphasis on technological sophistication at the expense of the underlying psycho-pedagogical theories [18].

Most of the digital teaching described in recent literature has been prepared as web-based works, since web technologies allow for easy incorporation of multimedia objects, interactive algorithms, animated simulations, etc. Such web-based learning objects may then be easily accessed from any computer and by a defined target audience (e.g. students of a particular medical school or course). The developed tools and simulations cover a wide range of medical disciplines, such as critical care [29,30] and acute medicine [31,32], cardiology [20], haematology [18], neurology [33], surgery [34] metabolic disorders [19,35], imaging methods [36,37], and cytogenetics [38]. Internet education resources for intensive care medicine were reviewed by Kleinpell et al. [29], who demonstrated that most of them are rather electronic forms of textbooks and articles than interactive simulations. Davids et al. [28] described an interactive

2 Blended learning is a formal education programme in which a student learns, at least in part, through online delivery of content and instruction with some element of student control over time, place, path or pace. While still attending the ‘brick-and-mortar’ school structure, face-to-face classroom methods are combined with computer-mediated activities [23].

web-based simulation in which the user treats patients with electrolyte and acid-base disorders, selects the therapies and doses and can immediately see the treatment results. CHAPTER B2 reviews the use of simulations in medical education in detail.

Worm and Jensen [39] recently suggested a new taxonomy to standardize e-learning material according to three different types and three different levels. The type corresponds to the level of Bloom's taxonomy [40] (presentations, scenarios, or games/simulations), while level refers to the multimedia development level, see TABLE B1.1. They performed a controlled randomized trial on 120 medical students and found out that higher levels of e-learning does, in fact, provide better results when compared with the same type of e-learning at lower levels.

VIRTUAL UNIVERSITIES

Until recently, universities have been offering higher or postsecondary education in a similar way for centuries. Students were staying on-campus for most of the time to get their degrees and diplomas. The idea to overcome the distance between students and their teachers may date back to the early 18th century in Europe. The first real distance education courses appeared a century later, in the 1840s, when Sir I. Pitman started teaching shorthand by mailing transcribed texts and receiving feedback from his students in return for correction [41]. Rothblatt [42] pointed out that the University of London was the first college to offer distance learning degrees as part of its External Programme in 1858. This was a fundamental step for the years to come allowing universities to organize examinations and award qualifications to students from other institutions or taking self-study courses. In the first several decades of the 20th century, numerous universities worldwide used correspondence courses, and particularly after World War II American universities started using the radio as a medium for distance education [43]. In the late 1960s, the Carnegie Foundation supported Wedemeyer's Articulated Instructional Media Project (AIM) [44] whose main goal was to exploit various communication technologies to provide off-campus learning. Actually, this led to new models for higher education institutions globally, including the United Kingdom, Germany, France, Spain, India, Mexico, South America, Israel, Africa, Australia, the South Pacific, Japan, Indonesia and Malaysia. In 1965/1966, C. Wedemeyer had the following vision of future e-Learning with deep respect for the social context of education [45]:

'... the extension student of the future will probably not "attend" classes; rather, the opportunities and processes of learning will come to him. He will learn at home, at the office, on the job, in the factory, store, or salesroom, or on the farm.'

'... the teacher will reach students not only in his own state or region but nationally as well, since the media and methods employed by him in teaching will remove the barriers of space and time in learning ...'

In parallel, there were the then government supported attempts in the United Kingdom to establish the Open University that accepted its first 25 000 students in 1971 due to the strong open admissions policy. It performed radical changes in the scope of the correspondence programme and became a valuable learning alternative to traditional form of education. It has been a leader in the development of technologies to enhance distance learning services and still remains the largest such institution worldwide [46].

Dynamic development and spread of information and communication technology, in particular the Internet and the world wide web, have made distance learning easier and faster. At the threshold of the new Millennium it was evident that technology was having an irreversible impact on universities and institutions of higher education around the globe. The position of distance learning within the higher education community was strengthened, but still there was a lot to learn on how to improve teaching/learning processes at a distance [47].

New terms began to emerge, e.g. e-learning institution, networked university, or virtual university all denoting more or less the same—distance or flexible education. Wikipedia defines virtual university as follows: *'A virtual university provides higher education programmes through electronic media, typically the Internet. Some are bricks-and-mortar institutions that provide online learning as part of their extended university courses while others solely offer online courses. They are regarded as a form of distance education. The goal of virtual universities is to provide access to the part of the population who would not be able to attend a physical campus, for reasons such as distance—where students live too far from a physical campus to attend regular classes; and the need for flexibility—some students need the flexibility to study at home whenever it is convenient for them to do so...'* [48].

It might seem that the advances in virtual higher education were pushed forward by technology alone; there is, however, another very important feature, namely access to course content. In 2000, the Massachusetts Institute of Technology (MIT) faculty and administration decided to publish the core content of all MIT courses on the web [49]. Named OpenCourseWare (OCW), it includes thousands of items, i.e. syllabi, reading lists, lecture notes, assessments and video lectures, being accessed by millions of students, teachers and the general public per year. To be used globally, some of the courses are being translated into different languages. Since MIT established this site, around 90 universities and colleges from 14 countries of the world have accepted OCW and created a consortium (OCWC) to share course materials. Students and the faculty affiliated with other universities may look to OCW to enrich their understanding of the courses they are taking or teaching, and nonstudents can exploit them for self-learning [50].

In accordance with the findings of Khakar [51], one can distinguish several types of institutions in terms of organization and management:

- Single-mode, pure virtual institutions where courses are designed and delivered to distance learners.
- Dual-mode institutions that alongside conventional on-campus classes also deliver virtual education to non-traditional students.
- Mixed-mode institutions with both conventional and distance education supervised by the same academic members.
- Collaborative virtual university (CVU) where several institutions are grouped together nationally or internationally to share resources and offer distance teaching/learning under single management.

Last but not the least, there is the important issue of online degree for most potential students. Usually, it is an academic degree, but it may include high school diploma or non-degree certificate according to the type of course. Online degree means that it is achieved primarily and completely via internet-connected computers rather than the standard on-campus process.

Based on the experience from the international project MENU (Model for a European Networked University for e-learning) [52], there are some key recommendations for academics and project leaders who are planning to develop a collaborative virtual university:

- Selection of professional, competent partnerships;
- Start with few partners, let the team and network expand step by step;
- All partners must understand the goal to be achieved;
- Definition of target user group(s);
- Administration/partnership agreement;
- Concentrate on the learning environment:
  - Different pedagogical methods;
  - Efficient learning tools;
  - Blended learning as a relevant alternative;
- Training of staff is inevitable;
- Allocation of extra costs for the early stages of transition to new methods;
- Flexibility to accept new emerging technologies.

TABLE B1.1 Levels of e-learning according to Worm and Jensen [39].

	Course level
Level 1	Text, images, audio, simple interactivities for content presentation. Template layout.
Level 2	Level 1 + video and simple animations. Fewer pages with template layout.
Level3	Complex animations, high-fidelity/3D graphics, multilevel and multivariable interactions.

TABLE B1.2 Useful links to particular virtual university projects.

Course level	URL
Open University—UK	http://www3.open.ac.uk/about/
Open Universiteit Nederland	http://www.ou.nl
The Finnish Virtual University	http://www.virtualcampuses.eu/index.php/Finnish_Virtual_University
Canadian Virtual University	http://www.cvu-uvc.ca/english.html
Open Universities Australia	http://www.open.edu.au/
Norwegian Network University	http://www.nvu.no/nvu.php
United Nations University—Global Virtual University	http://dev.grida.no/gvu/pdf/brochure.pdf
Global Virtual Univeristy	http://www.virtualcampuses.eu/index.php/Virtual_Global_University
Virtual Surgical University	http://www.websurg.com/about_us/index.php
Université Numérique Francophone des Sciences de la Santé et du Sport	http://umvf.cerimes.fr/
Virtual Bulgarian University	http://www.bvu-bg.eu/index.php?Clip=univ&lng=eng

DISCUSSION & CONCLUSIONS

Medical education is unique in the sense that apart from ordinary teaching and learning interactions, it includes the notion of clinical apprenticeship and acquisition of clinical skills. The old-fashioned way of teaching knowledge based curriculum focusing on biosciences followed by clinical experience is no longer satisfactory for medical education. The need for transition from traditional classroom learning approaches to active learning using self--directed, personalized collaborative learning environments is now evident more than ever before.

It is beyond doubt that virtual reality has embraced numerous areas of human activities and proved itself practical in terms of efficiency and as an attractive teaching tool. In medical education, there are special advantages of using virtual reality technology to create conditions for repeated training without risk or harm to patients, thus enhancing its education quality [54].

In concert with published experience [55], medical multimedia curricula, courses and knowledge modules should be frequently monitored by their developers to analyse the student perceived values of e-learning medical sessions. It may happen that the initial enthusiasm of the users will change due to overuse of multimedia content, e.g. animations and videos, which should complement rather than replace reading materials. Moreover, conversion of teaching materials for use in the multimedia environment is a time-consuming task for teachers. In medical education, it seems more practical to provide access to the education material online during normal curriculum when compared to a pure virtual mode.

From the organizational point of view, it may be alleged that virtual universities have become a real option in the field of higher education. Much effort is needed, however, to transform traditional universities in order to offer online programmes. Until present, there has been a gap in methodological approaches and theoretical models on how to manage purely virtual universities. These require virtual teams contrary to distance institutions that are dependent on an industrial model when large numbers of students/clients are taught by few trainers [56], mostly without any mutual communication. In contrast, virtual universities are based on e-learning activities taking place in a virtual campus under thorough guidance of tutors and/or academic advisors [57]. For future sustainable development of virtual universities, there is an urgent need to propose and implement a viable management model of teaching staff coordination to provide relevant education services. It is also inevitable to elaborate the guidelines for effective leadership of distributed academic workforce.

Sharing of education resources over the web has been a key development recently for educators as well as learners. Several standards and recommendations for indexing, sharing and repurposing education web resources have been introduced by at least two international projects: mEducator and MEFANET. The methods and tools utilized in MEFANET are described in detail in CHAPTER C1. In order to move from voluntary communities and networks, such as MEFANET or mEducator, towards virtual universities providing higher education qualifications and degrees, there is still much to be done in the field of e-assessment of students' skills and knowledge as well as in the field of digital content quality evaluation. The assessment of e-learning tools and distance education is difficult, because there is no reference to a golden standard and the use of controlled randomized trial is almost impossible in practice [53]. Digital content quality evaluation is further elaborated and discussed in CHAPTER B3. Another area requiring creative work is mapping the web education resources to the learning units, learning outcomes and e-courses, which together compose the curriculum of medical education. CHAPTER C5 comes up with a new platform for curriculum mapping and management.

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▸B2◂

SCHOLA LUDUS: GAMIFICATION OF MEDICAL EDUCATION

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'I hear and I forget, I see and I remember, I do and I understand.'
CONFUCIUS

Summary. Changes in medical practice resulting in limited instruction time and patient availability have paved the way for greater utilization simulation technology. By interacting with medical simulators under certain conditions, it is expected that learning will attain further efficiency and completeness along with higher retention rate in comparison to passive approaches. This chapter reviews recent literature on the history, motivation, classification and evidence of the use of simulation modalities with various levels of fidelity and authenticity in medical education and training. In conclusion, it suggests three topics for further research and development: (i) pedagogy over technology, (ii) multidisciplinary approach, and (iii) medical education research.

Keywords:
- simulator
- computer simulation
- computer-assisted instruction
- medical education
- clinical reasoning
- mannequin-like simulators
- virtual patients
- computational models of integrative physiology
- medical education research

Reviewer:
- ALEŠ RYŠKA

SIMULATION GAMES

The introductory ancient Chinese proverb applies to teaching in general. It means that if an educator simply talks about a subject matter to students, it is very likely that they will forget what was said. If the subject matter is told and shown to them as well, they are more likely to remember what was taught. If the educator involves them in a 'hands-on' activity, where they 'do' what they are taught, they will fully understand and the subject will become 'learned'.

A simulation game can be used without risk to test the simulated object's behaviour—for example, try to land a virtual plane, treat a virtual patient or test the behaviour of an individual physiological subsystem. Medical simulators, same as flight simulators (FIGURE B2.1), represent a completely new way of teaching in which a student may practice particular tasks under simulated conditions without any risk to real patients or passengers. Medical simulators can automatically respond to drug administration and various infusions, and react to the settings of connected medical devices, such as an anaesthesia device or an artificial ventilator. Unlike the real world, errors are reversible in a simulated environment. In addition, one can monitor various curves showing the dynamics of parameters or variables, which are not available in clinical investigation of real patients [1].

FIGURE B2.1 Simulation skyrocketed in popularity during the 1930s due to the invention of the Link Trainer for flight and military applications. Since then, many different fields adapted simulation to their own needs. (SOURCE: http://upload.wikimedia.org/wikipedia/commons/a/ac/Link-trainer-ts.jpg)

SIMULATION FOR MEDICAL EDUCATION—PEDAGOGY VS SKILLS TRAINING

Recent advances in clinical practice have shortened the duration of hospital stay for patients. This adversely affected the traditional medical student–patient contact.

In response, medical education institutions have turned to modern methods of training ranging from simple, text-based virtual patients to other forms of technological enhancements, such as serious education games and software simulations, and mannequins and robot-based simulators. These tools have provided effective and meaningful learning experiences. The simulation objects and games allow students to practice their responses in a variety of situations and learn from their mistakes before entering into medical practice.

Four important areas for simulation technology in health care professional skills training were identified more than two decades ago, when medical simulation was intended mainly to address the problem of poor skills training and proficiency [2]. These were: laparoscopic techniques, which provide surgeons with the opportunity to enhance their motor skills without risk to patients; the cardiovascular disease simulator, which can be used to simulate cardiac conditions; multimedia computer systems, which include case-based

FIGURE B2.2 Photo of 'Harvey' simulator from the Duke Human Simulation and Patient Safety Center (SOURCE: http://en.wikipedia.org/wiki/File:Harvey_old_internal.jpg).

TABLE B2.1 Classification of simulators per type [11].

Type	Specifications and remarks
Compiler-driven	Specific part-task trainers replicating a particular part of the anatomy. Varying levels of sophistication is used to practice specific procedures or interventions. E.g. intravenous-insertion arms, laparoscopic aides, urinary catheter trainers, airway management heads, central line placement torsos, spinal columns. Also includes general purchase items such as pig's feet (suturing), oranges (skin biopsies), and watermelon (epidural anaesthesia).
Event-driven	
Standardized patients, actors	These are actors trained to reliably role-play history taking and physicals, and test communication skills in a clinical encounter. E.g. simulated clinical situations, including mock disaster drills.
Hybrid simulations	Combination of standardized patients and part-task trainers.
Computer-based simulators	Uses mouse-and-keyboard navigation for multiple pharmacophysiological models.

programmes that constitute a generalist curriculum in cardiology; and anaesthesia simulators, which have controlled responses that vary according to numerous possible scenarios.

The development of mannequin simulators for clinical training is reviewed in [3] from its early beginnings in the 1960s, focusing on teaching cardiopulmonary resuscitation, cardiology skills, clinical anaesthesia skills, and crisis management. The commercially available pioneering mannequins were: Resusci®-Anne, for CPR and mouth-to-mouth ventilation training; Harvey, a full-sized mannequin that simulated 27 cardiac conditions (see FIGURE B2.2) with a history dating back to 1968; and SimMan®, a high fidelity mannequin with more anatomically correct airway offered by Laerdal company since the 1990s.

Since the introduction of mannequin-like simulators in the second half of the twentieth century, the medical education community has experienced numerous different modalities for performing simulations. Unlike the high-fidelity mannequins, computer-based learning environments involving elements of software engineering and computer science benefit from higher availability and lower costs. The anytime/anywhere benefit for students may outweigh the lack of haptic quality of simulations on the computer screen and via the keyboard. The wider range of simulation modalities has given birth to new questions and concerns about the pedagogical potential and the use and effectiveness of these innovative technologies. For example, dynamic virtual 3-D simulated environments for learning were critically overviewed in [4]. Besides particular examples of immersive interactive computer environments, characterized

TABLE B2.2 Classification of simulators per fidelity [11].

Type	Specifications and remarks
Low-fidelity simulators	
Screen-based text simulators	• Create scenarios with the user selecting one of several responses. • Based on the user's choice, a new text narrative is generated and more management choices are offered. • Example: in a scenario involving a patient with severe headache, the user may be offered options such as prescribing an analgesic or ordering CT scan of the head.
Static mannequins	• Used for hands-on practice. • E.g. intubation, laparoscopic training or cardio-pulmonary resuscitation Resusci dolls.
Medium-fidelity simulators	
Screen-based graphical simulators	• Particularly well-suited to demonstrate physiological modelling and pharmacokinetic and dynamic simulator processes associated with drug administration. • Usually, only a mouse interface is involved. • Example: Gainesville anaesthesia simulators Gasman and Body.
Mannequins with mechanical movement	• Includes a mannequin and software that can simulate movement interaction between a student and teacher. • Computer-based pictures help confer practical skills. • Includes 'range of normal variation'. • E.g. cardio-pulmonary resuscitation AMBU Man, endovascular procedures AngioMentor® and ultrasound UltraSim® or U/S Mentor®.
High-fidelity simulators	
Non-physiological programming	• Manually set parameters dependent on operator. • Parameters need to be reset after intervention.
Physiological programming	• Parameters change from baseline dependent on intervention and independent of operator. • Automatic generation of appropriate physiological responses to treatment-interventions in the mannequin allowed. • E.g. human patient simulator.

as Massively Multiplayer Virtual Worlds[1], authors also pointed out the need to analyze the benefits of virtual worlds, such as immersion, role-playing opportunities, simulation and personal interaction associated with the technology and its influence on formative and summative learning outcomes. Roger's Diffusion of Innovations Theory [6] and Siemens' Connectivism Theory [7] were proposed as useful theoretical frameworks serving necessary education research. Similar doubts and fears were stated also in [8]: *'While simulation offers*

1 Currently, the most popular virtual world used by the general public is the Linden Lab's Second Life [5].

many advantages over traditional methods of teaching, there are several challenges that must be addressed to ensure its effective use.'

MOTIVATION, EVIDENCE AND CLASSIFICATION OF MEDICAL SIMULATORS

Despite the initial doubts, simulation began to be perceived as a tremendous tool for healthcare educators, in that it allowed students to achieve their learning goals without putting patients at risk. Hundreds of original articles and reviews appeared. One hundred and thirteen articles were included in the review by Okuda et al. [9]. It was demonstrated that simulation-based training led to clinical improvement in multiple specialities, with clear evidence that the use of simulation technologies had also become well-established in undergraduate and graduate medical assessment. The authors predicted the future of simulation in medical education to be in credentialing and certification. They pointed out that The United States Medical Licensing Examination (USMLE) [10] integrated computer-based case simulations as far back as the early years of the twenty-first century. Another extensive review on the role of simulation in medical education [11] derived a comprehensive classification of medical simulators according to type and fidelity (the degree of realism and technical complexity of models)—see TABLES B2.1 and B2.2. Important questions were raised here, such as whether or not simulation-based education techniques result in decreased occurrence of errors, and whether the ability to cope with the errors that do occur is significantly improved. The authors anticipated the need for continuous empirical research in this field and point out that defining a newly emerging profession of 'Simulation-Based Medical Education (SBME) Educator' is a must. Similarly, simulation training was reported in [12] to be missing universal acceptance, mainly due to the lack of trained teachers and initial costs. One particular comparative research paper [13] on simulation-based team training approach for an obstetric emergency explained the use of a female birthing simulator mannequin in four standardized, simulated crisis scenarios. The design of the study included several pre-course and post-course measures, such as the perceived performance, confidence and competence in responding to obstetric emergencies; attitudes toward the utility of a rapid response system; teamwork in healthcare; and simulation-based training. Significant improvement in the overall task completion was noted from the first to the last simulation. A positive shift in the participants' perception of individual and team performance and their perceived competence was reported, while there was no significant change in the participants' ratings for confidence, attitude toward utility of team skills, attitude toward the use of simulation-based training, or attitude toward the utility of a rapid response system.

HI-FI MEDICAL SIMULATORS: FEATURES AND USE

'What are the features and uses of high-fidelity medical simulations that lead to most effective learning?' This question was addressed in [14], a review that synthetized existing evidence from more than 100 studies selected from more than 600 journal articles. The review focused on comparative research works involving simulation as an education intervention and eliminating reviews in favour of empirical studies.

The following set of 10 proper conditions, under which high-fidelity medical simulations facilitate learning, was identified from the best available evidence.

1. Providing feedback: an educational feedback is the most important feature of simulation-based medical education.
2. Repetitive practice: employing medical simulation techniques can help move medicine from the old method of 'See One, Do One, Teach One' to a 'See One, Practice Many, Do One' model [15] for success.
3. Curriculum integration: embedding simulation-based exercises as an integral part of the standard medical school or postgraduate education curriculum is an essential feature of their effective use.
4. Range of difficulty level: the range of task difficulty level is an important variable in simulation-based medical education.
5. Multiple learning strategies: high-fidelity simulations allow adapting to multiple learning strategies, which is an important factor for educational effectiveness.
6. Clinical variation: simulators that capture a wide variety of clinical conditions are more useful than those with a narrow range only.
7. Controlled environment: it is important that learners can make, detect and correct errors without adverse consequences.
8. Individualized learning: the importance of having reproducible, standardized education experiences where learners are active participants and not passive bystanders is highlighted in multiple studies.
9. Defined outcomes: clearly stated goals are necessary, with tangible outcome measures that will more likely lead to mastering the skills.
10. Simulator validity: direct correlation exists between simulation validity and effective learning.

The last item in the list—validity of the medical simulator—is discussed extensively in [1], mainly from the perspective of integrative physiology, which should compose the theoretical basis for simulators. The book describes a wide

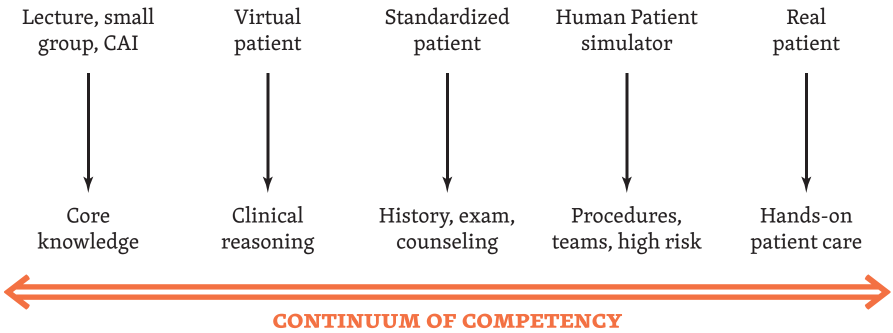

FIGURE B2.3 Medical simulation modalities matching the expected outputs for students' competence [16].

range of existing models of physiology systems, and its authors highlight the importance of model openness in terms of public availability of its mathematical equations as a key feature to verify validity of the simulator.

LO-FI MEDICAL SIMULATORS: VIRTUAL PATIENTS

Screen-based text simulators—as classified in TABLE B2.2—are often referred to as virtual patients (VPs) or virtual patient systems. From the linguistic point of view, a more appropriate term might be 'virtual clinical cases', because in fact they represent rather a narrative form of simulations introducing innovative pedagogy methods, such as case-based learning, problem-based learning or scenario-based learning, and enable future physicians and healthcare professionals to simulate important steps in the diagnostic and therapeutic process before exposure to patients. The critical literature review [16] proposed that VPs' most unique and cost-effective function is to facilitate and assess the development of clinical reasoning. This should involve a non-analytical process that matures through deliberate practice with multiple and varied clinical cases. The role of virtual patients in medical education considering other simulation modalities and the expected benefit in the medical students' competency is shown in FIGURE B2.3.

Besides clinical reasoning, VPs may also offer several advantages over standardized patients in teaching and learning of history-taking and communication skills, as shown in [17]. Increasing variety in the form, function, and efficacy of different VP systems has prompted the medical education community working in the field of VPs to construct a typology of VP designs [18] and to introduce VP commons [19] and interoperability standards. The format for exchanging case-based education resources in medicine, known as MedBiquitous' Virtual Patient [20], was established by the non-profit organization MedBiquitous

TABLE B2.3 VP typology framework empirically derived in [18]. This VP design typology can help clarify VP concepts and approaches and establish more objective and meaningful ways of reporting on or evaluating them.

Category	Factor	Description
General	Title	Name given to the VP activity.
	Description	Free-text.
	Language	Standard language indicator including version—e.g. EN-GB indicates British English and EN-US is US English.
	Identifier	Unique ID or address.
	Provenance	Author and other contributor information.
	Typical study time	Time in minutes for typical learner to complete activity.
Educational	Education level	Target learner level, for instance 1st year undergraduate, 3rd year resident.
	Education modes	Teaching, learning and assessment, and formative or summative aspects.
	Coverage	Topic area(s) covered.
	Objectives and outcomes	Objectives of the activity and any outcomes they address.
Instructional design	Path type	Linear string of pearls, branching.
	User modality	Number of users involved in an activity, roles they take.
	Media & resources	Use of images, audio, video, animations, etc.
	Narrative use and patient focus	Balance between presenting data (reading a history, getting test results) and telling a story (engaging in conversation, character, motive). In what way are patients involved in the activity design—are they the main focus (such as diagnosing and treating a patient) or a vehicle for other issues such as team work, basic science or professionalism?
	Interactivity use	Kinds of questions, tasks and challenges faced. Overall number of cognitive interactions.
	Feedback use	Kinds of feedback and whether during an activity or at the end (or both).
Technical	Originating system	Which tool or system was used to create the activity?
	Format	What technical format is used at the user end? Typically text/HTML for web and application/EXE for disc-based media.
	Integration and dependence	What other tools, systems or other contextual factors does the activity depend upon to run properly?

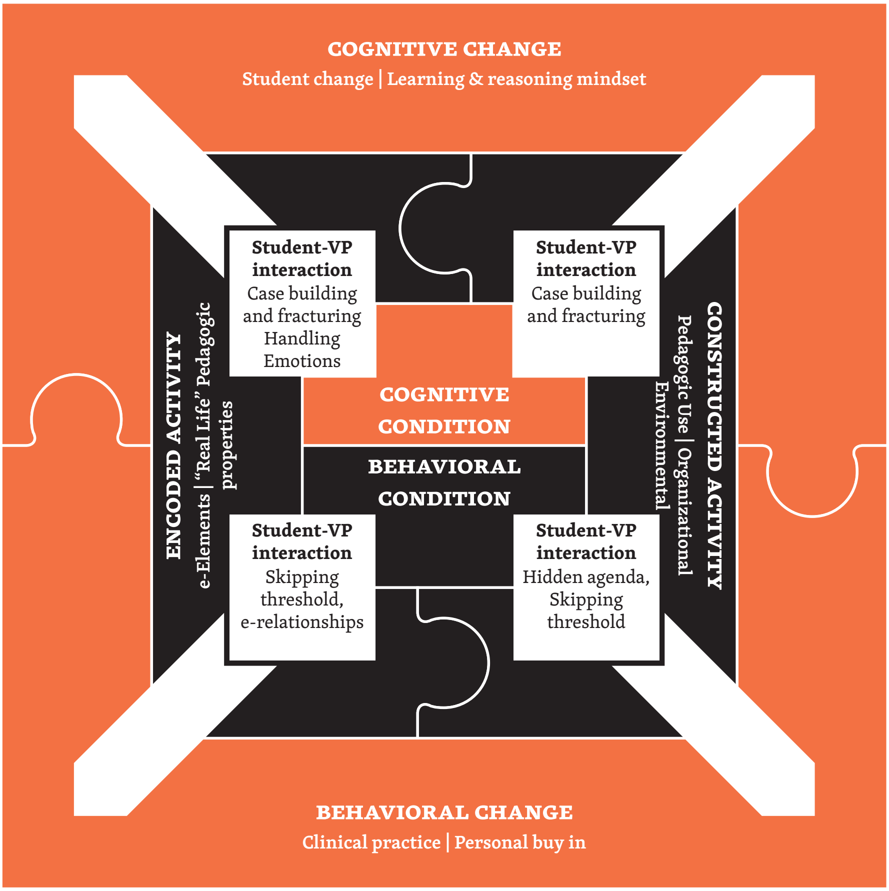

FIGURE B2.4 Virtual patient (VP) implementation model describes how different VP designs influence learning. The inner layer consists of the student's cognitive and behavioural preconditions prior to sitting a case. The middle layer considers the VP as an encoded object, an e-learning artefact and as a constructed activity, with associated pedagogic and organizational elements. The outer layer describes cognitive and behavioural change [27].

Consortium. Most VP systems include a player, authoring tool, administration component, storage system, indexing facilities and assessment tools, all of which are described in detail and discussed in [21]. Nineteen factors around four categories synthetized in [18] by empirically reviewing existing VP systems are shown in TABLE B2.3.

Since VPs entered the mainstream of medical education [22], a number of qualitative as well as quantitative education research studies have been published showing the results of VP implementation for learning and assessment. Focus group interviews were conducted in [23] to explore the opinions of medical students on the educational use of VPs. Five main themes were found to

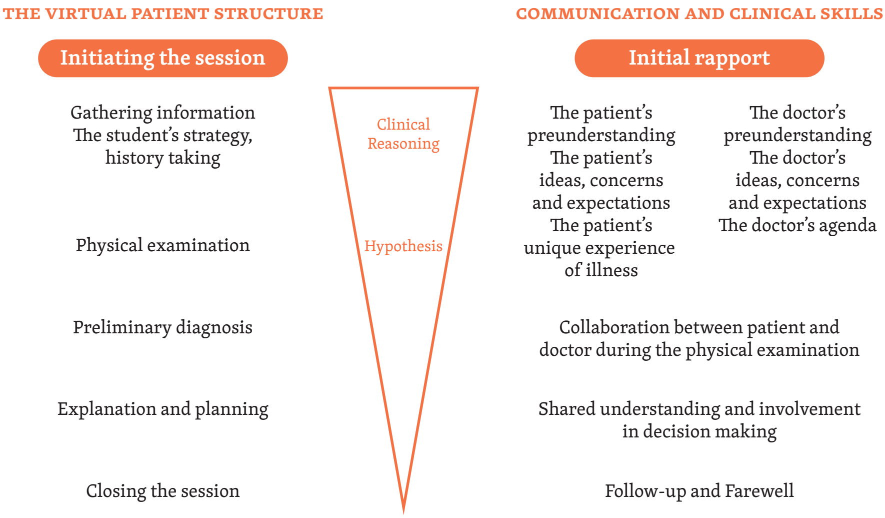

FIGURE B2.5 Virtual Patient Primary Care Model. The different dimensions of the VP case were structured to be congruent with the Calgary Cambridge Guides [35] and the PRACTICAL (Danish patient-doctor communication model [36]) training model in communication skills [28].

be associated with the successful use of VPs in medical curriculum: 1) learning, 2) teaching, 3) assessment, 4) authenticity and 5) implementation. The VPs design and content, the localization of the socio-cultural context, the realism of the cases, as well as the presence and quality of feedback were reported to be intrinsic features contributing to VPs authenticity. The use of VPs from the perspective of cultural competency and international education exchange was assessed in [24]. Although a number of statistically significant differences in the students' activity through the VPs authored in Romanian and English languages were found, the students' ability to reach the correct diagnosis and therapeutic plan was reported to be the same. Thus, developing curricula with VPs in English in non-English-speaking countries might be feasible, cost-effective and in accordance with the globalization of medical education. One can sense a controversy in these findings, as reduced authenticity of cases delivered in non-native language may limit the support of their reflective abilities. Recently, a multi-centre randomized 2 × 2 factorial design study evaluating two independent variables of VP design—branching (present or absent), and structured clinical reasoning feedback (present or absent)—was carefully designed [25]. The study was designed so that it followed the Consolidated Standards of Reporting Trials (CONSORT) statement on randomized trials [26] and aimed to answer the question of how the different VP designs influence clinical reasoning skills and student experience. The results of the research project

FIGURE B2.6 A shot from an emergency medicine course (AKUTNE.CZ): a real engagement of medical students during management of severe arterial bleeding—performed on a standardized patient.

FIGURE B2.7 A shot from the emergency medicine course (AKUTNE.CZ): a real engagement of medical students in severe traumatized patient—performed on the METI high-fidelity simulator.

were not available at the time of this publication. The same group of education investigators performed and published a qualitative research [27] composed of six focus groups, in which participants completed VPs with different designs, and participated in an evaluation and a focus group discussion. Based on their results, a three-layer model describing the interactions of students with VPs was constructed (see FIGURE B2.4). The model may enhance understanding of how and why the delivery and design of VPs influence learning. Another VP model specially designed for learning communication skills and clinical reasoning in primary care was developed and tested in [28]. This VP model was divided into five learning cycles in line with authentic patient consultation: 1) gathering information, 2) physical examination, 3) preliminary diagnosis, 4) explanation and planning, and 5) closing session (see FIGURE B2.5). Authoring and generation of VP scenarios remains a significant undertaking in terms of financial and time costs. Scenario development costs tens of thousands of dollars and at least twelve months of development per case [29].

LOW-COST COMPUTER-BASED MEDICAL SIMULATIONS

Complex mathematical models enabling the simulation of physiological mechanisms such as renal function, respiration or body-fluid balance, may enhance student learning by experimenting with the basics of physiology. The multimedia medical training simulator GOLEM [30] was based on a set of 39 non-linear differential and algebraic functions that described 89 input and 179 output variables. GOLEM's authors continue in their development efforts and recently invented their own implementation of the most extensive model of integrated physiology, HUMMOD [31]. The resulting HUMMOD-GOLEM edition, equipped with a web-based immersive graphic interface, is intended to be embedded into high-fidelity medical simulators or may serve to enrich existing VP systems, as it allows many different clinical scenarios to be simulated, including circulation insufficiency, renal disorders and diarrhoea. More broadly, delivering insight from computer simulations, such as in [32], leads to original knowledge as it elucidates physiological mechanisms that are not obvious intuitively and, in some cases, not readily testable in experimental studies. Besides the basic sciences, computer-based medical simulations also provide a vehicle to carry online education in other disciplines, e.g. medical imaging [33] or laboratory medicine [34].

PEDAGOGY OVER TECHNOLOGY

Simulation-based medical education should not be perceived only from the perspective of emerging technologies. The above-mentioned findings repeatedly show that the added values of medical simulators manifest only when the teaching/learning efforts are supported by the correct VP design and educators well-trained, particularly, in medical simulation. A unique example of a medical education environment providing adaptive, personalized, competency-based style of learning, where technology-based resources are supported with face-to-face learning, can be seen at St George's University, London. This medical school developed the first Problem-Based Learning (PBL)[2] curriculum open to graduates of all disciplines and later transformed it from the early paper-based form with online interactive VPs [37]. Relevant learning theories to underpin the development, design and delivery of an effective education programme for simulated team training are discussed in the conceptual review [38]. Its authors summarize that the ideal simulated team training programme needs a scenario for particular experience, followed by debriefing with a critical reflexive observation and abstract conceptualization phase, and ending with a second scenario for active experimentation. Further, they point out the importance of motivation with reality and context, advising to train with multidisciplinary team members and to act on the physiological variables. Enriching the interactivity of VPs with mathematical models of physiological and pathological processes is the main focus of the conceptual framework [39]. The technical challenges associated with development of VPs enhanced by physiology programmes are discussed from the perspectives of the computational modelling researcher and the virtual patient system developer, as well as the health care or medical educator.

CONCLUSION

This chapter outlined the history, motivation and basic principles underlying different simulation modalities in medical education. The findings presented in the literature available on this topic showed, among others, good acceptance of all simulation modalities by students and educators. High-fidelity simulators, as

2 Problem-Based Learning (PBL) is one example of widespread form of learning, which uses patient simulation to create a learning style close to the needs of practice. Many curricula in medicine are now built around these enquiry-based collaborative approaches to learning, especially PBL, where students work in teams to explore, manage or solve a problem.

well as the low-fidelity ones, in the form of screen-based simulators or virtual patients are usually regarded as an intermediate learning activity and a complement to both the theoretical and the clinical part of the education, filling the gaps in clinical knowledge. The benefits of simulation technology include improvements in certain manual/technical skills and in the acquisition and retention of knowledge compared with traditional lectures.

In conclusion, three topics for further investigation and development in the field of simulation-based medical education are presented and discussed here: 1) Pedagogy over technology: an adaptive, personalized, competency-based style of learning is achievable only when technology resources are supported with face-to-face contact with well-trained educators and with an underlying education method suitable to preselected learning/teaching goals; 2) Multidisciplinary approach: validated computational models of physiological and pathological processes will deliver substantial added values in clinical scenarios implemented with a medical simulator regardless of its fidelity; 3) Medical education research: different structures and designs of simulation-based sessions result in different learning outcomes in terms of increase in the trained skillset, engagement or reflection. The optimal shape of the teaching/learning environment employing simulation modalities should follow the results of a carefully designed research study taking into account various local socio-cultural conditions. Regarding the situation across the MEFANET network, the first pilot studies have already appeared, mainly in acute medicine [40,41]. Their methodology and results are further described and discussed in CHAPTER C2. FIGURES B2.6 and B2.7 show shots from a course of emergency medicine, which is organized as an important part of educational activities delivered by physicians, educators and medical students cooperating within activities related to the educational web portal AKUTNE.CZ—an integral part of the MEFANET network.

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▸B3◂

METHODS OF QUALITY ASSESSMENT OF E-PUBLISHED EDUCATION MATERIALS

MARTIN KOMENDA, DANIEL SCHWARZ

'Quality is never an accident; it is always the result of intelligent effort.'
JOHN RUSKIN

Summary. The rapid expansion of e-published education materials and its pedagogical impact on the society at large is no predictor of similar progress in formal learning practices in higher education. The efficiency offered by these tools, in the backdrop of discrepancies in the quality of the digital content as well as the methodological difficulties in developing new web portals and repositories, has failed to satisfy the mainstream needs for improving education processes in higher education. This chapter offers recent literature overview focused on the field of quality assessment and related domains such as metadata composition or using the crowd-sourcing concept. An appropriate combination of existing and new methods in this particular field has great potential for providing complex evaluation mechanisms of the education resources, thereby establishing guaranteed and approved channels for delivering information to students. Generally, highlighted is the necessity to perceive quality assessment as a multi-dimensional domain with many fundamental attributes.

Keywords:
- information quality
- educational repository
- web portal
- online assessment tools
- crowd-sourcing
- medical education

Reviewer:
- JAROSLAV MAJERNÍK

WEB PORTALS AND HIGHER EDUCATION

Several experts differ in their attitude towards, and perception of, the field of medical education. It is widely accepted, without reservations, that the progress made in modern information technologies plays an important role in medical and health care education. This is particularly true of the dramatic advancements of the past decade providing us with web-oriented tools that have the potential of revolutionizing the way we provide education [1]. Technological development, particularly the rapid growth of e-learning, is altering the nature of the medical education environment and the offered possibilities are increasingly irresistible. Continuing education on the Internet is gaining popularity and most participants are satisfied with the experience and find it to be an effective learning format [2]. As it was shown in CHAPTER B1, there is hardly any doubt that e-learning, if delivered appropriately, can be effective and can enrich the learning experience for the student with concurrent involvement of the educators in a more productive and rewarding manner.

Although face-to-face teaching, direct practice and observation in the operating room are essential, web technologies hold great promise to support and innovate the education process such that the student need not to be in a classroom for didactic talk or even be in the operating room to see how an arterial line is properly placed [3]. Today, people are used to being more connected with various information sources and to each other via Internet communication channels. This has led to the appearance of many new educational capabilities that are open, shared and inter-related; represented by wikis, blogs, podcasts, RSS feeds, social bookmarking and networking, interactive presentations, virtual patients and serious games, digital videos, etc. Modern educational web portals and repositories have the potential of being a powerful umbrella over all available multimedia resources. As the names signify, they represent web spaces devoted to storing and displaying a set of e-learning materials that can be utilized as archiving and storage tools or as shared resource for others interested in a particular topic [4]. Many of such systems have been designed in recent years. However, they usually, barring a few, represent either storage of diverse study/teaching materials or huge data warehouses without tools for organizing and guaranteeing the presented education content. Conole and Alevizou [5] published a review of the use of Web 2.0 tools in higher education. Such digital libraries or large reusable learning object repositories like Jorum[1], WISC-Online[2] or GLOBE[3] provide learning content for

1 Jorum—Learning to Share: http://www.jorum.ac.uk/.
2 Wisconsin Online Resource Center: http://www.wisc-online.com/.
3 Global Learning Objects Brokering Exchange: http://globe-info.org/.

educators without any registration or fees (in most cases). Additionally, many repository software projects have been undertaken including OAI[4], DSpace[5], and eduSource[6]. Then, on the other hand, there are medical education repositories of the likes of MedEdPortal[7], MELINA+[8], MERLOT[9] or HEAL[10] that use various review processes and publish mainly guaranteed learning content. In general, there is little doubt that the generic lack of a review process or complex quality assessment system represents a serious issue and hinders increased uptake and utilization of educational resources [6].

DIGITAL EDUCATION CONTENT QUALITY ASSESSMENT

Focus on the quality carries high importance in the processes of higher education and can be seen from many different perspectives. According to Collis and Moonen [7], the quality from the perspective of those representing a discipline or an educational programme often relates to the quality of learning resources and curricula, and to the quality of the instructors as indicated by their external reputation in the respective research communities. On the other hand, for instructors the quality of education means topicality and accuracy of information on the particular discipline, and their own performance: what impinges negatively on student responses to their lectures affects the mutual impression of the quality of the education process. For students, quality often relates to intelligibility and clarity: how well are the expectations of the course and its assessment practices indicated at the start of the course and reflected in the course? In this context, quality learner support is vital and social presence becomes a highly desirable feature to be embedded in the delivery of any learning product [8]. Since one of the educator's roles is to assess and select learning resources based on a particular curriculum framework and the students' needs and goals, the development of robust methods for education content evaluation becomes essential. It is important for the learner to be assured that the quality of the learning resources is reviewed or assessed. Unfortunately, systematic evaluation of computer-based education resources in all its forms—including integrated learning systems, interactive multimedia,

4 Open Archives Initiative: http://www.openarchives.org/.
5 DSpace: http://www.dspace.org/.
6 eduSource: http://edu-source.com/.
7 MedEdPortal: http://www.mededportal.org/.
8 Medical education linked arena: http://www.meducator3.net/melinaplus/.
9 Multimedia Educational Resources for Learning and Online Teaching: http://www.merlot.org/.
10 Health Education Assets Library: http://www.healcentral.org/.

complex learning environments, etc.—often lags behind the development efforts [9]. Guaranteeing the correctness of the published education content seems to be a long-term problem and is often related to system design, development and the services offered. Generally, we need to ensure that the quality assessment will serve as an effective support rather than a complicated barrier during the publishing process. Quality can mean different things; however, common quality issues include accuracy of information and knowledge disseminated in the content. Just because the content is correct does not mean that it is appropriate for use in every context. Quality is also a matter of trust: students have to trust the information provided if they are to use it [10].

METADATA QUALITY ASSESSMENT

The quality of portal/repository metadata, as a formal description of education materials, is one of the most important issues directly influencing the relevance and final output of a learning object for the target group, i.e. the students and the academic staff. These systems are called upon to play a central role in automated approaches to e-learning since they provide the required support for access and search options concerning the particular learning object, oriented not only to humans but also to software agents and search engines. As a consequence, completeness of metadata becomes a key requirement for every high-quality repository [11]. The primary purpose of a proper set of metadata is to provide adequate and correct information to the user in order to obtain a correct overview of the available education content without having to access it. Margaritopoulos et al. [11] introduced a new conceptual framework for assessing metadata quality using a method based on exploiting the structural and semantic relations among digital resources in a repository. Such relations create logic rules, which are distinguished into the following major categories: rules of inclusion, imposition and restriction. For each metadata record in a repository, all of the rules are applied. Sicilia et al. [12] published a comprehensive study on the proper use of metadata records focused on education resources, representing the first step towards the notion of completeness that could eventually be used as an estimator of the quality of metadata records, and in aggregated terms, of the learning object repositories. They also confirmed that the concepts of completeness of the learning object metadata records and the completeness of learning object repository are required to serve as quality indicators about the descriptions of reusable learning contents.

QUALITY ASSESSMENT FRAMEWORKS

Several more or less effective mechanisms aimed at guaranteeing content have been published and utilized so far. E.g. in [13] Yang et al., an instrument is proposed that measured the user-perceived service quality of web portals. They proposed and validated a five-dimensional service quality toolset involving: usability, usefulness of content, adequacy of information, accessibility, and interaction. These tools provide a useful scale for researchers desirous of measuring the service quality of web portals. Bottentuit & Coutinho [14] selected a set of indicators that, in their point of view, should be necessarily integrated to a portal dedicated to educational issues: (i) ease to use, (ii) services, (iii) communication, (iv) content, (v) performance and (vi) information. It is essential to take these quality issues into account in the construction and/or management of the education portal if a successful portal with significant traffic of site users and promoters is desired. Another approach, a portal data quality model (PDQM), was presented by Caro et al. in [15]. This model was constructed from the data consumer's perspectives and its production included three initial phases: (i) identification of web data quality attributes and definition of a classification matrix, (ii) classification of data quality attributes into the matrix, (iii) validation. During the first phase, a set of 41 quality attributes for quality evaluation of web portals was compiled. The same investigators did an extensive web data quality revision in [16] and captured several quality attributes. The most considered were accuracy, completeness, timeliness, conciseness, consistency, currentness, interpretability, relevance and security. Finally, Elissavet et al. [17] described a comprehensive evaluation framework for hypermedia courseware, which concerned social and practical acceptability. The term social acceptability is related to the social basis of an education system (student-, teacher- or patient-centred). Practical acceptability was examined through the evaluation of the following four sectors: (i) content, (ii) presentation and organization of the content, (iii) technical support and update processes and finally, (iv) evaluation of learning.

CROWD-SOURCED QUALITY ASSESSMENT

Recent trends in medical education emphasize collaboration through team-based learning. In the technology world, the trend towards collaboration has been characterized by the crowdsourcing movement [18]. Howe and Robinson [19] originally coined the term 'crowdsourcing' to describe a problem-solving approach that outsources tasks to an undefined, often anonymous, population. It is a neologism from the words crowd and outsourcing, and represents the transfer of services from professionals to the public via the Internet. In crowdsourcing, problems are broadcast to the public in the form of an open call for solutions giving access to a large network of potential participants. There are three fundamental reasons why education is an exciting subject for crowdsourcing research: (i) crowd-techniques are required in order to deliver quality education in some areas, (ii) existing techniques are ready for application to this new area, and (iii) online education represents a new, relatively unexplored way of creating crowds. It is clear that crowdsourcing methods have great potential for improving online personalized education. The challenge areas such as education resources quality, personalization of study materials and providing well-founded feedback offer the promise of rapid progress and substantial impact [20].

The current manner of collaboration in education was built on the principle of digital education content sharing. For illustration, Bow et al. [18] developed and implemented a crowdsourcing model for creating study materials. They began by building an infrastructure that facilitated the use of question and answer sets as flashcards, followed by the development of foundational content based on the curriculum of the first year. The mentioned approach serves as a model for collaborative learning in other education systems that require assimilation of large amounts of information. Keimel et al. [21] introduced a framework for crowd-based video quality assessment. They proposed using the power of the Internet to assign simple tasks to a group of online workers. The main idea is to utilize crowd-sourcing platforms to perform subjective testing with a global worker pool, usually with a web-based application, that can be accessed via a common web browser. It pertains to tasks that cannot or not efficiently be solved by computers but are simple enough to be performed by untrained participants. The challenges faced by crowd-based quality assessment from the conceptual, technical, motivational and reliability perspectives were also discussed. Chen et al. [22] proposed and evaluated a crowd-sourceable framework to quantify the quality of multimedia content. This approach differs from the traditional mean opinion score (MOS) rating [23] as follows: (i) it enables crowdsourcing because it supports systematic verification of participants' inputs, (ii) the rating procedure is simpler than MOS approach so there is less burden on the participants, (iii) it derives interval-scale scores that enable subsequent quantitative analysis.

Moreover, Atkins et al. [24] presented the need for designing the next generation platforms to close the loop and accelerate the improvement of material through reflected use. They introduced content quality assessment and enhancement for providing high-quality material production, which is based on replacing the traditional pre-publication review, often accept/reject and exclusive, with a post-publication review based on a more open community of third-party reviewers experienced in using the materials. In this pre-publication model, credentialed materials are not merely distributed through the network; post-publication materials are credentialed through use in the network. This system lowers the entry barrier into the author community and thus fosters diversity of opinion and subject matter, and increases the quality of the resulting materials. Probably one of the most comprehensive approaches based on crowd-sourced concept was published by Leacock and Nesbit [25].

They described the structure and theoretical foundations of the Learning Object Review Instrument (LORI), which balances assessment validity with efficiency of the evaluation process. It provides the instrument enabling learning object users to create reviews consisting of ratings and comments on nine dimensions of quality: content quality, learning goal alignment, feedback and adaptation, motivation, presentation design, interaction usability, accessibility, reusability, and standards compliance. Perhaps the most salient aspect of learning object quality and certainly the one most relevant to the expertize of subject matter experts is content quality. It is defined by veracity, accuracy, balanced presentation of ideas and the appropriate level of detail of the learning object. This model can be used in a variety of evaluation models; in this particular case, it was applied in collaborative participation where reviewers first independently evaluate a set of objects and then discuss their divergent ratings.

DISCUSSION & CONCLUSIONS

Questions on education content quality are frequently raised as learning resources are expected to be trusted and authoritative. This chapter is focused only on the assessment of the quality, which significantly helps to provide a well-balanced and guaranteed digital content in higher education. The assessment of student knowledge is another area of scientific research where many results have been published [26–28]. In terms of e-content quality, there are various models, concepts and frameworks that have the potential to facilitate innovations in professional development, teacher training and teaching practices, as well as improvements in the quality of student learning and experiences. We mentioned freely accessible repositories and web portals, which only exceptionally use various peer-reviewed mechanisms for guaranteeing the quality of published resources (for instance, at MERLOT only 14 percent of submitted materials have been reviewed). On the other hand, probably the largest medical education content publication service MedEdPortal (provided by the Association of American Medical Colleges) clearly marked all learning materials with the appropriate review logo based on the evaluation approach (Peer Reviewed, Editorial Reviewed, Special Collection Reviewed) [29]. Methods for assuring quality in the learning resources domain are still in development. We pointed out frameworks and the mechanism for content quality assessment, which are based on metadata description, crowd-sourced approach or guaranteed and reviewed content. Using just one single assessment method or technique is not sufficient to determine competence. Essentially, what is needed most is a change in the mind-set. As the first step, it is necessary to look at the assessment as a multi-dimensional problem. It may drive innovative enhancement, which might extend the quality assessment models newly developed in accordance with crowd-sourced methodology. In essence, the primary objective is common for all mentioned platforms: provide relevant, correct and useful education data to medical learners and educators. The MEFANET solution (see CHAPTER C1) promises more complex functionality and wider range of tools for organizing the published contents, as well as the possibility of presenting the contents complete with the comments of selected tutors from expert medical societies. In this manner, it provides clear and apparent guidelines for assessing the quality of multimedia content published on medical and health care education portals.

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▸B4◂

FEDERATED AUTHENTICATION FOR MEDICAL APPLICATIONS IN MEDICINE

MICHAL PROCHÁZKA

'I believe in libertarian options because they allow an interesting management of the capital and are based on co-operation, reciprocity, contract, federation.'
MICHEL ONFRAY

Summary. Since the web is the most frequented site for portals containing medical study materials, the security of such web-based systems is crucial for the users and providers of the portals. Despite the plethora of possibilities offered by the current technology, it is still somewhat challenging to select an authentication system that suits the users as well as the service providers due to the implicit conflict between their notions and requirements. While the former group prefers simplicity of the process, the latter often lean toward complex authentication procedures. Ironically, raising the bar leads rather to weakening of the whole system as the users seek innovative ways of bypassing it (e.g. the infamous sticky notes with password stuck on monitors). Apart from authentication, proper access control is often required along with support for various dynamic scenarios. For instance, in order to handle the dynamic groups of users, where memberships change more often than not, an efficient approach is needed to decide whether or not a given user is a member of a particular group. For example, a group of physicians from one institution could be identified easily if access to a personal agenda is given. As this is usually not the case, the owner of the portal providing medical material to physicians has to set up their own identity management systems. This in the backdrop of the fact that highly simplified and similar scenarios are very common nowadays, incurring additional overheads and possible inaccuracies culminating in compromised system usability and security. Federated authentication is a promising solution to address the mentioned issues, and it will be described in this chapter.

/ **Keywords:**
- federated authentication
- SAML2
- single sign-on
- eduID.cz

/ **Reviewer:**
- ROMAN ŠMÍD

IDENTITY FEDERATIONS

A possible solution to the problems outlined in the summary above is presented by the federated identity management, which has gained significant attention recently. The identity federation model renders the authentication step easy for common users; mainly since it does not require the users to register new authentication credentials with each new service. Instead, it utilizes the existing identity management systems and allows them to hand over authentication to end services. Federated identity management is one of the solutions being adopted by a large number of institutions nowadays, even commercial giants such as Microsoft. Identity federation is an infrastructure that connects identity management systems from different institutions and services providers, requiring user authentication. Identity federations enable sharing of information on the users through a standardized protocol that is accepted by every party in the federation. Every organization participating in the federation manages its users via a local user management system. An identity provider (IdP) service is built on top of such an existing user management system, providing the interface for accessing authentication information and other attributes about the user, like name, affiliation and unique identifier. Every service provider (SP) in the federation can obtain this information by calling the IdP service. SPs process the data returned by the user's home IdP and use it to make access control decisions. Before users are allowed to use a service, they have to present a set of attributes issued by their IdP. These attributes are provided to the users or to a service working on their behalf upon proper authentication of the user with the IdP.

Identity federation is generally used as depicted in FIGURE B4.1 [1]. A user visiting a federated service is first checked and if no authentication information is known to SP (step 1), the user is redirected to his or her IdP web page (step 2). After the user has successfully authenticated with IdP (step 3), the respective IdP creates a response containing confirmation of successful authentication and additional information about the user (step 4). The response is then sent to SP, which verifies validity of the response and extracts information about the user. Finally, SP makes an authorization decision and allows/denies access to the user. The same principle is applied when the user accesses other SPs. Therefore, the user needs to maintain only one account and one set of credentials for all SPs within the federations. These credentials are only managed on IdP and not available to SPs, which enhances their security.

The principal advantage of using the federation model is the fact that users use their home institution's credentials (which may be a user name and password, a digital certificate, a hardware token, or something else) to authenticate to arbitrary services within the federation without exposing them to SPs.

Every SP in the federation can use this mechanism transparently from the user's point of view. There is no need to introduce new credentials for every new service or to synchronize existing credentials (like passwords) among different services. Having no additional credentials also means there is no need to distribute them among the users. Such an arrangement not only simplifies credential management but also makes it more secure in comparison to the practise of login and password on SP page. Users are only required to maintain one piece of authentication information; therefore, more requirements on the quality of credentials can be applied. SP can never see the user's credentials because the service only receives response from the IdP. The federation model is undoubtedly more acceptable to users as it is not tied to any particular authentication method and institutions can decide on the most appropriate method for their users.

Enhanced privacy is a potential side effect of the above-mentioned use of assertions. IdP can provide only assertions that do not contain precise user identity, i.e. it can provide the information that a person is member of a particular group without revealing his or her name or other unique identification. The assertions are sufficient for a service to make an authorization decision; however, the precise nature of the audit trace is hidden from SPs; hence, user privacy is enhanced.

The leading middlewares[1] for building identity federations in higher education sphere are Shibboleth [1], Microsoft's ADFS[2] and SimpleSAMLphp[3]. All are built on the Security Assertions Mark-up Language, version 2 (SAML2) [2], which is an XML-based specification to define a common XML framework for exchanging authentication, authorization and attribute assertions between entities. Identity federations built on SAML2 protocol define three additional entities besides identity and service provider: discovery service, metadata and federation operator. The discovery service is availed by users to locate their home organization IdP. With the discovery service, SP does not redirect the users directly to IdP, but to the discovery service page where the user then selects his or her IdP. Metadata is an XML based document containing information about all entities within the federation. Obviously, metadata has to be properly managed. All parties have to be listed and each party has to have an up-to-date copy of the metadata in order to be able to create a communication

1 The leading middlewares implementing IdP and SP entities are compatible with each other because they are using standardized SAML2 protocol for communication. Domain service (DS) is optional component of the federation which makes selection of the right IdP easier for the user. DS is independent from different middlewares. Metadata is just one part of the SAML2 specifications used for defining trust among SPs and IdPs.

2 Microsoft's ADFS: http://msdn.microsoft.com/en-us/library/bb897402.aspx

3 SimpleSAMLphp: https://simplesamlphp.org/

link with another entity, as well as to verify the messages received from other entities. Metadata is usually maintained by the federation operator, which also defines the federation policies and introduces new SPs and IdPs. Every IdP can define an attribute release policy for each SP within the federation. The attribute release policy defines the attributes about the user that can be released to a particular SP. Therefore, an IdP releases different sets of user's attributes to different SPs. The set allowed is defined in an agreement between the SP and IdP or between the IdP and the federation operator. Therefore, the user is not the one who decides which attributes will be released. The user can only accept or decline releasing of the set as a whole. Since the decision is not left to the user, the relevant IdP has to obey the appropriate privacy laws.

EDUID.CZ

The Czech national academic identity federation is called eduID.cz[4]. The federation is operated by CESNET Czech National Research and Education Network[5]. EduID.cz is primarily oriented non-exclusively to universities, which means that commercial service providers as well as identity providers from the public domain can also be part of eduID.cz. Every IdP and SP has to accept the eduID.cz policy, which sets the basic level of trust among identity providers and service providers. IdPs acknowledge that they will release only correct and up-to-date information about the users. This is a very strong requirement because SPs make authorization decision based on user's attributes. On the other hand, SPs have to guarantee that data received on the users shall not be misused. The process of joining identity federations including eduID.cz usually requires a set of administrative tasks for setting up the trust and responsibilities, and technical tasks that require a different level of complexity depending on the organization of the identity management system (IdP case) or on the ability of the service to adopt federated identity and render an authorization (SP case).

The eduID.cz is well suited for services that are destined for users from different higher education institutions. Users access the services in the standard manner and the service provider does not need to deploy direct connection with each user's home organization. Service providers that are part of the identity federation do not need to manage user credentials nor deploy reset password services since this is done on the IdP side.

4 http://www.eduid.cz

5 http://www.cesnet.cz

SERVICES IN IDENTITY FEDERATIONS

Service providers are the key component in the identity federations, which make them interesting for the users. On the other hand, participating in an identity federation from the service point of view dramatically decreases the amount of effort needed to make the service available to different users from different organizations. In the next two subsections there are examples of existing services available in the academic identity federations.

MEFANET

MEFANET is an ideal service that can be federated as it contains several instances of MEFANET portals on different universities that have to be available for all users from all universities. By placing each MEFANET portal in eduID.cz, all users can have access without the need for negotiating with their home institutions.

During the process of defining the process of integrating MEFANET portals into eduID.cz and the type of information required from identity providers, one obstacle was identified. MEFANET portal needs to know the affiliation of the user at faculty level. This information has not been released by any of the IdP connected to eduID.cz by that time. From the technical point of view, no common attribute existed that can handle such information. Therefore, we embarked on defining a special attribute that shall contain information about the user's affiliation with a faculty in a form that is comprehensible for the existing MEFANET portals. MEFANET portals render simple authorization decision on access for each user. Permission is protected at three levels; content is available to all (from users of a particular university to users from a particular faculty of the university). Identity provider, through eduID.cz, delivers information about user affiliation to the university and also to the faculty so that the MEFANET portal can run access check at each visit by the user. This data is released at each access to the MEFANET portal, meaning it is always up to date. Upon loss/cessation of affiliation of a user with the university, access to contents dedicated to the university in the MEFANET portal is automatically denied.

Since 2008, all MEFANET portals are accessible via eduID.cz. Recently, efforts are being made to build the identity federation in Slovakia. In order to allow Slovak IdP on MEFANET portals, all that is needed is to incorporate the Slovak identity federation metadata in MEFANET portals. This is a clear demonstration of the valuable assistance provided by identity federations to service providers in delivering content to authenticated users.

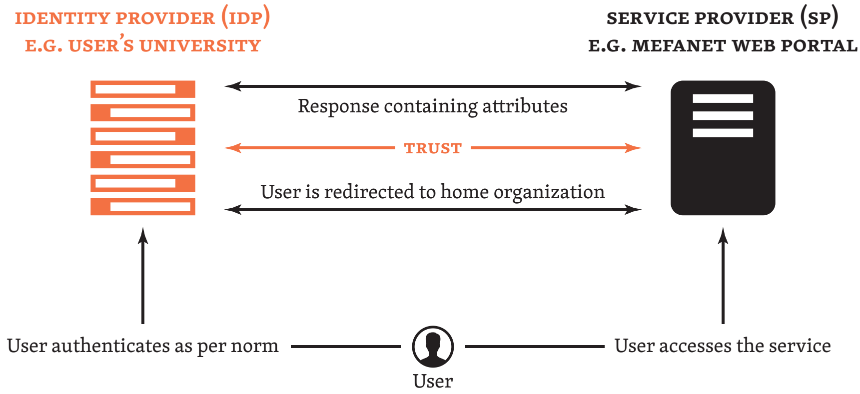

FIGURE B4.1 Identity Federation Scheme.

GLOBAL SERVICE PROVIDER—ATLASES

While MEFANET portals are mainly oriented on the Czech and Slovak environments, the Masaryk University is providing another service called Atlases [3]. Atlases is an atlas of high resolution pathological images that can be viewed using the virtual microscope in a web browser. Moreover, Atlases contains annotations to clinical pictures and images from pathologists. The distinctiveness of the atlas as a source of information led it to be made available to the rest of the world. To prevent theft of the images, we deployed federated authentication. Every user has to register; however, those with granted federated identity simply go through registration without the need to login and enter the password.

Atlases is linked to nearly 20 academic identity federations from all over the world, serving nearly 40 000 users (September 2014). Atlases is an example that valuable services like MEFANET can be easily exposed to the world without the need for investing in laborious user management on the service side.

INTERFEDERATION—EDUGAIN

Nearly all European countries operate their own academic identity federation. Service providers desirous of providing services on global scale can leverage eduGAIN[6] to effectively reduce technical and administrative overheads

6 http://www.edugain.org

needed to connect to each of the federation separately. When MEFANET decides to provide services outside eduID.cz, it can be easily accomplished by registering MEFANET portals in eduGAIN and thus make them readily available to all identity providers registered in eduGAIN.

DISCUSSION & CONCLUSIONS

Nowadays, users are well familiar with the federated identity concept that is utilized by companies of the likes of Google and Facebook. Although the technical solutions applied there are different, the concept from the user's point of view is the same. Accessing different services from different administrative domains using one single identity is preferred by users as well as the service providers. Therefore, enabling services using federated identity affords ease of use by lowering the barrier to access the service and, at the same time, by offering enhanced security for user credentials.

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▸B5◂

LEGAL AND ETHICAL ASPECTS OF E-LEARNING AND E-PUBLISHING IN MEDICAL AND HEALTH CARE FIELDS

DANIEL SCHWARZ, MARTIN KOMENDA, RADIM POLČÁK, LADISLAV DUŠEK

'I publish, and therefore I will be robbed.'
A TEACHER-REALIST

Summary. Using the Internet as a source of information has become an inseparable part of the today's student life. It has become apparent and considered as the norm by students that subjects taught at universities are supported in electronic form. Teaching and learning materials come in the form of PowerPoint slides, digital textbooks, web sites, digital images or videos. Therefore, an educator who is the author of such electronic material has to become thoroughly familiar with the laws applicable to the Internet environment and to use the contents therein. The notion that anything posted on the Internet is freely downloadable and distributable is a common error. Rarely do users realize that certain rules must be respected and they include, among others, the Copyright Law. Another interesting issue in this area to be solved by authors teaching in the respective fields of clinical medicine relates to data ownership rights, especially in cases when data from the medical records of real patients is used for the purpose of authoring teaching materials. Does the data belong to the physicians, whose endeavours formed the materials, or is the data the sole property of the patient? And where does the health care facility come into the ownership? This question also should take into account that various modalities were used to create the data in the first place. There are plenty of other questions that can be encountered very often at various forums—e.g. under what circumstances can the data be used for electronic support of teaching or learning?

/ **Keywords:**

- intellectual property rights
- copyright
- citations
- anti-plagiarism
- creative commons
- medical records
- informed consent

/ **Reviewer:**

- RADEK POLICAR

OWNERS OF INTELLECTUAL PROPERTIES—PUBLISH!

Educators—authors of electronic study materials—not only ask questions relating to transgressions of the Copyright Law but often have concerns about the fate of their intellectual property. Therefore, they are afraid of publishing in a web-based environment built for the purpose of sharing their works, such as the MEFANET portal platform, as they presume that any kind of sharing can lead to pilfering. The answer to their concerns is quite simple: such thefts can happen in the same manner as to the author's car. The car can be broken into or even stolen from a supermarket car park, regardless of the security measures installed. But this fact does not deter the owner of the vehicle from using it for his/her needs provided that adequate precautions are observed and carelessness avoided. Similarly, the risk of pilfering of intellectual property should not be the reason to deprive the righteous masses of such valuable works. Leave the thieves and plagiarists to their own dreadful fate, and owners of intellectual property—publish your works![1]

INTELLECTUAL PROPERTY RIGHTS, COPYRIGHT LAW

Intellectual property, in general, refers to unique creations of the mind. Intellectual Property Rights (IPRs), as a term, refers to the legal rights granted with the aim to protect the creations of the intellect. Moreover, copyright, refers to the 'right to copy', and is essentially a form of IPRs applicable to any expressible idea or information that includes creative works [1, 2].

It may seem problematic that the Copyright Law deals with subjects such as literary, audio-visual or scientific works—all of them being intangible assets resulting from the process of thinking. In terms of human understanding, a theft of goods in a store is perceived differently when compared to unauthorized copying and redistribution of a text published on the Internet. However, from a legal point of view, there are no such differences and in both cases it is a violation of property rights, i.e. illegal acts.

1 The parallel to the risk of stealing a car is naturally not entirely accurate. The author, whose work someone copies or misuses, loses nothing compared to a person whose car was actually stolen. The actual risk of negative impact of misused copyrighted works on the author is only very slight, compared to the benefits resulting from the publication (i.e. well-known works of the author, the feedback possibility and citation potential), which are much more interesting.

COPYRIGHT LAW AND INTERNET

One can hardly imagine working daily without using the Internet. That is why it is important to remember that the Copyright Law applies to online material as well. For example, if you were creating a web site, it is not permitted to copy the source code from another site and reproduce the template by adding your own contents to it. The content of the website itself cannot be redistributed without proper citations, which is often forgotten when creating or compiling electronic teaching or learning materials. Authors of scholarly articles in scientific or engineering journals are usually very sensitive about the neglect of citations of their scientific works. On the other hand, the authors are able to unconsciously ignore the fact that the Copyright Law lays down rules for using citations of any kind of works including the texts or images posted on the Internet. An appropriate question to ask would be if a predefined format in which the citation should be stated actually exists? The law does not stipulate a specific format. However, it does state that the title of the work as well as the source and author's name should be given in reference to the cited work, if such data is available. There are many different systems of citations and references varying across academic fields. It is, therefore, recommended to use the most common system in the field to which the work is focused on. It is not required to pay any fees when using someone else's work within the citations [3].

When reproducing images, photos, audio or videos, it is important to remember that these items are also subject to Copyright Law and the use has to meet the terms and conditions specified in the license agreement with the copyright holder. For example, a proper citation will not be sufficient when referencing an image owned by a company operating on the market with commercial databases of digital media. This company has the right to control the reproduction of their work and may demand payment for such reproduction.

Copyright infringements, even inadvertently, occur almost on a daily basis. In the practical application of Copyright Law, the degree of interference is adjudicated. Hence, authorities enforcing Copyright Law are principally engaged in serious misconduct. For example, if someone creates a presentation of holiday photos with a familiar tune in the background and the purpose is to show it to friends, despite the copyright infringement, the offense is not likely to be acted upon by the relevant authorities [3].

COPYRIGHT LAW AND E-LEARNING

The issue of IPR's in connection with authoring of teaching materials also engages legal departments at universities. An educator-author often needs to use a portion of a text or an image retrieved from the Internet or scanned from

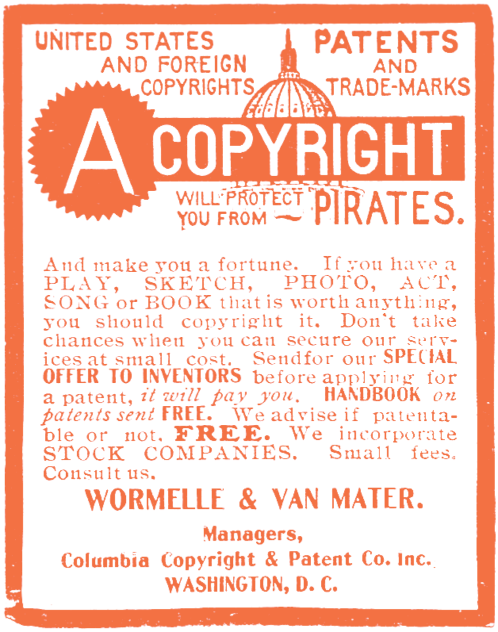

FIGURE B5.1 An advertisement for copyright and patent preparation services from 1906, when copyright registration formalities were still required in the US. Retrieved from Wikimedia Commons (http://en.wikipedia.org/wiki/File:Copyrightpirates.jpg).

existing textbooks and monographs. Obviously, graphic illustrations help to better explain the subject being taught and not every educator is skilled in creating computer graphics to draw a desired scheme or sketch by themselves. It is, therefore, much easier and more efficient to use other resources and insert them into the e-learning material along with proper citations.

Educators—authors do not infringe the Copyright Law when they reuse [3,4]:

A. excerpts from published works by other authors in reasonable extent in their e-learning materials. It is a must to use the excerpts (snippets) only and not the whole work. The reasonable extent of excerpting means to consider each individual case separately with 'common sense';
B. excerpts from works or even retrieved whole small works (e.g. a poem or song) for the purpose of criticism or review. Such use must be in accordance with fair practice and to the extent required for the specific purpose;
C. whole works by other authors in the classroom for the purpose of illustration or scientific research, not designed to achieve any direct or indirect economic or commercial benefit. It is always necessary to specify, where possible, the name of the author, unless it is anonymous work, or the name of the person under whom the work was placed in public, and the title of the work as well as the source. In other words, it is allowed to use the whole work for the purpose of teaching provided that the use of the work itself is not the only objective.

ANTIPLAGIARISM SOFTWARE

Not acknowledging the use of someone else's work is called plagiarism and it is these kinds of unethical authorship practices that are taken very seriously by universities and publishers today. Many publishing houses declare the policy of 'Zero Tolerance on Plagiarism' and recently have started to use powerful software solutions that can verify the origin of published works. For example, CrossCheck is a well-known tool in the academic community. This tool is powered by the Ithenticate software from iParadigms. CrossRef members collaborate to maintain a single database of published articles against which checking can take place. CrossCheck uses originality detection software to compare manuscripts against a unique database of more than 30 million articles from over 200 publishers including Elsevier, IOP, Nature, Springer and Oxford University Press, among others [5]. Besides proprietary solutions like CrossCheck[2] there are also public services where one can run the detection of plagiarism in copy-pasted text or even in a submitted document, see e.g. Grammarly.com plagiarism checker[3] or a text-similarity based search engine, such as eTBLAST[4]. Universities in the Czech Republic generally use the system Theses.cz[5], which was developed and is operated by Masaryk University. It also serves as a national registry of theses.

Digital watermarking technique is usually used to protect authors of and copyright owners of digital media. Basically, this technique embeds additional information, or in simple terms an invisible signal, into an electronic document (image, video, audio, 3D model, text, etc.). The watermarked version of that document then carries all the necessary information to identify authorship as well as copyright ownership. Digital watermarking methods can also be used to guarantee authenticity of the digital media [6].

FREQUENTLY ASKED QUESTIONS

Very often, medical educators ask experts of Copyright Law at various forums [3,7,8] on the same or similar topics. The following list comes with answers to the three most common questions.

Q1 Does the university own copyright to any of the works created by its academic staff or students?

A1 In order to answer this, we have to consider two different scenarios. (i) Works created within the employment—the university holds the copyright unless

2 http://www.crossref.org/crosscheck/
3 http://www.grammarly.com
4 http://etest.vbi.vt.edu/etblast3/
5 http://theses.cz/

otherwise agreed with the employee. (ii) School works, such as bachelor theses, master theses, dissertations, essays or any task to meet the study requirements at the university may be used by the university for teaching or for its own internal use, but may not be used for the purpose of economic benefit. However, this does not include computer software.

Q2 How can I ensure that my images from medical imaging modalities will not be stolen? I publish them for the students in the learn management system of the university and some of them are rare and precious, especially to me.

A2 Whether an X-ray image or an image of a histological specimen should be considered as copyrighted works depends on many factors. But most often they are not perceived as the result of creative work and therefore, not protected by copyright. However, if the educator–author completes the image with arrows and labels (e.g. Latin names of specific regions of interest), embeds it into the e-learning material, where it is further commented on, then such an enriched image is definitely treated as the author's work and therefore, protected by Copyright Law.

Q3 Can I reuse and cite an image with anatomical scheme, which I modified, so that the original labels were deleted and new labels translated into the Czech language were inserted? I would like to make the modified scheme available to students.

A3 If the labels are an integral part of the original scheme (not as separate list of numbers or letters), then the described modification will represent as infringement of the original work and may have legal implications. In this case the consent of the copyright holder is required.

CREATIVE COMMONS LICENSES

The Creative Commons (CC) domain offers a unique way to publish one's content under the clear and comprehensible rules relating to IPRs. It helps to bring the open access approach[6] into teaching and learning with the use of modern information and communication technologies. This is the reason why MEFANET and its core projects provide a set of pre-defined types of CC licenses to its community during the authoring and editing process.

6 Open access means unrestricted online access to peer-reviewed scholarly research. Open access is primarily intended for scholarly journal articles, but is also provided for a growing number of theses, book chapters, and scholarly monographs. Open access comes in two degrees: gratis OA, which is free online access, and libre OA, which is free online access plus some additional usage rights. These additional usage rights are often granted through the use of various specific Creative Commons licenses [9].

The primary aim of Creative Commons public licenses, according to its status, is to build a layer of reasonable and flexible copyright into the existing restrictive Copyright Law. The CC provides authors with a powerful tool for strengthening their position when specifying details about the terms and conditions governing the use of their work. The set of established licenses enable authors to dedicate their creative and original work to the public domain [10]. All Creative Commons licenses have many important features in common. Every license helps authors to retain copyright while allowing others to copy, distribute and put the work to some use. These common features serve as a baseline, from which authors can choose to grant additional permission when deciding how they want their work to be used. Since most authors, educators, and scientists are not educated in law, the licenses are available in a format that is simply explained, making it easier to understand, with easy expression of some of the most important terms and conditions related to IPRs. It means that the authors of works, the users, and even the Web itself can understand [11] the CC licenses.

Since December 2002, several incremental versions have been made available to rationalize the text of licenses. Updates include the current version 4.0, published in November 2013. Some of the clauses have been deleted or added during the upgrades and incompatibilities may occur as a consequence [12]. The 4.0 licenses are reported, however, to be the most robustly produced by Creative Commons to date[7]. Dozens of improvements were incorporated to make sharing and reusing CC-licensed materials easier and less dependable than ever before. The Creative Commons staff, board and community have identified several goals for the 4.0 license suite, which includes [13]:

- *Internationalization*—to further adapt the core suite of international licenses to operate globally, ensuring that they are robust, enforceable and easily adopted worldwide;
- *Interoperability*—to maximize interoperability between CC licenses and other licenses in order to reduce friction within the commons, promote standards and stem license proliferation;
- *Long-lasting*—to anticipate new and changing adoption opportunities and legal challenges, allowing the new suite of licenses to endure for the foreseeable future;
- *Data/Science/Education*—to recognize and address impediments to adoption of CC by governments as well as other important, publicly-minded institutions in these and other critical arenas;

7 CC4: Those who are interested in publishing works under this license should always look at the national version according to the place where the work is going to be published. The CC 4.0 licenses have recently been imported into the Czech law, see http://www.creativecommons.cz/2014/06/04/zahajeny-verejne-konzultace-prekladu-licence-creative-commons-4-0/.

- *Supporting Existing Adoption Models and Frameworks*—to remain mindful and accommodate the needs of our existing community of adopters leveraging pre-4.0 licenses, including governments but also other important institutions.

Creative Commons licenses consist of four major condition modules: Attribution (BY), requiring attribution to the original author; Share Alike (SA), allowing derivative works under the same or a similar license; Non-Commercial (NC), requiring that the work is not used for commercial purposes; and No Derivative Works (ND), allowing only original work, without derivatives. These modules are currently combined to form six major licenses of the Creative Commons[8]. Given that you are the author of intellectual property, these are the six possible ways how CC licences protect your authorship.

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8 Creative Commons licensing sample from [14]: Permission is granted under Creative Commons Attribution License to replicate, copy, distribute, transmit, or adapt this report freely provided that attribution is provided as illustrated in the citation below. To view a copy of this license, visit creativecommons.org/licenses/by/3.0/ or send a letter to Creative Commons.

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An additional special license-like contract is the CC0 option or No Rights Reserved. CC0 enables scientists, educators, artists and other creators and owners of copyright protected content to waive such interests in their works and thereby place them, as completely as possible, in the public domain so that others may freely build upon, enhance and reuse the works for any purposes without restriction under copyright or database law. In contrast to CC's licenses that allow copyright holders to choose from a range of permissions while retaining their copyright, CC0 empowers yet another choice altogether—the choice to opt out of copyright and database protection, and the exclusive rights automatically granted to creators—the 'no rights reserved' alternative to our licenses [13].

ETHICAL ACCEPTABILITY OF E-LEARNING WITH THE USE OF PATIENT MEDICAL RECORDS

In addition to the previously-mentioned IPRs, there is another problematical aspect and this is the ethical use of data obtained from real patients and then used in e-learning materials for students in the medical and health care fields. Recently, these ethical aspects have been the subject of intensified professional discussions due to increasing public knowledge and other socio-economic changes. One noticeable difference is the gradual shift in physician-patient relationship, which has moved from paternalism to partnership.

Does a physician-author commit an offense if he or she uses data from medical records of a patient in order to create or enrich e-learning materials? Who is the rightful owner of medical documentation? Is it the property of the patient or does it belong to the physician or to the health care facility? Medical records and documentation in practice by R. Policar [15] focuses on this topic in detail. Concurrently, the Supreme Court of the Czech Republic has also been looking into these issues. According to the Czech law, property rights only pertain to medical documentation but the information on the document is not recognized as ownership material. A patient has the right to be familiar with the information provided therein, has the right to read information from the medical records and also has the right to be given a copy of his/her medical record. However, a patient does not have the right to acquire ownership of the original medical documentation [15].

The same rules apply when:

- using data from medical records,
- evaluating the ethical acceptability of biomedical research,
- using the data from medical records for the purpose of creating or enriching e-learning materials.

Everything must be done in accordance with the law and the patient has to be informed about the objectives and nature of the materials intended for use. A patient must give written informed consent and it is this document that lets the patient know how the data will be handled—through informed consent. Of course, there should be sufficient space for any questions related to a patient's participation in an e-learning project. Intelligible and adequate instructions must also be compiled and duplicated in order to create an agreement with one copy going to the patient. Ample time for the patient to decide is also necessary [16].

DISCUSSION

The above text is drawn from the Czech law, particularly on specific issues, such as the extent of citing and excerpting someone's work or the questions regarding works created within employment. IPRs are, however, governed by the law of the place where the work has been created, and its use is governed by the law of the place where it is used. Copyright protection is generally comparable throughout the civilized world thanks to existing international conventions, but on specific issues the national legal systems may vary—even within the EU. The particular conditions for the protection of intellectual property described in this chapter apply to the use of works in the Czech Republic.

Special attention has to be paid in case of copyrighted works with a component created using medical documentation (here again the national legal systems differ in what is considered the copyrighted work—it may be even an X-ray image in some countries). Besides originality and authorship, very important is the legislation regarding handling of medical records, general legislation regarding the protection of personality and regulations for the protection of personal data. All these legal regimes apply to such cases jointly. In practice, it is necessary to solve the legal issues of publishing any medical documentation component through the patient's informed consent.

In practice, it is a common problem that the author provides a journal or a publishing house with exclusive license to his/her work, and then decides to recycle it for use in some proceedings or a book. The intention or cause might be quite innocent—somebody might ask the author of the article to agree on its inclusion in a collection or a reader-book. Authors should realize that the work to which they have given someone a license may no longer be at their disposal—especially in the case when the license is exclusive and thus prevents even the author from further re-using the work. Higher risks are when combined with public/free/open licenses, such as CC. There are cases when scientists, in good faith but mistakenly, put their articles into repositories available under CC but which previously had been published in prestigious journals. If the procedure is reversed, no problems arise. At first a draft manuscript needs to be given to the public under CC licenses in order to collect responses and feedback, and then at the end the completed article may be offered to a publisher exclusively.

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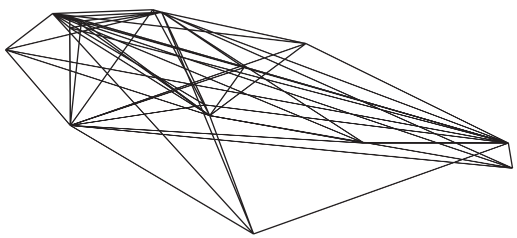
C



▸ C1 ◂

THE SYSTEM OF E-PUBLISHING EDUCATION MATERIALS AND INFORMATION DISCOVERY SERVICE IN MEFANET

DANIEL SCHWARZ, MARTIN KOMENDA, LADISLAV DUŠEK

'Data is a precious thing and will last longer than the systems themselves.'
TIM BERNERS-LEE

Summary. One of the basic goals of Medical Faculties Network (MEFANET) is to advance medical teaching and learning with the use of modern information and communication technologies. For this purpose, MEFANET, as an instrument, embarked on developing an original and uniform solution for education web portals that, together with Central Gateway, offer and share digital education content. Three fundamental elements of the MEFANET e-publishing system are described here: (i) medical disciplines linker—to sort and categorize the published items; (ii) authentication/authorization framework—to provide an effective and easy authentication mechanism for user identification; (iii) multidimensional quality assessment—to ensure the publishing of quality data content. Metadata schema of the e-publishing system is also presented here—this 'data about data' is used to describe education content published through the MEFANET portal platform, in order to better organize the contents and to facilitate the acquisition of relevant information as well as its context. The information discovery service of the MEFANET portal platform includes full-text indexing in metadata as well as in the referenced documents and faceted search with dynamic clustering of the search results.

Keywords:
- e-publishing
- metadata harvesting
- taxonomy
- federated authentication
- digital quality assessment
- web-scale discovery system
- deep indexing
- faceted navigation

Reviewer:
- STANISLAV ŠTÍPEK

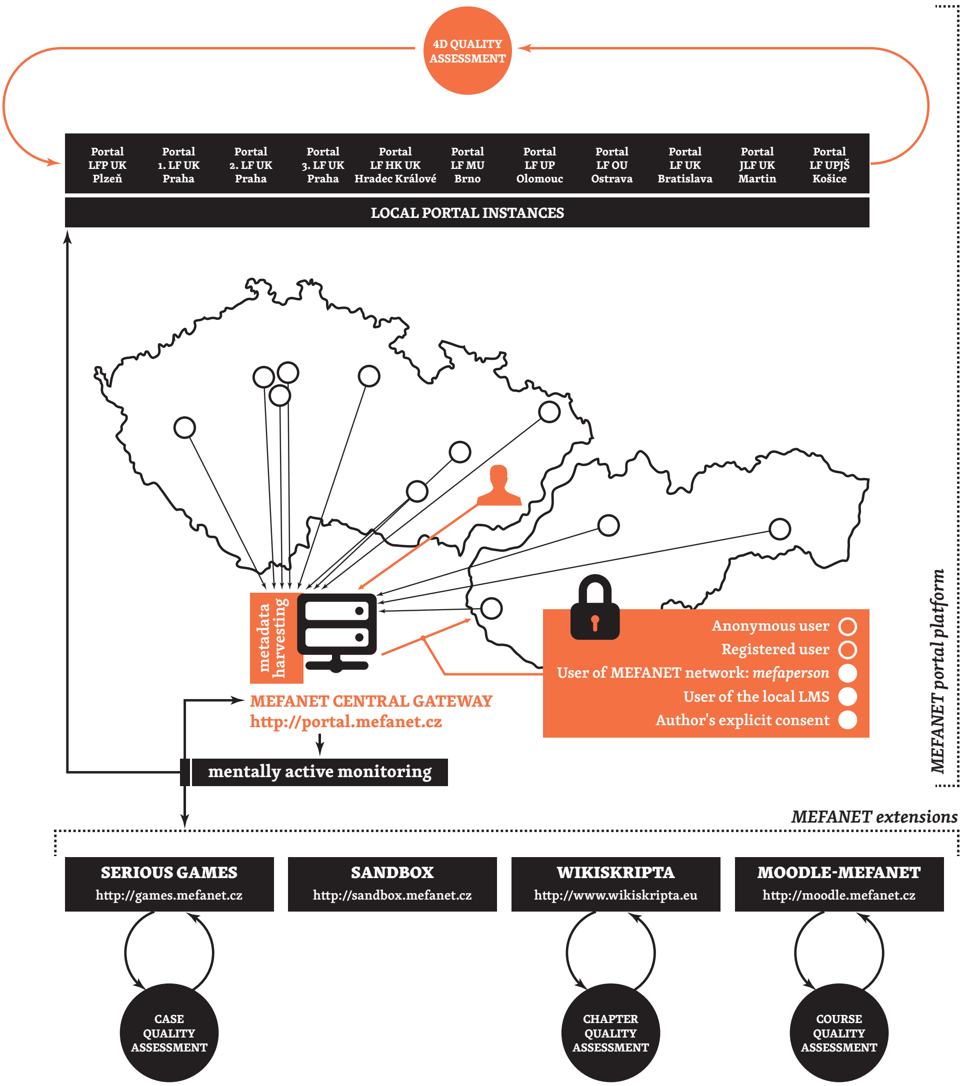


FIGURE C1.1 MEFANET covers all medical schools in the Czech Republic and Slovakia. They share each other's digital teaching and learning materials by using an e-publishing system, which consists of eleven instances of education web portal and the Central Gateway. The extensions of the MEFANET e-publishing system appear as standalone platforms for their users. However, all teaching or learning materials indexed by the MEFANET Central Gateway undergo similar procedures for multidimensional quality assessment [4].

STANDARDIZATION AND SHARING OF A PORTAL PLATFORM AMONG ALL MEDICAL FACULTIES IN THE MEFANET PROJECT

The Medical Faculties Network (MEFANET) has established itself as the authority for setting standards for medical educators in the Czech Republic and Slovakia, two independent countries with similar languages that once comprised a federation and that still retain the same curricular structure for medical education. One of the basic goals of the network is to advance medical teaching and learning with the use of modern information and communication technologies. For this purpose, MEFANET, as an instrument, embarked on developing an original and uniform solution for education web portals that, together with Central Gateway, offer and share digital education content. The primary objective of the MEFANET portal platform is to ensure publishing and horizontal accessibility of electronic teaching tools for teachers and students, while fully respecting the independence of the individual faculty [1–3].

A community of eleven medical faculties provides a large target audience, encompassing various academic staff members—over 30 000 potential users. Logically, there appeared the need for a transparent and unified source of teaching contents. It was decided to design and implement a robust e-publishing system, which provides the following benefits in particular to the users at engaged medical faculties: (i) easy data sharing and capturing; (ii) ease of use and access; (iii) common authentication framework; (iv) quality assessment of published contents.

There are plenty of tools and platforms for sharing electronic resources, but it was known in the MEFANET technical team right from the beginning that specific target groups would be addressed: and those were medical teachers and students. Therefore, the idea of a central LMS (Lear Management System) or a sophisticated digital library was rejected from the start, since such platforms do not provide the authors of education contents with the possibility of publishing their work—not making them easy to be followed by others. An original system for electronic publishing was developed which, simply put, is for teachers and students just like a medium where the electronic resources are always reviewed and should be cited when reused.

The idea of a shared e-publishing system is based on a set of standalone web portals. Obviously, it is not a good idea to rely on a centralized application hosted for all medical schools, which could prove to be inflexible and rather a more vulnerable alternative solution. Essentially, each portal instance is an independent publication media with its own ISSN code and editorial board. Local metadata describing the digital education contents are replicated regularly in the Central Gateway. In other words, the e-publishing system is regularly doing here something what we refer to as metadata harvesting, see FIGURE C1.1.

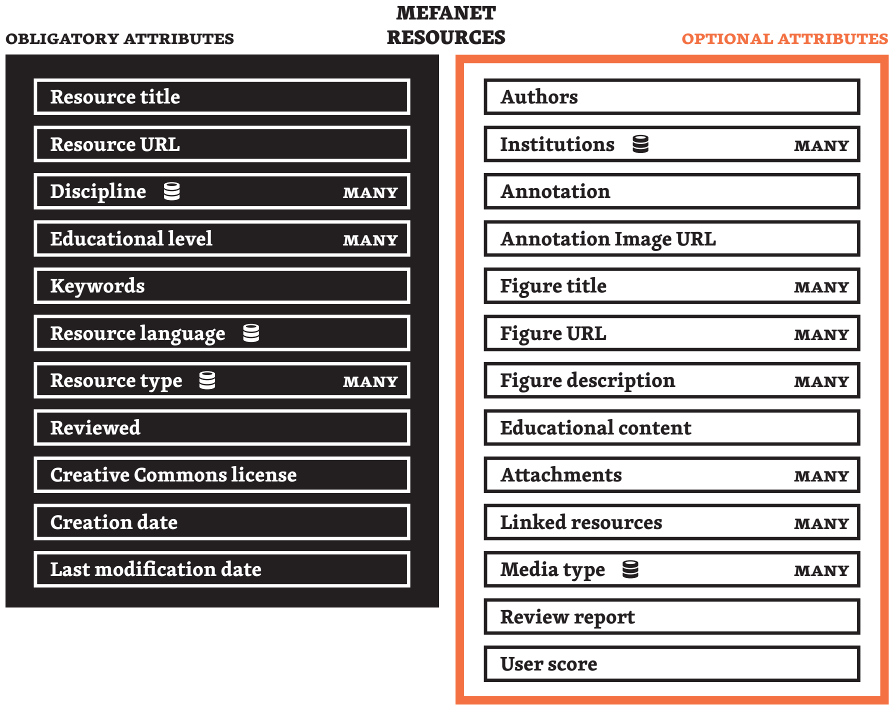


FIGURE C1.2 Overview of all attributes in MEFANET metadata schema.

NEW ICT TOOLS FOR TECHNOLOGY-ENHANCED LEARNING

Recently, new tools for technology-enhanced learning have been introduced to the MEFANET network besides the common e-publishing system. These new tools appropriately complement the portal platform for e-publishing, as they provide higher level of interactivity for students during their self--study process. FIGURE C1.1 shows how the new four tools such as Sandbox[1],

1 MEFANET Sandbox—http://sanbox.mefanet.cz—has been created in response to the procedures of mentally active monitoring. These procedures have set and strict rules for published contributions—all metadata have to be completed, the contributions' granularity is checked for deficiency or excess of attached documents and all the attachments or external links have to be available for assigned user groups. It is not always possible to stick to all these rules, as the electronically published teaching materials pass through various stages of development. However, it would be a pity not to offer them to students as supplementary materials, although without the guarantee of quality. Additionally, such teaching materials should be offered to potential co-authors from other faculties. Thus, Sandbox may potentiate the collaborative creation of electronic teaching materials among teachers.

WikiSkripta[2] (see CHAPTER C3), Moodle-MEFANET[3] (see CHAPTER C4) and Serious Games[4] (see CHAPTERS B2 and C2) are related to the already established and standardized MEFANET Central Gateway[5].

MEFANET METADATA SCHEMA

Metadata is used to describe education content published through the MEFANET portal platform, in order to better organize the contents and to facilitate the discovery of relevant information as well as its context. The MEFANET metadata schema consists of a set of compulsory and optional attributes, see their overview in TABLE C1.1 and FIGURE C1.2.

MEFANET EDUCATION WEB PORTAL

Every member of the network provides a standalone instance of the MEFANET portal platform in the form of an education web portal, which differs only in local configuration, graphic template and various ISSN (International Standard Serial Number). The main purposes of the MEFANET education portal are: (i) to help teachers with publishing their education works; to

2 WikiSkripta—http://www.wikiskripta.eu—provide a collaborative Web2.0 space for the production and storage of medical teaching materials. This platform is mainly aimed at continuous creation and editing of texts for pre-gradual education by students themselves. An editorial team has been designed to provide support to authors as well as for quality monitoring. The most important feature of WikiSkripta is simplification of production of learning materials, easy updating, and inspiring cooperation among people interested in the same topics. The texts are not created in the form of encyclopedia contributions; rather, short chapters of a textbook are produced.

3 Moodle MEFANET—http://moodle.mefanet.cz—is one instance of LMS for those teachers from MEFANET community who want to try to design and run an electronic course. Moodle belongs to learning management systems and is available as open-source software under the GPL open license. It integrates various tools for study management and sharing of teaching/learning materials. Among others, the system makes it possible to control access rights, to provide tools for the administration of courses, study plans and students' activities. Further, it contains tools for communication, creation, operation and evaluation of teaching courses and objects, students' examination, etc.

4 The Serious Games extension—http://games.mefanet.cz—is the latest development in MEFANET and it is designed for indexing metadata about simulation-based learning objects, also known as electronic virtual patients or virtual clinical cases.

5 The MEFANET Central Gateway—http://portal.mefanet.cz—is another web-based application that collects all metadata from the web portal instances across the MEFANET network. Students and academic staff can search and browse through the contributions of different medical faculties sorted by medical disciplines, authors, schools or other criteria.

help authors of multimedia teaching and learning tools to communicate with the users of these tools; (iii) to help people involved in lifelong learning of physicians and health care professionals; (iv) to help students of medicine and healthcare disciplines with navigating through various tools for electronic support of their education. All independent instances of the education web portal are complemented by the MEFANET Central Gateway. This crucial part of the MEFANET e-publishing system enables effective gathering of all metadata on the contents published, with the use of portal instances. A complete image of the available digital contents across the whole network is constructed in this way. Users can freely browse the objects sorted by various attributes, such as the medical discipline, author, faculty, or quality assessment criteria [5].

TECHNOLOGIES

The education web portal as well as all other components of the MEFANET portal platform has been developed in the form of web-based applications using PHP programming language and MySQL database on the server-side, and with the use of XHTML, CSS2 and JavaScript on the client-side. Selected third-party components were also used, such as eduID.cz federation (authentication framework), Apache SOLR engine (full-text search and document deep indexing) jQuery (javascript library), Google Analytics (monitoring and analytics) and CKEditor (rich text editor). The newest version of the MEFANET Central Gateway has been coded with the use of Foundation5 (responsive[6] front-end framework).

FUNDAMENTAL ELEMENTS OF THE MEFANET E-PUBLISHING SYSTEM

The MEFANET Central Gateway is not only a place for publishing, but it works also as a search engine that gathers metadata about teaching materials published at different medical faculties, which means that it is actually a 'Google' for medical schools. When intending to combine teaching materials from different medical schools, it is necessary to implement certain rules or maintain some basic principles of publishing in the MEFANET. Alternatively, one would end up presenting an incompatible mixture to medical students.

6 Responsive webdesign is an approach to site coding providing easy reading and navigation with minimum resizing, panning, and scrolling across a wide range of devices, from mobile phones to desktop computer monitors.

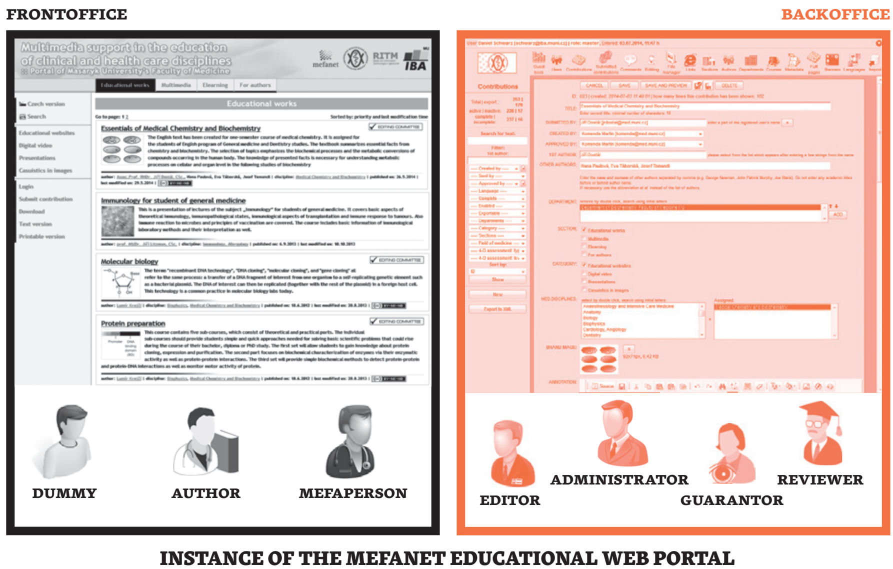


FIGURE C1.3 FrontOffice and Backoffice sections of the MEFANET education portal instance with user roles assigned.

Scalability and extensive customizations are the important and desired properties of the MEFANET portal platform. On the other hand, there are several legitimate requests for particular common conventions that should be followed on the part of local administrators. With this in mind, three fundamental elements in the MEFANET e-publishing system have been established, which are common and obligatory to all portal instances and the Central Gateway: (i) medical disciplines linker—to sort and categorize the published items; (ii) authentication/authorization framework—to provide an effective and easy authentication mechanism for user identification; (iii) multidimensional quality assessment—to ensure the publishing of quality data content. Other features, such as properties and functionalities, can be adapted or localized to meet the needs of the particular institution. A detailed description of the three fundamental elements is given further in this chapter.

MEDICAL DISCIPLINES LINKER

Essentially, it is a kind of medical specialization list, which represents the main taxonomy of contributions within the frame of the network. It is the only obligatory structure for all instances of the education web portal and the Central Gateway, see TABLE C1.2. An alternative could be to use what other authors refer to as the standard Conspectus method [6]. However, medical disciplines mapping according to the Conspectus method proved to be inapplicable for MEFANET purposes.

TABLE C1.1 Overview of all attributes in MEFANET metadata schema. The attributes controlled by vocabulary are in bold with an asterisk. The obligatory attributes for all MEFANET portal platform extensions are in deep orange. The system attributes are in light orange.

Attribute name	Database entity	Portal	Sandbox	WikiSkripta	Serious Games	MEFANET Moodle
Id	id					
Local id	export_id					
Platform id	source_id					
State	active					
Resource title	title					
Resource URL	url					
Authors	authors					
Institutions*	institutions					
Annotation	annotation					
Discipline*	discipline					
Annotation Image URL	annotation_img_url					
Educational level*	level_id					
Figure—title	figure_title					
Figure—description	figure_description					
Figure—URL	figure_url					
Educational content	body					
Attachments (URL)	attachments					
Linked resources	linked_resources					
Keywords	keywords					
Resource language*	language					
Media type*	media_type					
Resource type*	type_id					
Reviewed	is_reviewed					
Review report	review_report					
User score	user_score					
CC license	cc					
Creation date	created_at					
Last modification date	lastmod_at					

TABLE C1.2 The list of medical disciplines for categorization of education content. Any change to this taxonomy is subject to approval of the MEFANET Coordinating Committee.

Anaesthesiology and Intensive Care Medicine	Anatomy
Biology	Biophysics
Cardiology, Angiology	Dentistry
Dermatology	Diabetology, Dietetics
Emergency Medicine	Endocrinology, Metabolism
Epidemiology, Preventive Medicine, Hygiene	Gastroenterology and Hepatology
General Practice Medicine	Genetics
Geriatrics	Haematology
Health Care Sciences	Histology, Embryology
Immunology, Allergology	Infectology
Internal Medicine	Laboratory Diagnostics
Medical Ethics and Law	Medical Chemistry and Biochemistry
Medical Informatics and Information Science	Microbiology
Nephrology	Neurology
Neurosurgery	Nuclear Medicine
Obstetrics, Gynaecology	Occupational Medicine and Toxicology
Oncology, Radiation Therapy	Ophthalmology and Optometry
Other	Otorhinolaryngology
Paediatrics, Neonatology	Pathology and Forensic Medicine
Pharmacology	Physiology and Pathophysiology
Psychiatry, Psychology, Sexology	Public Health Care, Social Medicine
Radiology and Imaging	Rehabilitation, Physiotherapy, Occupational Therapy
Respiratory Medicine	Rheumatology
Sports Medicine	Surgery, Traumatology and Orthopaedics
Urology	

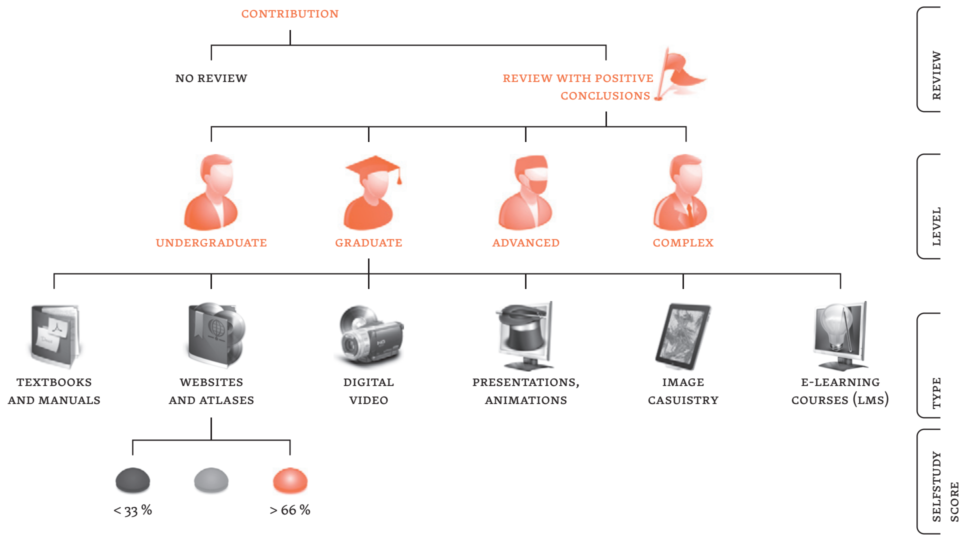


FIGURE C1.4 Four-dimensional quality assessment of the contributions involves the following four dimensions: 1. expert review, 2. education level of target users, 3. classification by type, and 4. self-study score.

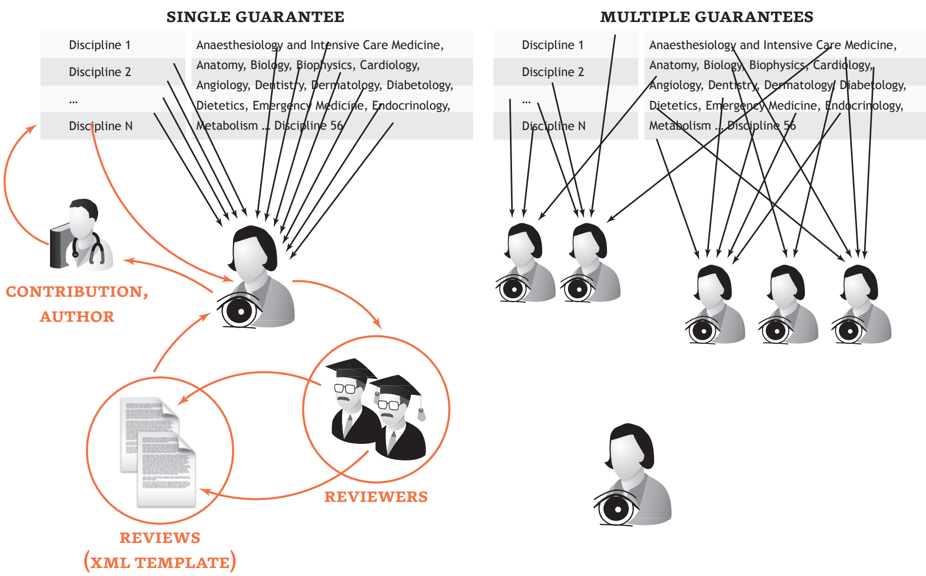


FIGURE C1.5 A contribution workflow scheme. 1. The author and technical editor finishes the contribution. 2. The guarantor, who is associated with particular medical disciplines, is notified about a new contribution to his/her field of interest. 3. The guarantor, either alone or with the help of the faculty's editorial committee, invites two reviewers to present their reviews online with the use of XML-template-generated forms.

THE AUTHENTICATION/AUTHORIZATION FRAMEWORK

The authors of the shared teaching materials can choose from the following user groups, in order to permit or deny access to their materials: (i) non-registered anonymous users, (ii) registered anonymous user who accepts the terms of use within his/her registration, (iii) MEFAPERSON—user of MEFANET network, i.e. a student or teacher from any Czech or Slovak medical school, (iv) a user from a local university whose affiliation to that university has been verified at the portal via the local information system, (v) a user to whom attachments are made available only after the author's explicit consent. Services of the Czech academic identity federation eduID.cz are used in order to check the affiliations of the users of the portal instances. This federation uses the Shibboleth technology, which is one of the several authentication frameworks allowing the sharing of web resources among institutions using the SAML (Security Assertion Markup Language) standard protocol. The portal instances act as service providers in this federation, whereas the information systems of the involved schools act as identity providers.

Thanks to the identity federation eduID.cz—a service provided by the Czech academic internet operator CESNET (see detail in CHAPTER B4)—users of the MEFANET portal platform do not have to create eleven separate accounts—they just log in to their home institution and this institution provides their identity data to the service providers, which are the MEFANET portal instances.

MULTIDIMENSIONAL QUALITY ASSESSMENT

There are four dimensions of critical importance when evaluating the quality of electronic teaching materials: 1. expert review, 2. education level of target users, 3. classification by type, and 4. self-study score, see FIGURE C1.4. The review includes binary questions as well as open questions. The structure of the review-form can be localized easily, just by modifying an XML template file. The second dimension is represented by the education level of the target group of the teaching material, which is a useful piece of information for the users as well as for the reviewers. The 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 the learning management systems. The last dimension—self-study score—shows what users think about the usability of a particular contribution in their self-studies. They select a scalar value on a scale of 0 to 100 points and further add information about their education level: a) student, b) graduate, c) postgraduate. The final score is computed as a weighted average of all votes, where the weights reflect the gap between the student's level and the level of contribution's target users.

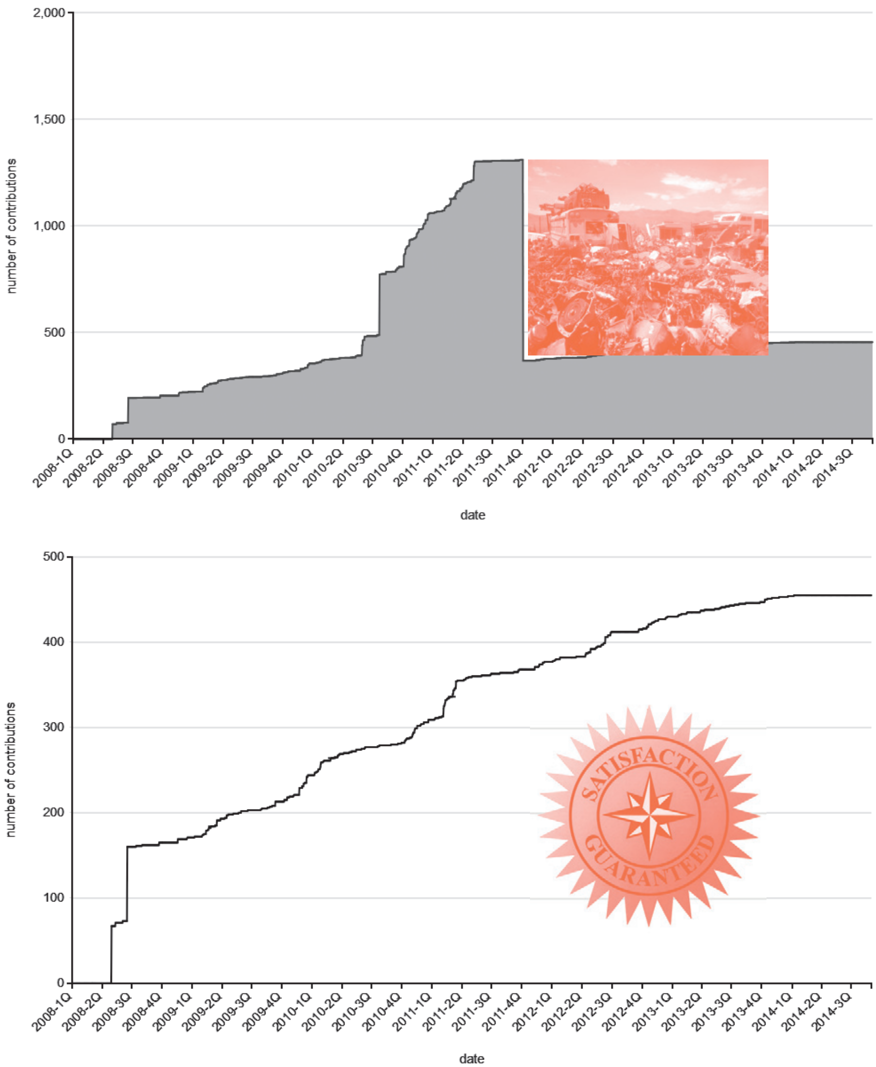


FIGURE C1.6 Progress of published contributions (May 2008 – August 2014):
a) MEFANET Central Gateway and SANDBOX, b) MEFANET Central Gateway alone:
since the successful implementation of all editorial processes, the MEFANET portal platform has been the only continuous source for students concerning quality evaluated materials.

The values of the first three dimensions of the 4-D assessment are composed by authors, guarantors and reviewers. Their activities as well as the workflow of a contribution are explained in FIGURE C1.5. Besides the 4-D quality assessment, all contributions submitted to the Central Gateway undergo an additional editorial process called 'mentally active monitoring'. It focuses on the following issues: (i) metadata is filled properly; (ii) granularity of the attachments is appropriate; (iii) all attached documents and the links are accessible for users with MEFAPERSON role, at the least. The monitoring of these three important issues is done not only at syntax level but also semantically, and it is therefore carried out by a team of editors in cooperation with the editors responsible for the local portal instances.

MEFANET CENTRAL GATEWAY: DEEP INDEXING AND FACETED SEARCH

The latest developments in the MEFANET portal platform directed towards web-scale discovery system. The term web-scale discovery (WSD) system or services refers to a tool with the major application sphere in libraries and information science. A WSD system provides its users with the possibility of seamlessly searching across a vast range of local and remote content. One single search across a comprehensive index typically produces a large, relevancy-ranked results list with the possibility of refining the searching results using facets. Faceted search or faceted navigation allows users to better explore the search results with the use of multiple filters corresponding to the properties or values of the information elements. As the properties and values of the information elements vary with different search results, facets perform their dynamic clustering and allow accessing the content in multiple ways rather than in a predetermined, taxonomic order. In the case of the MEFANET Central Gateway, the following facets are used: (i) accessibility and user roles, (ii) medical disciplines, (iii) education level of target users, (iv) keywords, (v) languages, (vi) faculties, (vii) resource types, (viii) portal platform and its extensions.

The open source SOLR™ search platform from the Apache Lucene™ project was used in the MEFANET Central Gateway for faceted search, full-text content indexing and handling documents (e.g. Word documents, PDF documents or PowerPoint presentations) attached to the contributions—this feature is sometimes referred to as deep indexing. The total size of the index is only 90 MB though containing 8886 documents of different sizes: 6804 are included from the content published on WikiSkripta and 1082 documents are from the content published on the MEFANET portal platform (the numbers are valid as of August 2014).

The number of contributions published through the MEFANET portal platform has been growing since the launch of the Central Gateway, see FIGURE C1.6. The first three local rapid risings correspond to the process of gradual launching of new instances of the web education portal. The last rapid decline corresponds to the introduction of the above-mentioned 'mentally active monitoring', i.e. quality assessment procedures and other rules pertaining to metadata completeness and public availability of referenced documents.

DISCUSSION & CONCLUSIONS

High-quality digital education contents production has become a matter of prestige at medical schools in the Czech Republic and Slovakia, and the volume of teaching and learning materials available is growing rapidly—thanks to the MEFANET project and its ICT platforms, which have been continuously developed and adopted to the needs of the MEFANET community since 2007. Four new extensions, which complement the e-publishing system standardized in MEFANET, are usable independently; however, their complex application in conjunction with the portal platform as a tool for final e-publishing will allow more effective repurposing of the materials created with the use of the extensions, as well as broader integration of the digital education contents among the MEFANET community. Further development aims at encouraging the publication of materials for the teaching of clinical reasoning based on the concept of interactive algorithms or virtual patients.

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‣ C2 ◂

CASE-BASED INTERACTIVE LEARNING IN MEFANET

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'Too much teaching kills the learning!!!'
NICHOLAS BALACHEFF

Summary. This chapter introduces a special extension of the MEFANET e-publishing system devoted to all types of serious games produced and shared across the education network. Presented herein are four different case studies demonstrating the results of efforts in creating advanced teaching and learning tools based on simulations and combined with up-to-date pedagogical methods, such as problem-based learning. Given that these case studies differ among themselves in many ways—either in a specific medical field or in technical or didactic processing—their descriptions in this chapter vary as well. AKUTNE.CZ interactive algorithms and SEPSIS-Q education scenarios—created at Masaryk University—are focused on the management of a wide range of acute patients and situations. PEDKAZ is a database of linear clinical cases in paediatrics following the principles of evidence-based medicine. EKAZUISTIKY are virtual cases delivering branched learning objects focused on optimal diagnostic procedures. The last case-study, HUMMOD-GOLEM, is focused on physiology modelling and explaining the history and the state-of-the-art nature of integrative physiological modelling.

/ **Keywords:**
- MEFANET
- gamification of medical education
- serious games
- acute medicine
- physiological modelling
- virtual cases
- educational clinical scenarios
- problem-based learning
- scenario-based learning
- team-based learning
- students' attitudes

/ **Reviewer:**
- ANDREA POKORNÁ

EPISTEMOLOGICAL QUESTIONS

The challenge in designing and implementing computer-based learning environments is the complete and comprehensive incorporation of all pertinent teaching features: the capacity to recognize and capture relevant events from observing learner activity, the ability to understand the learning needs and then to provide adequate feedback in the most appropriately adapted form. This task becomes even more demanding when the concerned knowledge cannot be fully accessed with explicit representation but has to be materialized by means of simulations and shared within the apprenticeship approach. What is meant by 'relevant event', 'learning needs' and 'adequate feedback' represent epistemological[1] questions that cannot be answered only in technical terms [2]. This statement can be also supported by the outputs from the review in CHAPTER B5, which was focused on papers relevant to gamification of medical education. Simulation-based medical education should not be perceived only from the perspective of technologies. Simulations facilitate learning only when learning efforts are supported by appropriate design of the lessons and the learning environment, as well as by educators who are particularly well-trained in medical simulation.

The optimal shape of the computer-based learning environment employing simulation modalities should follow the results of a carefully designed research study taking into account various local socio-cultural conditions. Regarding the situation across the MEFANET network, the first pilot studies have already appeared, mainly in acute medicine [3,4]. The authors of the papers described their simulators as interactive algorithms and educational scenarios. Both these variants can be, however, classified as event-driven, screen-based text simulators with low fidelity—according to the classification of simulators provided in TABLE B2.1 and TABLE B2.2. The same classification applies to all three herein described case-based learning environments across MEFANET, whereas the last fourth case study describes computer-based medical simulations employing complex mathematical models of physiological regulation systems.

As it was shown in FIGURE C.1, one of the extensions of the MEFANET e-publishing system is devoted to all types of serious games produced and shared

1 Epistemology is the branch of philosophy concerned with the nature and scope of knowledge and is also referred to as 'theory of knowledge'. It questions what knowledge is and how it can be acquired, and the extent to which knowledge pertinent to any given subject or entity can be acquired. Much of the debate in this field has focused on the philosophical analysis of the nature of knowledge and how it relates to connected notions such as truth, belief, and justification. The term 'epistemology' was introduced by the Scottish philosopher James Frederick Ferrier (1808–1864) [1].

FIGURE C2.1 One particular case of a screen-based text simulator (AKUTNE.CZ interactive algorithm) displayed at the serious gaming extension of the MEFANET e-publishing system: http://games.mefanet.cz.

across MEFANET. Therefore, it is obvious that the metadata harvesting procedures, which were described in CHAPTER C1 mainly for web-based learning materials, include also metadata describing and classifying various features of the particular case-based learning environments or even individual cases, see TABLE C1.1 and FIGURE C2.1.

SERIOUS GAMES ACROSS MEFANET: FOUR CASE-STUDIES

CASE STUDY 1: ACUTE MEDICINE [AKUTNE.CZ, SEPSIS-Q.CZ]

AKUTNE.CZ interactive algorithms in the teaching/learning of acute medicine take the form of content-rich virtual cases as they link together process flowcharts and multimedia. Creating such algorithms or electronic virtual patients is extremely laborious and time-consuming. Following the principles of

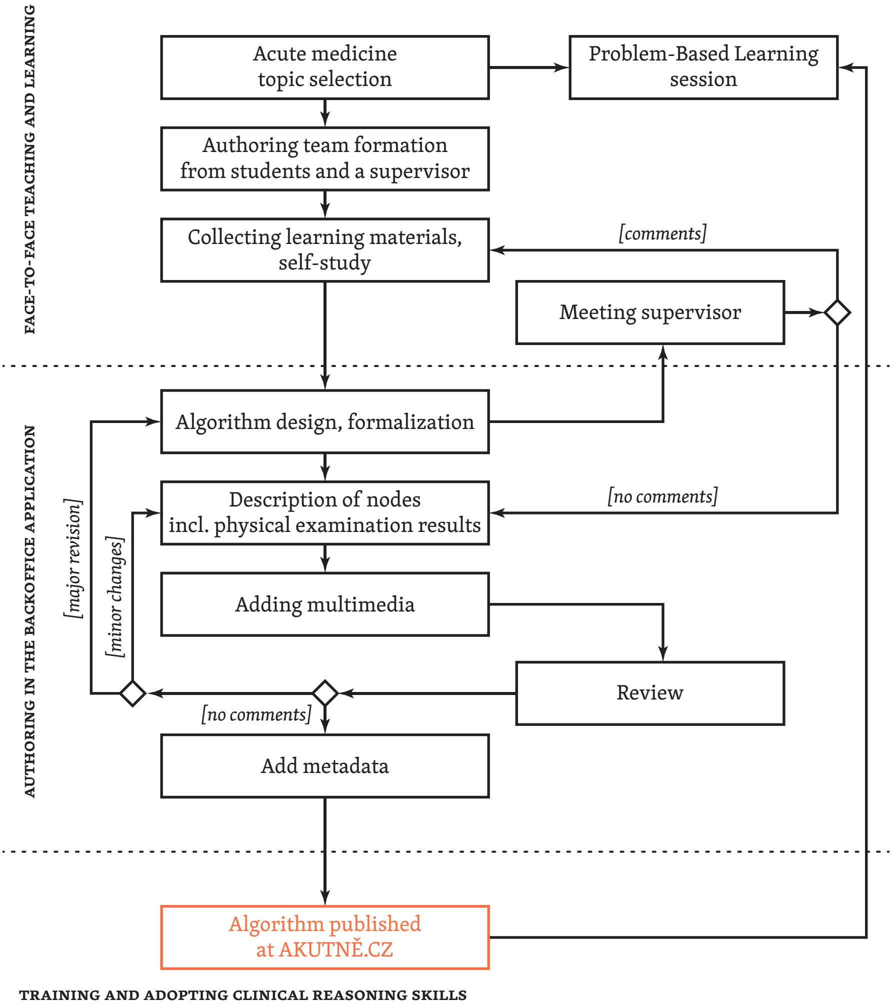

FIGURE C2.2 The authoring workflow of an interactive algorithm leads from choosing the topic through a review process to deployment to teaching in the form of a moderated PBL session [3].

student-centred learning, the authoring teams comprises of medical students of the 4th, 5th, and 6th year of study under the constant and expert supervision of an experienced clinician. The estimated time spent on actual work to produce one interactive algorithm is roughly between 10 to 50 hours (approx. one semester). The team members exhaust their time on collaborative work including the creation of multimedia content, essential meetings and self-study. The first draft of an algorithm is then prepared as a text file describing the situation at each node and then progresses to designing the correct as well as incorrect answers, inclusive of comments to the set of answers. After incorporating the supervisor's remarks, the values for vital signs and physical and laboratory examinations are added and the whole algorithm is then entered node-by-node into an online Backoffice application, together with supplementary multimedia files. Each algorithm must contain at least one video and/or one picture in all its nodes. The resulting algorithm to be played with is generated in the form of a flash object. Prior to publishing, its URL is first sent for internal review by the AKUTNE.CZ group after incorporating the comments of an external reviewer—an experienced clinician or an academic staff member. For external reviews, preference is given to peer-reviewers outside the authors' institutions. With all the comments and remarks addressed, the algorithm is then supplemented with metadata for subsequent publication on the AKUTNE.CZ education portal and indexed by the MEFANET Central Gate. The completed and published algorithms are used by students, either as outlines for Problem Based Learning (PBL) sessions or as supplementary learning objects for training and adopting correct clinical reasoning skills. The authoring workflow is summarized in FIGURE C2.2.

The interactive algorithms are authored using a web-based (PHP/MySQL) backoffice application, which provides the students–authors with the following functionalities through its online forms and drag'n'drop control: 1. node-based scenario design, 2. description of the situation in each node, including the intervals of parameter values of vital functions, intervals of laboratory values and multimedia, 3. description of the correct answers as well as distractors with the option to repeat or end in fatality, 4. data export of each finished algorithm to an XML document. The resulting XML documents are then rendered into a Flash Player or HTML5 object resembling a serious game. A student–player moves between the nodes during the game; the nodes may be of different types, see FIGURE C2.3. Each move causes a shift in the timeline as a side effect of the student–player's response, lending authenticity to the scenario and creating a stress effect, which is very much pronounced in real-life situations when dealing with acute patients. Continuous change in the various numerical parameters reflecting the development of the patient's clinical status and vital signs over time (such as blood pressure, pulse, oxygen saturation, etc.) is also available. A screenshot of an algorithm node is shown in FIGURE C2.4.

SEPSIS-Q Educational Scenarios comprise an important part of the EPOSS[2] & SEPSIS-Q research projects, which are aimed at developing a database for monitoring the survival and treatment course of patients with severe sepsis and mapping of sepsis epidemiology in the Czech Republic, as well as assessing the quality of life and improvement in the quality of care provided to patients under treatment for severe sepsis. A data acquisition system, which

2 EPOSS: Data-based **E**valuation and **P**rediction of **O**utcome in **S**evere **S**epsis (http://eposs.registry.cz)

NODE PATH	1A	1B	1C	2A	2B	3A	3B	3C	3D	4A	4B	5A	5B	6A	6B	7	8	9
right option	●			●		●				●		●		●				
wrong option, to repair		●			●								●		●			
wrong option, fatal			●				●	●										
alternative option									●		●							
terminating node																●	●	●

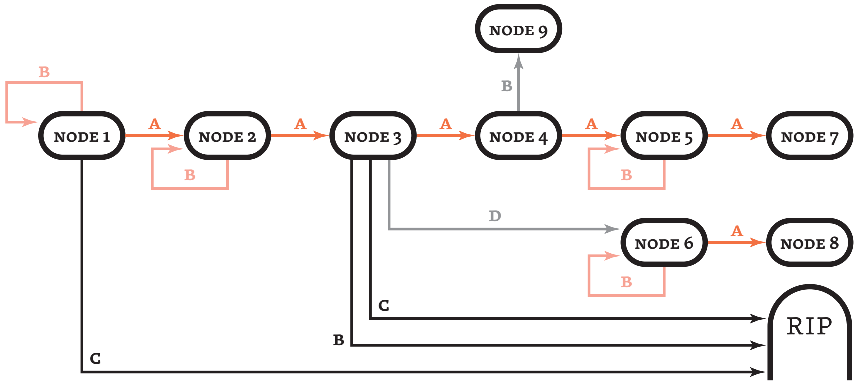

FIGURE C2.3 Various types of nodes and options/answers, which may be used for authoring an interactive algorithm [4].

is the core ICT facility of the projects, includes a set of online forms (electronic case-report forms—eCRF) for filling parametric data such as the input data (fulfilment of the criteria of severe sepsis, birth date, gender, clinical workplace, etc.), the clinical parameters recorded in 10 stages during the first seven days of hospitalization, as well as information on anti-infection therapy regarding the course of the disease and finally, information on discharge from hospital (discharge protocol). Furthermore, there are inputs for follow-ups on the 90th, 180th and 360th days of the diagnosis, as well as a form to describe the causes and the date of death. The EPOSS database allows export of septic patient data to the SEPSIS-Q education portal, constituting the cornerstone of SEPSIS-Q scenarios. The authoring process of SEPSIS-Q scenarios is shown in FIGURE C2.5.

The SEPSIS-Q education portal[3] is equipped with BackOffice application (PHP/MySQL), which enables convenient and comprehensive web content management. Upon the completion and approval of a clinical scenario, it becomes immediately available online through the appropriate section of the SEPSIS-Q education portal. Here, the scenarios are sorted by mortality, gender, the severity of the sepsis and according to the organ/systems that are the primary source

3 SEPSIS-Q education web portal: http://www.sepsis-q.cz

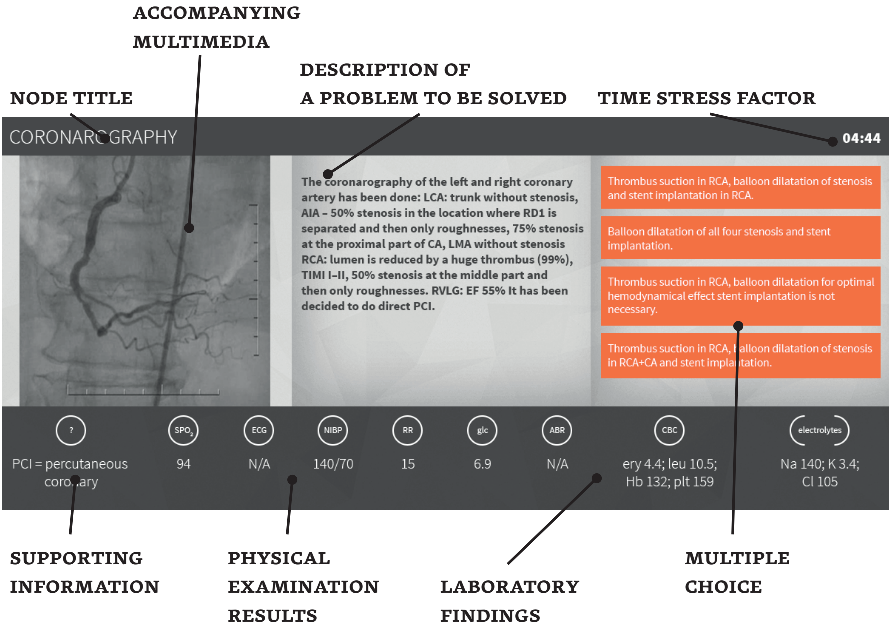

FIGURE C2.4 Detailed screenshot of one node of an algorithm for training clinical reasoning skills in acute coronary syndrome [3]. There are more than 40 online algorithms in the Czech/Slovak and English languages covering a wide range of topics in acute medicine. Peer-reviewed algorithms were used for conducting PBL-like sessions in General Medicine (First Aid, Anaesthesiology and Pain Management, Emergency Medicine) as well as in Nursing (Obstetric Analgesia and Anaesthesia for Midwives, Emergency Medicine, Intensive Care Medicine).

of sepsis. Each scenario comprises the title and an abstract and information on the respective author. Selecting one scenario from the entire collection activates a player, which takes the form of a Flash or HTML5 object executed in the Adobe flash player environment—see the screenshot in FIGURE C2.6.

The lack of support for Flash technology on mobile devices from Apple prompted the developers of AKUTNE.CZ interactive algorithms as well as SEPSIS-Q educational scenarios to shift towards HTML5 and jQueryMobile technologies, in order to offer the simulation-based learning/teaching tools in cross-platform manner.

Scenario-based learning sessions in courses that use the interactive algorithms and/or educational scenarios take usually 3 hours. The lessons are carefully designed with clear learning objectives and contain attractive elements of problem-based learning and team-based learning methods (PBL/TBL). The first half of the lesson comprises of presenting the theoretical context. In the second part, students use their computers and play with the selected interactive algorithms to complement the discussed topic. Students then go through the algorithm's nodes on a projection screen together with a teacher.

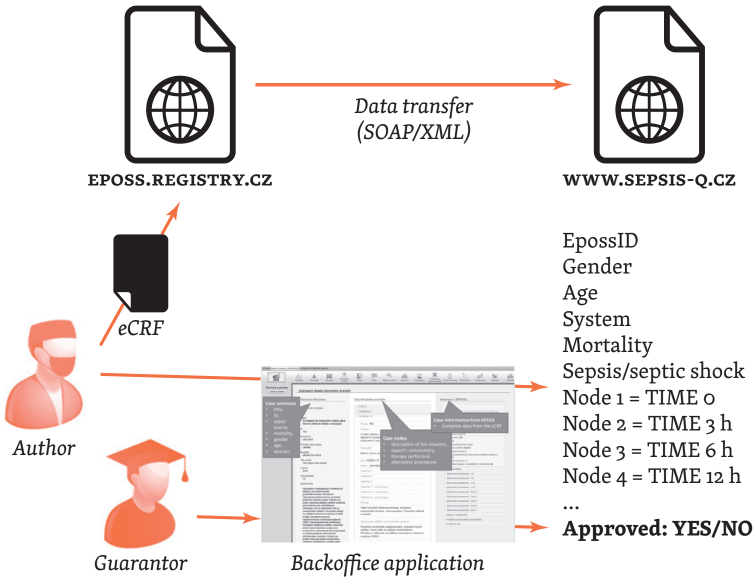

FIGURE C2.5 An illustration of the authoring process in publishing clinical scenarios on the SEPSIS-Q education portal. A special module has been developed for managing clinical cases, operated by the authors of the clinical scenarios as well as by the guarantors.

After introducing the situation at the presented node, students vote for further action and try to explain their reasons for the decision based on their knowledge. Bad and good choices are explained to them with supplementary theoretical background. Students can use any information available on the Internet or in other resources to gather evidence and facts for their choice. The teacher then adds clinical experience as well as tips and tricks for the specific situation. Evaluation and debriefing along with a short questionnaire is conducted at the end of each PBL/TBL session.

Evaluation of students' attitudes to the use of simulations in medical education. In 2013, two surveys were conducted among the students of the Faculty of Medicine at the Masaryk University [4] and among the users of AKUTNE.CZ portal in general [3]. The purpose was to ascertain how students perceive the efforts towards authoring and implementing simulation-based teaching and learning—i.e. techniques that are so demanding to create. Positive attitudes towards the interactive algorithms outnumbered the negative responses. Confirming the expectations, one of the strongest positive answers concerned the participants' desire to use the interactive algorithms not only for their self-studies during leisure time but also in face-to-face teaching and learning. An interesting finding was the most negative attitude to using the tools for the final exam preparation.

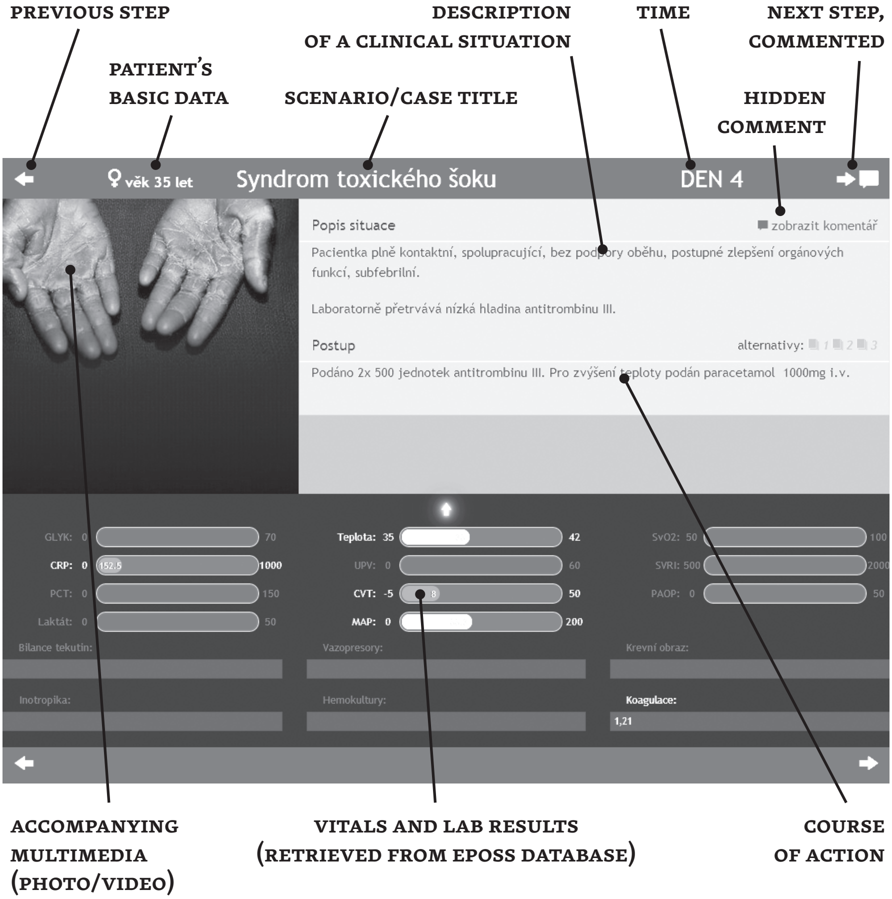

FIGURE C2.6 Detailed screenshot of one node of a SEPSIS-Q scenario (in Czech) [4].

The published SEPSIS-Q clinical scenarios (there are 8 scenarios in October 2014) represent various types of patients from young and healthy to senior polymorbid individuals with different types of sepsis of different origins (urinary tract, genital tract or intestinal). This selection of septic cases creates a unique viewpoint on sepsis as a variable and fluctuating state and helps the student or doctor studying these cases to accustom themselves to recognizing and appropriately dealing with this condition. The experience gained by practicing on virtual patients creates particular resistance to common mistakes, such as underestimation of the crucial decision points in the diagnosis and/or treatment and misinterpretation of the warning signs. The real-life data, together with the time factor, supports the importance of rapid reaction and prompt initiation of targeted therapy.

CASE STUDY 2: PAEDIATRICS [PEDKAZ.CZ]

The main objective of the **PEDKAZ project** is to innovate the subject of paediatrics with the intention of enhancing quality and modernizing and developing respective university teaching in order to extend student's knowledge and skills. This is in line with the new trends in viewing medicine as an evidence-based medical subject and with new, ever-growing, findings in paediatrics [5,6]. At present, more emphasis is being given to the practical aspects of student teaching, the ability to make their own decisions, practice the acquired skills and to incorporate multimedia learning support.

This project is based on individual case reports addressing specific paediatric patients and resulting in better decision-making skills of the students and future graduates. It was essential to implement this project due to the rapid and unprecedented developments in medicine, as it is necessary to adapt and modernize the teaching of medical students in order to combine new theoretical findings with the acquired clinical skills, an aspect so badly needed for preparing the future generation of physicians. Students are increasingly overwhelmed with new theoretical knowledge, but modern study support for practical training and testing of students of paediatrics, as one of the core subjects of medical training, has been missing up till now. This project can be utilized by all students of the study programmes of General Medicine and Dentistry of the medical faculty.

Preparation and practical work with PEDKAZ.CZ. The gathering of data and visual documentation were crucial as the necessary platforms for further high-quality processing of materials. Data collection for the preparation of teaching materials was conducted through thorough examination of the available literature (textbooks, recent articles in professional journals, internet resources, including server updates, etc.). Highly valuable information was also gathered from meetings with experts from other workplaces in the Czech Republic and through participation in professional conferences. The major part of data collection consisted of field work. At the meetings of the implementation team and at consultations with leading professionals in paediatrics, suitable patients were selected for case studies from various disciplines. Data was assembled in the form of extracts from medical records, patients' cards, and photographing and filming patients, always with the consent of each patient and/or their legal representatives. In the course of creating base materials for case reports, the data base from radiology department was used to obtain visual documentation. The values of laboratory results were acquired thanks to the hospital information system.

An essential part of the preparation was the development of new online computer programme. The created editorial programme serves the purpose of simulating work with a patient, from acquiring information on admission up to the final treatment. All case reports are extended with the accommodation of a theoretical section so that students have the opportunity to extend their knowledge through the internet literary references, which are a part of each case. The programme has its own internet domain—www.pedkaz.cz and is password protected.

Work with this study support is divided into several sections. The first part is anamnestic, in which a student obtains basic information on a patient (history taking): current condition, personal history, social, family, pharmacological, allergies, epidemiological and gynaecological history. Some of the information is extended by photo or video documentation. After reading this section, a student should be capable of forming an idea of the source of the problems and subsequently, he/she should be able to prepare the possible differential diagnosis of the case and to decide about potential hospitalization of the patient and thus determine the urgency of his/her condition. Another part is the diagnostic and therapeutic stage where a student indicates the respective examinations and evaluates the results. He/she chooses from a wide range of laboratory, radiological and specialized examinations divided into many subgroups. The aim is to teach students how to indicate examinations in close-to-real-life situations and make their own decisions. On the basis of the obtained information, the student then selects from 5–10 diagnostic options and justifies the correctness of his/her decision. In the therapeutic part, the student again chooses from 5–10 options of therapeutic approaches for the patient based on the assumed diagnosis. After concluding the testing phase, evaluation of the student's performance in the case study is displayed with a commentary on the mistakes and the correct answers, including notification of what should have been examined. Finally, the theoretical part is displayed with a theoretical summary of the diagnosis and the literary references.

Altogether, this project consists of 180 case reports from different fields of paediatrics: cardiology, intensive medicine, allergology, surgery, neonatology, nephrology, endocrinology, gastroenterology, pneumology, rheumatology and haematology.

Three modes of this programme have been configured: (i) Teacher: the programme runs in trial mode and the results and the correct answers will be displayed to the examiner only after entering the personal username and password; (ii) Student: this mode serves as a self-study tool for students. Students, wherever connected to the Internet, can test themselves on a case study and correct answers are displayed immediately after saving the entered data. The programme is, however, set in such a way that the sequence of optional responses is mixed in repeated testing in order to prevent abuse by students training for an exam. (iii) The last option is the administrator: case studies can be inserted into the programme.

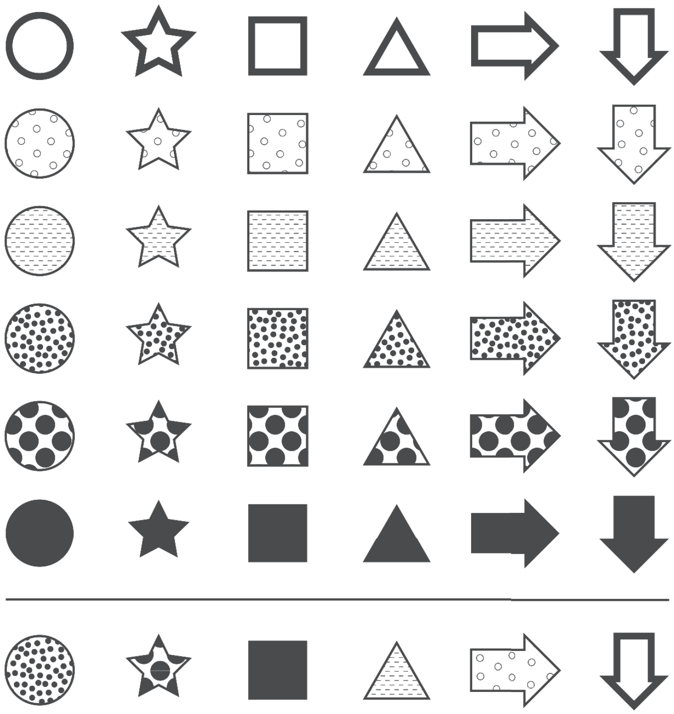

FIGURE C2.7 Pseudo-random combinations lead to a higher number of cases available for teaching/learning in the project e-kazuistiky.cz.

The computer programme not only allows testing of the student but is also able to evaluate, according to pre-set submission by authors, errors in scoring and notifies the tested student of the failures or deficiencies, including the justifications and explanations. The programme is set in such manner that the tested student works in the same way as if he/she would examine a real patient and thus he/she improves practical medical performance and develops one's own skills. Visual documentation is also highly important as it, thanks to real radiological pictures and patients' photos, simulates real work with a patient.

CASE STUDY 3: DIAGNOSTICS, INTERNAL MEDICINE [E-KAZUISTIKY.CZ]

Programme E-kazuistiky.cz (Virtual cases) represents an interactive problem-based learning system designed especially for undergraduate medical education in the different specializations of internal medicine. The main priorities of the system are maximal flexibility, realism, multi-level evaluation of student performance and potential for further development and expansion into other clinical disciplines without any restrictions as to the type of disease and the diagnostic procedure. The important advantage is also the close link to a proven education system using virtual pathological slides[4] allowing overlap of Virtual cases into the preclinical disciplines of medical education. Virtual cases were newly created in collaboration with clinical and preclinical disciplines teachers, programmers with experience in clinical medicine and undergraduate medical students. Thus, the composite team of designers ensures a balance between the (often different) demands of teachers, physicians of clinical and preclinical disciplines, programmers and students on the ideal education tool.

The main pedagogical objectives of the project are: (i) simulation of real-life diagnostic problems; (ii) training of rational use of diagnostic procedures; (iii) automatic evaluation of the knowledge and skills of students; and (iv) the possibility of re-evaluating the progress of students with teacher's comments during practical training.

The system is designed as a set of various outpatient clinics of different internal medicine subspecializations (gastroenterology, cardiology, haematology, rheumatology, pulmonary medicine, diabetology, etc.). Once enrolled in the system, each student receives a unique login and access to the selection of medical offices as required by the teacher. The teacher has the possibility to define the set of case studies that may appear in every concrete office, the number of patients and the criteria for passing the course as well. This system allows simulating either an office of concrete medical specialty or acute medicine (generate only acute cases) or general medicine (cases are generated across all specializations). Personal data, medical history and basic clinical investigation (current clinical picture) are generated for each virtual patient. The tool for case generation (creation) is unique and is based on pseudo-random data combination (some rules are necessary to maintain: information about patients of the same sex, similar age, etc., see FIGURE C2.7). The source data for this process is anonymous information about concrete real patients organized in a database of objective findings and medical history. Students must suggest an optimal diagnostic algorithm and determine the correct diagnosis based on input information for successful completion of each case. Rich multimedia database enables to present the clinical findings and the results of diagnostic tests not only as text but in fully multimedia manner—as photographs, videos, virtual histological slides, etc. Examination results are extremely realistic and present, in addition to their benefits, the common limitations of the selected tests as well (false positive and negative findings, poor quality of examinations, etc.).

The original multi-level system of student evaluation is based on the score in each step of the diagnostic algorithm. If the selected tests are beneficial for the diagnosis in a given situation, the student receives positive (so-called 'bonus') points. If the investigation is without contribution or may even harm

4 Virtual slides: http://www.patologie.info/vip

the patient on the other hand, the student receives negative (so-called 'malus') points. The optimal (minimal) level of 'bonus' points (that must be fulfilled before it is possible to establish a definite diagnosis) was determined for each diagnosis (otherwise the conclusion is considered speculative and not supported by the sufficient number of diagnostic tests performed). The maximum level of 'malus' points is set for each diagnosis as well; the investigation is immediately terminated as unsuccessful. A very important part of Virtual cases is also teaching economic intelligence to the students. The real price of every investigation method was determined and user has information about the selected diagnostic algorithm costs at every moment. After the maximum cost specified for the determination of every diagnosis is exceeded, the investigation is also unsuccessfully terminated. Since students are at liberty to choose from any available diagnostic test, another key feature of the system is also the original evaluation tool allowing assessment of optimal/acceptable/incorrect sequence of suggested diagnostic methods.

The first 20 clinical cases were published in the system and the programme is routinely used in the 4th year of undergraduate medical curriculum (internal medicine) at the Medical Faculty of Charles University in Hradec Králové. The quality and user friendliness of the project, as well as the hands-on experience, were evaluated through anonymous questionnaires completed by teachers and students, resulting in mostly positive feedback. The most appreciated attribute of the system from the student's perspective is the game-like involvement and multimedia-supporting environment; from the teacher's perspective it is the possibility of detailed analysis of each student's performance and clear identification of the weakest areas in the tuition system. Teachers can objectively evaluate the diagnostic capabilities, diagnostic approach and the strengths and weaknesses leading to the success or failure of each individual student. Furthermore, the authors have developed a completely new interactive author's section, enabling much easier input of new patients into the system without the need of detailed knowledge of the backoffice of the system. It is expected that this section will help to further increase the number of authors who will be willing to contribute with new clinical cases.

CASE STUDY 4: PHYSIOLOGY MODELLING [HUMMOD-GOLEM]

Models for integrative physiology. The Internet allows connecting interactive multimedia with complex simulation models, thus providing rather new pedagogical opportunities, particularly when it comes to explaining complex relationships, actively exercising practical skills and verifying theoretical knowledge. The old credo of the pioneering 17th century pedagogue John Amos Comenius—Schola Ludus, i.e. 'school as a play'—finds its application in incorporating multimedia educational play into training courses [7].

Just as the theoretical foundation of an aircraft simulator is based on an airplane model (see CHAPTER B2), medical simulators are based on accurate models of the physiological systems of the human body. Complex integrative simulators of human physiology are of considerable importance in the teaching of pathophysiology and the study of pathogenesis of varied pathological conditions; such simulators include models of not only individual physiological subsystems but also their mutual association with a more complex unit. The field of integrative physiology deals with the study of these associations. It seeks to describe the physical reality and explains the results of experimental research, and also to create a formalized description of how these physiological regulations are interconnected, and to explain their function in a healthy human and their malfunction in the presence of diseases.

One of the first extensive mathematical descriptions of these interconnected subsystems was published in 1972, by A.C. Guyton and two other authors [8]. From the start, the article went far beyond the scope of the physiological articles of its time. Its heart was an extensive diagram pasted as an appendix, resembling a drawing of some electronic device. However, instead of electronic components, the diagram showed interconnected computational blocks (multipliers, dividers, summators, integrators, functional blocks, and so on,

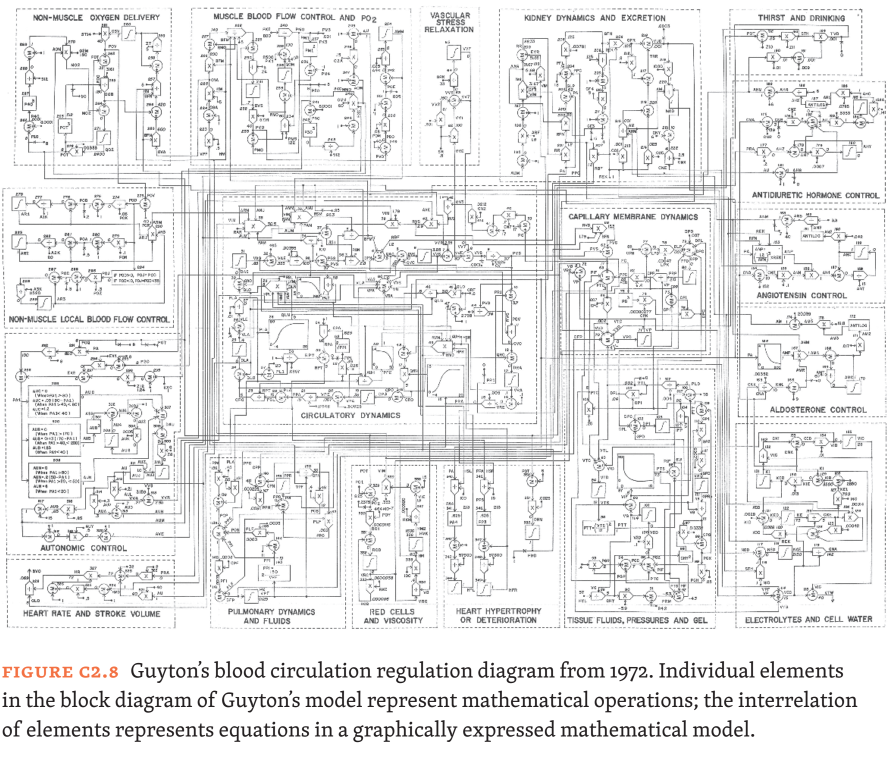

FIGURE C2.8 Guyton's blood circulation regulation diagram from 1972. Individual elements in the block diagram of Guyton's model represent mathematical operations; the interrelation of elements represents equations in a graphically expressed mathematical model.

that symbolized mathematical operations performed with physiological variables. Instead of writing a system of mathematical equations, Guyton et al. used a graphical representation of the mathematical relationships (FIGURE C2.8).

The whole diagram was a formalized description of how the circulatory system self-regulates and its context within the body, using a graphically expressed mathematical model. This method was quite new at that time. Yet the comments and reasons given for assigning the various mathematical relationships were very brief. In 1973 and then in 1975, further monographs [9,10] were published providing more detailed explanation of a number of approaches applied. Guyton implemented this model in Fortran. Guyton's graphic notation of the formalized description of physiological relationships was soon adopted by other authors—for example, Ikeda et al. [11] in Japan or the research group of Amosov in Kiev [12]. 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 models of other authors who adopted the expression notation of Guyton) were implemented in Fortran and later in C++ language.

Guyton and his collaborators and disciples kept developing the model continuously [13]. The Guyton's model was an inspiration as well as a resource for designing complicated complex models of physiological regulations for explaining causal chains of reactions in the body to various stimuli, and also to understanding the development of pathological conditions. Besides others, a modified Guyton's model has become one of the foundations for an extensive model of physiological functions in the NASA programme 'Digital Astronauts' [14].

As early as at the beginning of the 1970s, Guyton was aware of the large potential of using models as independent education aids, and he made the effort to apply them in education within the realm of the then capacities of computer technology. He used his graphic diagram in the classes to explain the basic relationships among individual physiological subsystems. A model implemented in Fortran on a digital computer was used concurrently to observe their behavior in the course of adaptation to various physiological and pathological stimuli. Later, in 1982, one of Guyton's collaborators, Thomas Coleman, created the model HUMAN designed predominantly for educational purposes [15]. The model allowed for simulating a number of pathological conditions (cardiac and renal failure, hemorrhagic shock, etc.), and the impact of some therapeutic interventions (infusion therapy, effect of some drugs, blood transfusion, artificial pulmonary ventilation, dialysis, etc.). In 2008, Meyers and Doherty made the original Coleman's education model HUMAN implemented in Java, available on the web [16].

Model design in Simulink simulation environment. Today, designing simulation models is facilitated by specialized software environments. Guyton's graphic notation was very similar to the recent graphic simulation software

Simulink by Mathworks. This similarity inspired us to resurrect the classic Guyton diagrams into a functional simulation model written in Simulink [17]. However, simulation-based visualization of the old diagram was not easy—namely, because there are errors in the original diagram! This is not a problem in printed picture, but if one tries to liven it up in Simulink, the model collapses immediately. Our Simulink implementation of the (corrected) Guyton model is available for download[5]. A Simulink implementation of a much more complex later Guyton model is available on this website as well.

The Guyton's diagram and the Simulink network design based on the diagram are quite difficult to grasp at first 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 higher hierarchical level, as the case may be. Individual Simulink subsystems represent a kind of 'simulation chips' hidden from the user by the structure of the simulation network, just 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 behavior 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 behavior, and especially for clearer expression of mutual dependencies among the 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 the 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 behavior in an appropriate simulation-based visualization environment, see FIGURE C2.9.

Simulink blocks were used to create the Simulink library of physiological models called Physiolibrary[6]. The library also includes an extensive integrated

5 Simulink implementation of the (corrected) Guyton model: http://www.physiome.cz/guyton.

6 Physiolibrary is freely available at: http://www.physiome.cz/simchips.

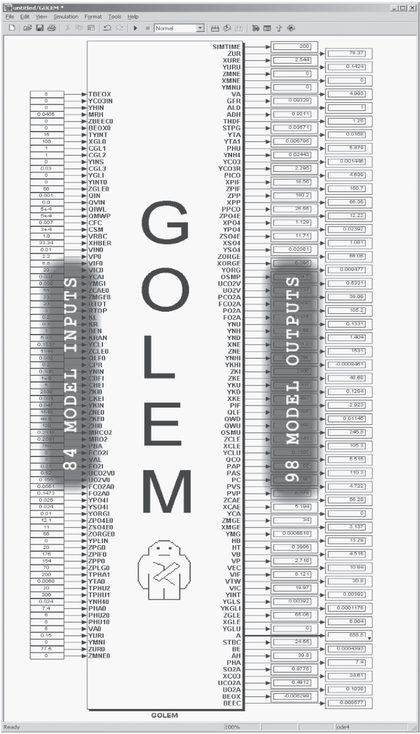

FIGURE C2.9 Simulation chip containing the integrative model that serves as a framework for our Golem education simulator. The simulator is based on mathematical simulation models of body-fluid balance, respiration, circulation and renal function. The mathematical description consists of 39 non-linear differential and algebraic equations of more than 200 variables. In the graphic environment of Simulink, simulation model input values can be connected to separated 'pins' of the simulation chips and the time-course of the corresponding variables can be registered on virtual displays or oscilloscopes.

model of physiological regulations that has been used as the foundation for our GOLEM education simulator. The model uses a hierarchical structure composed of individually nested and interconnected Simulink blocks.

Golem instead of the patient. 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 [18–24]. 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 in its background, the simulator could be used to demonstrate clearly how individual physiological subsystems are related to each other, and how these connections are manifested in individual pathophysiological conditions.

The theoretical concept of GOLEM simulator is the large simulation model based on mathematical formalization of blood gasses transfer, acid-base, electrolyte, volume and osmotic equilibrium, the function of the respiratory and urinary system, including the influence of hormones. The model design is based on classical models of Guyton et al. [8], Ikeda et al. [11] and Coleman et al. [15], which we have redesigned and extended. It consists of 39 nonlinear differential equations and contains 84 input and 98 output variables.

The GOLEM simulator enables visual demonstration of the mutual relations between the individual physiological subsystems and the manifestation of these relations in individual pathological conditions. The simulator enables the computer modeling of various pathological conditions and the influence of appropriate treatment. The simulator, therefore, becomes a visual learning aid for better understanding of the nature of physiological regulations and the manifestation of their malfunctions.

The following simple example of an acid-base disorder should demonstrate how easy it is to manipulate the simulator and how the simulator shows causal links during a pathophysiological disorder and therapeutic interventions.

By changing the value for metabolic production of strong acids, we can cause metabolic acidosis in our 'virtual patient' (FIGURE C2.10A). The ratio of metabolic production and renal excretion of strong acids is highly increased. H^+/Na^+ and H^+/K^+ exchange at cell membrane is activated. Intracellular and extracellular buffers buffer H^+ ions (FIGURE C2.10B). Our virtual patient is showing signs of metabolic acidosis—the blood has been acidified, Base Excess and actual bicarbonate concentration are decreasing, and pCO_2 is also slowly decreasing (FIGURE C2.11A).

Acid-base values on compensatory diagram are in the acute metabolic acidosis range. This is the beginning of a progressive reaction by the ventilation center to counteract metabolic acidosis (FIGURE C2.11B). Respiratory compensation is at the maximum in about 12 hours. Decreasing pCO_2 is leading to rise of arterial blood pH. Acid-base parameters are approaching the compensated metabolic acidosis range (FIGURE C2.12B). The slow response of the respiratory system to metabolic acidosis is due to the relative impermeability of bicarbonate across the blood-brain barrier (FIGURE C2.12A). While CO_2 penetrates easily and pCO_2 in blood and cerebrospinal fluid is at the same level, this is not the case for bicarbonate. Thus, bicarbonate reaches equilibrium, cerebrospinal pH decreases, and the respiratory center is further stimulated; alveolar ventilation increases resulting in decrease of pCO_2. Values of acid-base parameters are slowly approaching towards compensated metabolic acidosis range. The renal response progressively develops. Titratable acidity and NH_4 excretion increases, urine pH decreases. Renal response is at its maximum in 3–5 days (FIGURE C2.13A). The simulator allows virtual therapy so that we can start alkaline infusion for metabolic acidosis. To help the strong acid input/output balance, we can start bicarbonate infusion by simply adjusting the appropriate rate of bicarbonate intake in the simulator and alkaline infusion therapy of metabolic acidosis of our virtual patient is initiated (turning the knob commences bicarbonate infusion therapy—see FIGURE C2.13A). BE and pH slowly

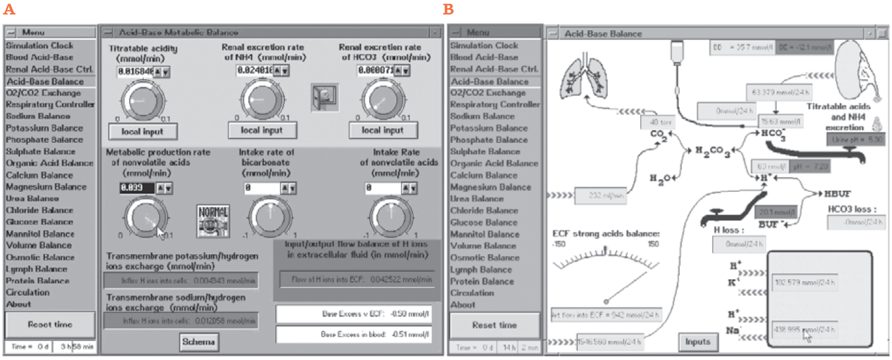

FIGURE C2.10 Simulation game of metabolic acidosis in Golem simulator. Turning the knob, we can increase the metabolic production rate of non-volatile acids (a). Hydrogen ions production rate is greater than bicarbonate production rate by the kidneys (b). Acid-base balance shifts to strong acid retention. Hydrogen ions are exchanged for K^+ and Na^+ in cells.

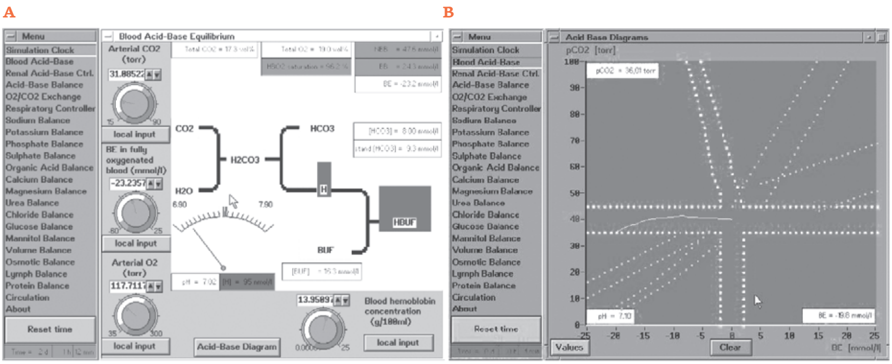

FIGURE C2.11 Blood acid base equilibrium in acute metabolic acidosis (a). Blood buffered acidotic load, BE and bicarbonate concentration decrease. Acid-base values on this compensatory diagram are in the acute metabolic acidosis range (b).

increases after bicarbonate infusion, pH approaches to normal value, but pCO_2 remains stable for a while (thanks to respiratory compensation) at its low level. We must take pCO_2 into account when choosing the doses of alkaline infusion in order not to overdose (FIGURE C2.13B).

In virtual therapy, there is some margin for error (alkaline infusion overdose which in real life can be dangerous). If we overdose the infusion (FIGURE C2.14A), we correct BE but hyperventilation leads the patient from acidemia to alkalemia, which can be dangerous. During acidemia (FIGURE C2.14B), the cell membrane exchanges potassium ions for hydrogen ions entering into

A B

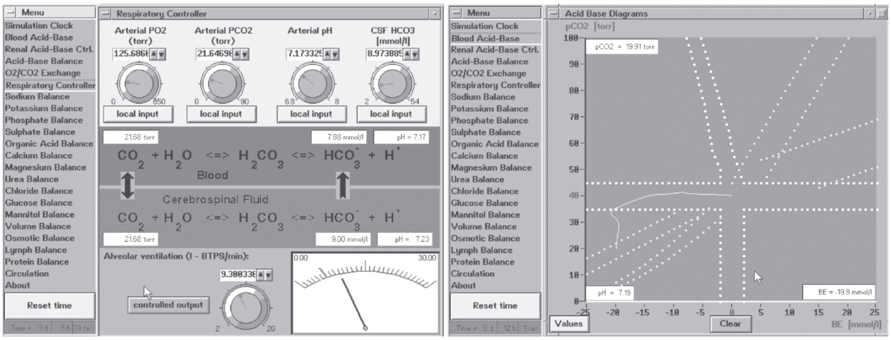

FIGURE C2.12 The response of the respiratory system on metabolic acidosis is developed: pH in cerebrospinal fluid slowly decreases, and respiratory center is stimulated (a). Therefore, alveolar ventilation increases and acid-base parameters are approaching the compensated metabolic acidosis range (b).

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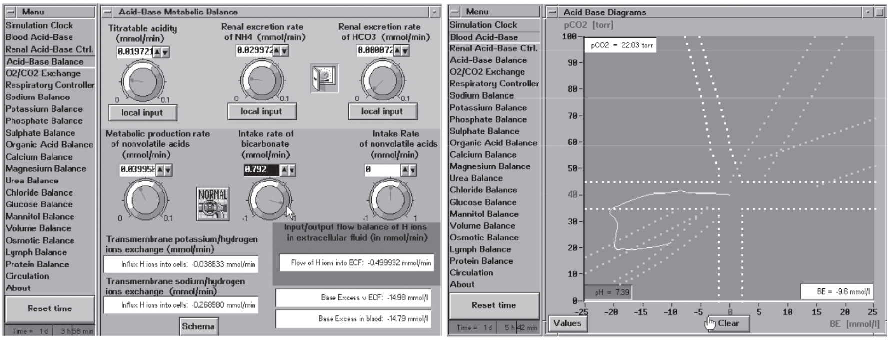

FIGURE C2.13 Renal response slowly develops. We can try treating the patient by infusion therapy. Turning the knob commences bicarbonate infusion (a). In acid-base diagrams we can see the results of our treatment (b)—we must take pCO2 into account when choosing the doses of alkaline infusion in order not to overdose. We must correct pH to normal value and be careful not to shift pH to alkalemia, which can be dangerous.

cells to be used by buffers. If acidosis lasts too long, the supply of potassium in the cells decreases resulting in depletion of K^+. Inadequate therapy would quickly lead the patient from acidemia to alkalemia, as the cell exchanges K^+ for H^+ (from intracellular buffers). Since the extracellular reserves of potassium are limited, its plasma concentration will quickly and dangerously decrease.

It is necessary to replace the lost potassium. We can then try correcting it, or simply press 'Restart' to try and re-run the entire simulation. We also can try to correct the K^+ depletion. We must use potassium infusion in glucose and insulin—insulin takes glucose into the cells (FIGURE C2.15A) but also increases

A B

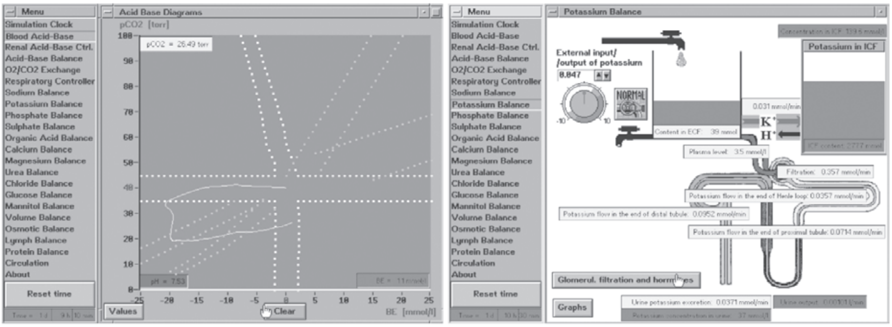

FIGURE C2.14 Alkaline infusion overdose, pH shifts to alkalemia (a). Potassium concentration in plasma dangerously decreases (b).

A B

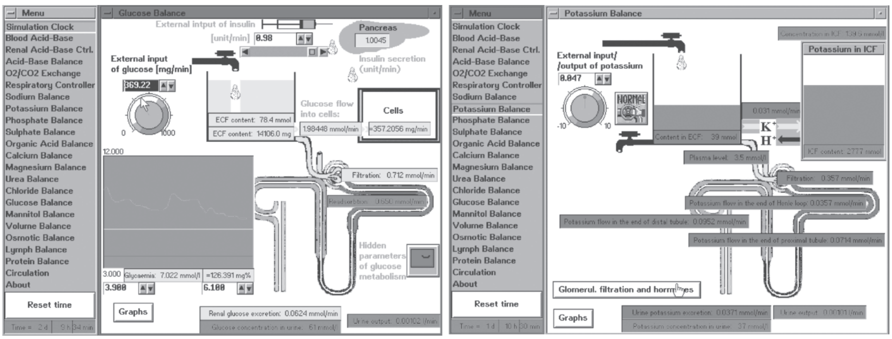

FIGURE C2.15 To correct K⁺ depletion, a potassium infusion in glucose and insulin is used: insulin takes glucose into the cells (a) but also increases the entry of potassium into cells resulting in faster correction of K⁺ deficiency (b).

the entry of potassium into cells resulting in faster correction of K^+ deficiency (FIGURE C2.15B). The infusion must not contain too large concentrations of potassium (as this would increase K^+ to dangerous levels).

A mistake is no reason to get upset since the patient is 'virtual' (and so death as a result is just virtual). A real patient would not take our carelessness so easily, however. The simulation can be stopped at any time by using the Stop switch on the simulation clock and we can then take our time to analyze the many variables in the individual's physiologic subsystems windows.

From the pedagogical point of view, it proved to be highly advantageous to explain the physiological meaning of individual regulatory circuits by means of disconnecting and reconnecting individual regulatory bonds. Upon disconnecting the 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. We have, therefore, introduced in Golem the possibility of 'disconnecting regulation' of some of the regulated physiological variables, and their 'switching to local input' [20]. Disconnection of the regulatory loops made it possible to limit the simulation to an individual physiological subsystem, and to examine its behavior independent of the complex regulatory relationships within the whole body, and thus to observe the behavior of individual physiological regulatory relationships separately, which contributed to better understanding of the physiological relationships.

HUMMOD—Extensive Models for Education Simulators. Guyton's disciple, Thomas Coleman, Robert Hester at al., elaborated on the large education simulator Quantitative Circulatory Physiology (QCP) [25]. 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 approximately 750 parameters that modify physiological functions. The values of these parameters can be saved or read from an external file, which enables the user to prepare a number of scenarios for various pathological conditions. The authors of QCP have prepared many scenarios (as input files) for education needs, and, together with appropriate comments, have made them available for free download from the QCP website. This simulator has proved useful in teaching [26].

The successor to QCP simulator is Quantitative Human Physiology (QHP), renamed to HUMMOD. This simulator supports the simulation of numerous pathological conditions, including the effect of therapy. With more than 5000 variables, HUMMOD seems to provide the most extensive integrated model of physiological regulations available today. Unlike QCP, whose mathematical background is hidden from the user in the C++ source code, HUMMOD's authors decided to separate the simulator implementation from the description of model equations in order to make the model structure clear for the wider scientific community [27–31]. Unlike commercial virtual patient simulators, where the structure of mathematical model is hidden, HUMMOD is available as open source code[7].

HUMMOD's mathematical model is written in special XML language. The last version of HUMMOD incorporates thousands of files spread across hundreds of directories. Thanks to this fact, the model equations and their relationships are comprehensible only with difficulty, and many research teams developing medical simulators prefer to use older models as basis for their own expansions—for example, by the SAPHIR (System Approach for Physiological Integration of Renal, cardiac and respiratory control) international research

7 HUMMOD model and the simulator are available at: http://hummod.org.

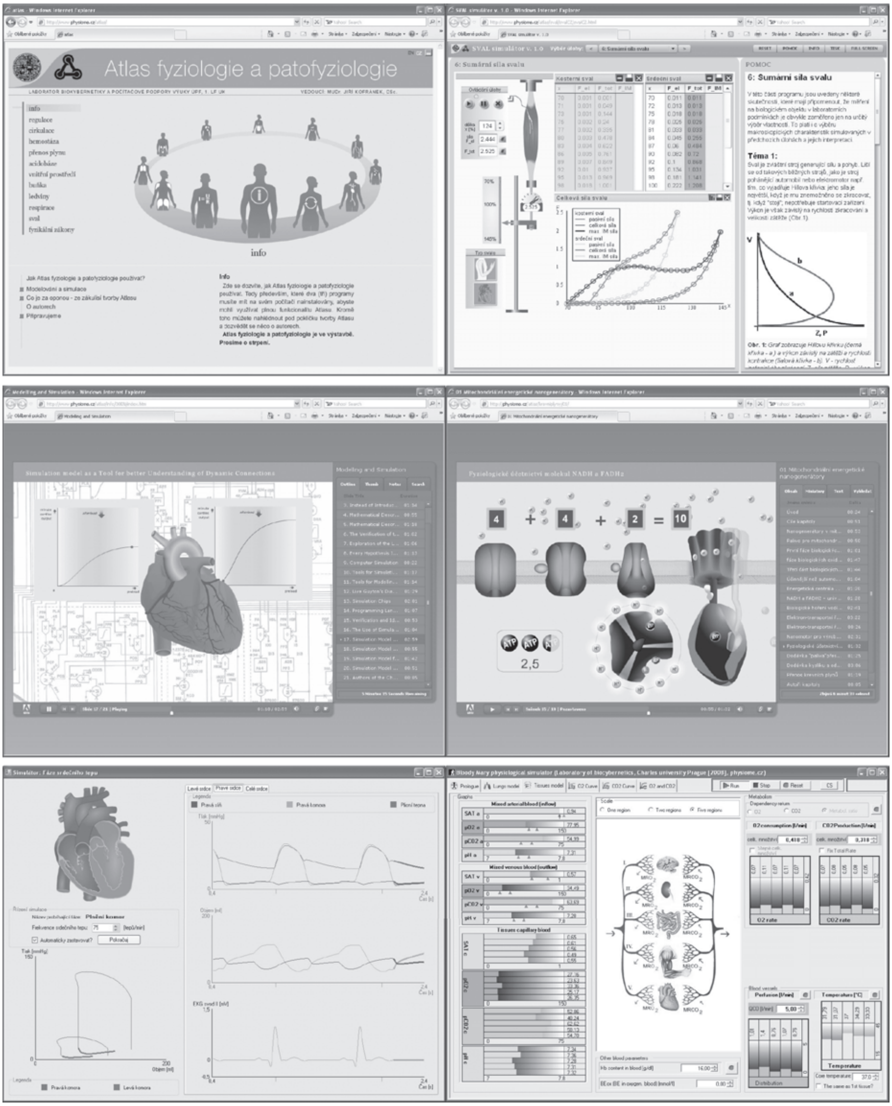

FIGURE C2.16 The Atlas of physiology and pathology combines interactive interpretations with sound, animations and simulation games. It has been created in the Czech and English versions as well. It is freely available at: www.physiome.cz/atlas.

team, as they found the source text of the QHP/HUMMOD model very difficult to read and understand for project participants [32]. Similarly, Mangourova et al. [33] recently implemented the 1992 Guyton model [34] in Simulink, rather than the more recent (but poorly legible) version of HUMMOD created by Guyton's collaborators and disciples.

Thanks to cooperation with the American authors of HUMMOD, a special visualization tool was created [35] that provides a clear graphic representation of the mathematical relationships used, visually representing thousands of files of source texts used by the most complicated physiological model in the world. Besides other benefits, this has also been helpful in discovering some errors in the HUMMOD model.

The source texts for the models that are the foundation of medical simulators should be publicly available, given that they are the result of freely-available theoretical studies of physiological regulations—then it becomes easy to find out as to what extent the model corresponds to physiological reality. Therefore, the structure of the Czech model, which is called HUMMOD-GOLEM Edition, is published[8] in its source form, together with the definitions of all variables and equations. Unlike the original American implementation, the Czech model is implemented in Modelica, which makes it possible to provide a very clear expression of the model structure.

Modelica [36] is a non-proprietary, object-oriented, equation based simulation language to conveniently model complex physical systems. It is often used to model mechanical, electrical, electronic, hydraulic, thermal, control, electric power or process-oriented subcomponents. Unlike other object-oriented languages, classes in Modelica may contain equations. Each class in Modelica can be externally represented by a user defined icon. A component in Modelica, therefore, represents an instance of class for which equations or parameters are defined. Components (represented as icons) can be linked through connectors. These connections are not only assignments of values; they can also represent causal equality. The user graphically links these icons to create a system of equations. The structure of the model in Modelica, therefore, reflects the structure of the modeled system, unlike the model in Simulink, which expresses the structure of the calculation procedure rather than the structure of the modeled reality. Unlike the block-oriented simulation environment in Simulink, the structure of Modelica models corresponds to the physical essence of the modeled reality (the compiler takes care of the 'dirty work' of solving the resulting system of algebraic differential equations). Models in Modelica

8 HUMMOD-GOLEM Edition is the result of the efforts of the Laboratory of Biocybernetics and Computer Aided Teaching (Charles University in Prague). It is available at: http://physiome.cz/Hummod.

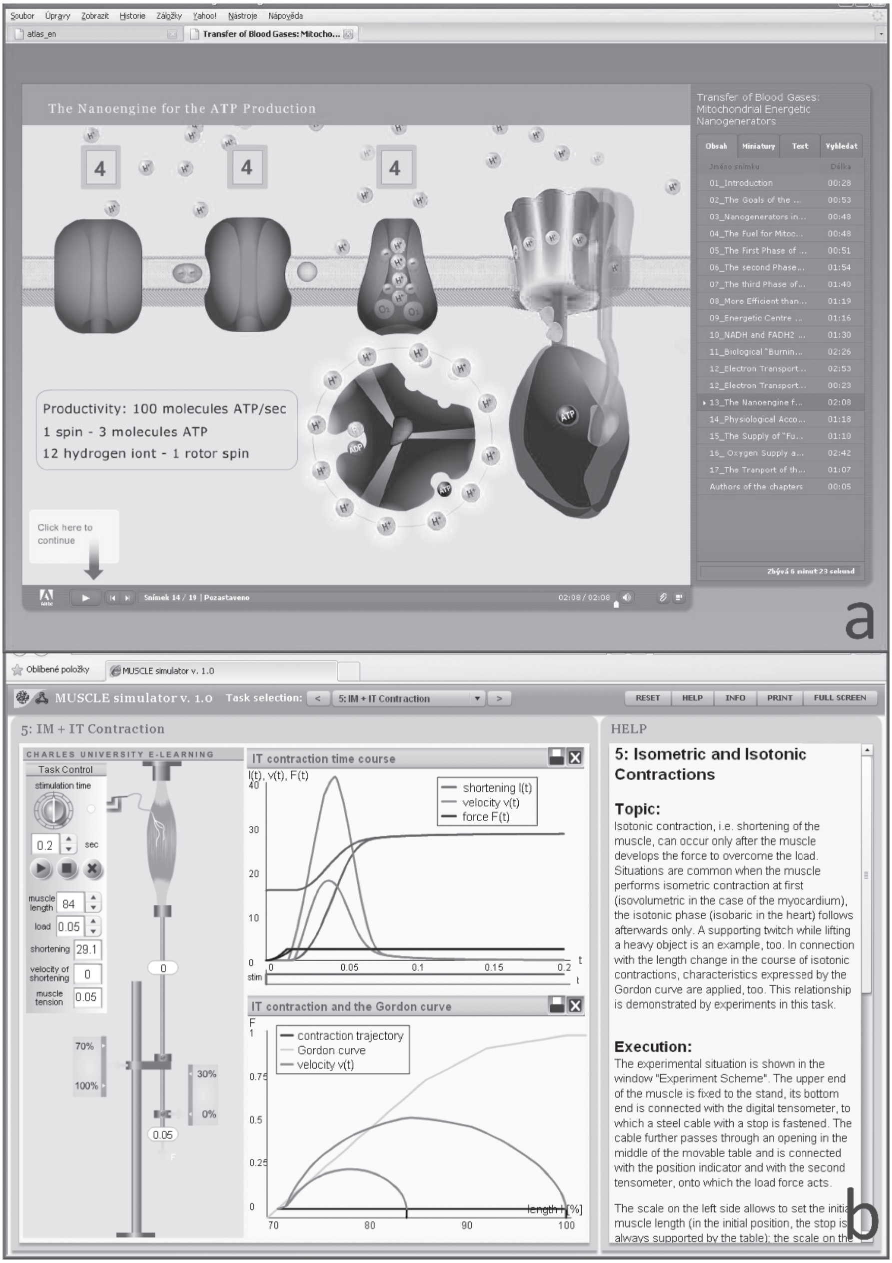

FIGURE C2.17 Audiovisual interactive lecture in the explanatory part of the Atlas of Physiology and Pathophysiology. Every audio-explanation is accompanied by synchronized animated images. An explanation can be stopped at any moment in order to take a more detailed look at the accompanying animation. Rewind is possible using the slide at the bottom of the player. Explicatory chapter including various simulation games.

are, compared to those in Simulink, clearer and more self-documenting. The source code of models resembles the structure of modelled reality.

Atlas of Physiology and Pathophysiology—simulation games on the Web. The experience in application of large complex models (of the GOLEM or HUMMOD type mentioned above) in teaching shows that large and complex models harbour a disadvantage from the didactic point of view, namely their complex control. The large number of input variables, as well as the broad scale of options of observing the input variables, require rather thorough understanding of the very structure of the simulation model on the part of the user, as well as knowledge of what processes should be observed in simulations of certain pathological conditions. In the opposite case, a complex sophisticated model seems to the user only as a 'complicated and not very understandable technical toy' (similarly as if the user should face a complex airbus simulator without prior theoretical instruction).

Therefore, instruction models (and apparently not only complex ones with hundreds of variables) alone are not enough for efficient use in teaching. They must be accompanied by explanation of their application—using interactive education applications at best. The possibility of using all advantages of virtual reality to explain complex pathophysiological processes arises only upon establishing the connection between explanation and simulation play. In order to link the possibilities offered by interactive multimedia and simulation models in medical teaching, we have designed the concept of an Internet computer project, the Atlas of Physiology and Pathophysiology [41,42], conceived as a multimedia instruction aid that should help to explain, in a visual way using the Internet and simulation models, the function of individual physiological subsystems, and the causes and manifestations of their disorders (see FIGURE C2.16).

The Atlas thus combines explanation (using audio and animation) with interactive simulation play with physiological subsystems models, all available for free from the Internet[9]. The explicatory chapters of the Atlas are designed as audio lectures accompanied by interactive multimedia images. Every animation is synchronized accurately with explanatory text. Some simulators combine the model with the explicatory part—for example, the simulator of mechanical properties of muscles (see FIGURE C2.17).

Other simulators can be run separately and the scenarios used under their control are planned as part of relevant explanatory chapters. The complex model of blood gases transport[10] is an example; this model can be used as an instruction aid in explaining the physiology and pathophysiology of

9 Atlas of Physiology and Pathophysiology: http://physiome.cz/atlas
10 The complex model of blood gases transport: http://physiome.cz/atlas/sim/BloodyMary

oxygen and carbon dioxide transport (e.g. to explain the consequences of ventilation-perfusion mismatch).

The user interface of models used as the foundation for simulation plays rather evokes animated images from the printed Atlas of Physiology [43] or Atlas of Pathophysiology [44] than abstract regulation diagrams used in the teaching of bioengineers. Unlike printed illustrations, however, images forming the user interface of multimedia simulators are 'live' and interactive—changes in the simulation model variables are manifested by changes to images. Using the interactive illustrations thus conceived it is possible to implement serious simulation games that shall help explain the dynamic links in physiological systems better than a static image or even simple animation, and help especially to understand the casual features in the development of pathogeneses of varied diseases.

Simple aggregated models for explanation of pathophysiology disorders. From the didactic point of view, it is always necessary to proceed from simple to more complex things in explanations. According to this principle, it is therefore suitable to use rather simple aggregated models (with few variables) during explanation, explain the essential principles using these models, and then start making the model (and describe the physiological reality) more complex gradually.

Instruction simulation plays, forming part of the internet Atlas of Physiology and Pathophysiology, need not be always based on a highly complex model demanding hundreds of variables from the calculation point of view—even a simple interactive model can be a good helper in explaining the pathogenic chain of development of various pathological conditions.

It is very efficient to disconnect the regulation loops in the model at first and enable the students to study the responses of the selected physiological subsystem on changes of input variables in the simulation game (however, they are regulated in the living body). The dynamics of behaviour in gradual changes according to a single input are observed at first, while other inputs are set on a chosen constant value (the so-called 'ceteris paribus' principle).

As an example of explaining the physiology and pathophysiology of circulation with a simple aggregated model, the simplest model of circulation with disconnected regulatory links can be demonstrated here. It has intuitive control, and helps to clarify the relationships among individual variables of the circulatory system (i.e. pressure and flow in the pulmonary and systemic circulation) and the essential variables affecting these pressures and flows that are themselves regulated by neurohumoral means (see FIGURE C2.18).

The variables of this model include: (a) system and pulmonary peripheral resistance; (b) the pumping function of the right and left ventricles implemented simply as the slope of the Starling curve, expressing dependence of cardiac output on filling pressure of the ventricles; (c) tonus of vessels changing

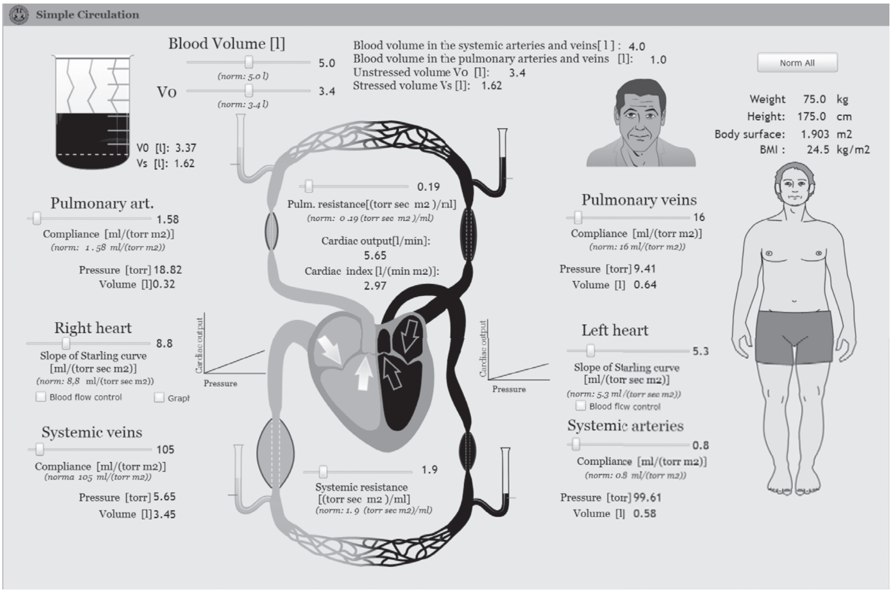

FIGURE C2.18 Very simple model of circulation demonstrates the significance of main variables affecting the circulatory system—pumping functions of heart, resistance, compliances, blood volume and its distribution into unstressed and stressed volume.

unstressed volumes and elasticity expressing dependence of pressure on the volume of vascular filling; and (d) the total volume of circulating blood. The body regulates these variables as mentioned above: resistance is controlled by means of both nervous and humoral regulation; myocardial frequency and inotropy modifies the shape of the Starling curve; venous tone (again regulated by neurohumoral means) of large veins changes their unstressed volume (if venotonus increase, unstressed volume decreases and subsequently stressed volume increases); and the circulating blood volume is affected especially by renal activity, the rennin-angiotensin aldosterone system, etc.

However, these variables represent input (i.e. non-regulated) quantities in an aggregated model; the aim of the interactive simulation is to obtain a clear notion of the influence of these quantities on blood pressure, and the flow and distribution of the blood volume among the individual parts of the bloodstream. Thus, interactive simulation with this model helps to explain the regulation of essential quantities in the circulatory system in the pathogenesis of various circulatory system disorders.

From 'Art' to 'Industry' in designing the educational physiological models. When creating a web simulator, two types of problems must be taken into consideration. The first is the creation and identification of the mathematical

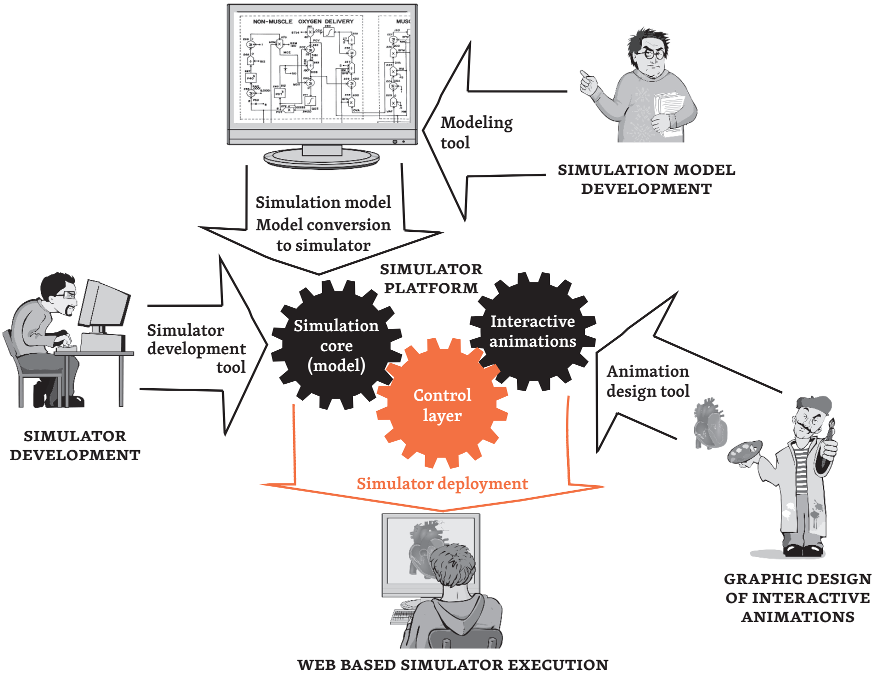

FIGURE C2.19 Workflow of web based simulators development and deployment. The simulation core is connected with interactive animation by a control layer. The model core is programmed manually or by means of automatic generation from a modelling tool (e.g. the Modelica-programming-language-based tool). Graphic components are created in Adobe Flash or Microsoft Expression Blend. Creating animations in Expression Blend offers the advantage of creating the animations and the simulator in same .NET platform.

model. This work is more of research than development work, based on the creation of formalized mathematical description of the modelled reality. For the creation, tweaking/debugging and verification of simulation models, special software development tools are used. Matlab/Simulink delivered by Mathworks or open-source Modelica represent the most preferred development tools. The most important innovation in Modelica is the option to describe each part of the model as a set of equations and not as an algorithm used to solve these quotations. Models created in Modelica are well-arranged and better reflect the structure of the modelled reality.

The other problem apparent during the creation of tutorial and education simulators is the creation of the tutorial software itself. It is a very demanding development work, which requires the combination of ideas and experiences of teachers who create the script of the tutorial application, the creativity of art designers who create the multimedia components interconnected with the

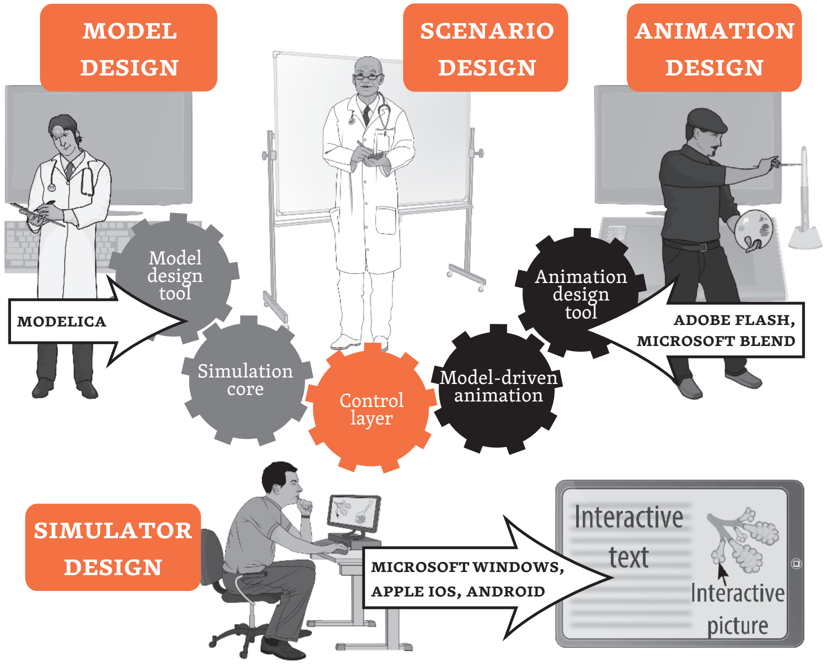

FIGURE C2.20 Design of interactive textbooks with model-driven animations.

simulation model in the background, as well as the efforts of programmers who finally 'stitch together' the final masterpiece into its final shape.

To automate the model debugging transfer from the simulation development environment (using Simulink or Modelica) into the development environment where the development application is programmed, specialized software tools are used (FIGURE C2.19) [35].

The rapid development of tablet PCs, which are beginning to be used as a medium for electronic distribution of books and interactive education materials, opens the possibility of creating a medical textbook of entirely new type. Instructional text can be accompanied with interactive animated pictures controlled by the model in the background. It gives us great education possibilities to explain the complex dynamics of physiological processes (FIGURE C2.20).

DISCUSSION & CONCLUSIONS

The times of enthusiasts who created the first education programmes at the turn of the 80s, excited about the new potential of personal computers, has long gone. Today, the design of good-quality education 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: (i) experienced teachers whose scenarios provide the foundation of a good-quality education application; (ii) system analysts responsible, in cooperation with professionals of any given field, for the creation of simulation models for education simulation games; (iii) artists who design the external visual form of the simulator; (iv) information science specialists (programmers) who 'stitch together' the whole application to its final form.

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 effort needs to be devoted to the process of creating and mastering the tools, but it pays in the end. The process of designing an education programme thus acquires ever more features of engineering design work.

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WIKISKRIPTA—A HANDY PLACE FOR COLLABORATIVE LEARNING

MARTIN VEJRAŽKA, ČESTMÍR ŠTUKA, STANISLAV ŠTÍPEK

'Learning should be a joy and full of excitement. It is life's greatest adventure; it is an illustrated excursion into the minds of the noble and the learned.'
TAYLOR CALDWELL

Summary. WikiSkripta (www.wikiskripta.eu) is an open wiki-based collection of medical education materials. Access is not restricted and anyone can read as well as post or edit texts, with teachers as wells as students of medical faculties being contributors to WikiSkripta. Teachers can approve high-quality articles; these approved articles are visibly marked. WikiSkripta is a textbook rather than an encyclopaedia. Short contributions can be assembled into larger 'chapters' corresponding to needs of individual subjects or courses. WikiSkripta contain almost 8000 articles and became the most used web site for medical education in the Czech and Slovak Republics with 20 to 40 thousand visits per day.

/ **Keywords:**
- WikiSkripta
- wiki in education
- student-centred learning
- medical education
- collaboration
- community

/ **Reviewer:**
- DANUŠE BAUEROVÁ

WIKI AS A COMMUNITY PROJECT

When Ward Cunningham installed his first wiki in 1995, he probably had no idea that he was laying the foundation of one of the most visited website in the world. The first ever wiki called 'WikiWikiWeb' was a site intended as discussion forum for software developers [1]. Cunningham's idea was to make the web quickly editable by its users; 'wiki' is the Hawaiian word for 'quick'. Six years later, one of Cunningham's co-workers, Ben Kovitz, had dinner with Larry M. Sanger. Sanger was editor-in-chief of Nupedia, an online encyclopaedia. Despite its great ambitions, Nupedia struggled to survive; its highly qualified contributors were extremely busy and slow—only 12 articles written during a year. The idea of a wiki-based complement to Nupedia was conceived and Wikipedia was launched in 2001. Nobody expected that this 'complement' might beat Nupedia in the first month of existence. Wikipedia's growth was so rapid that it contained more than 20 000 articles just after one year. Today, Wikipedia is the sixth most visited website (after the three search engines, Facebook and YouTube).

The rapid rise of wiki can be easily interpreted as a consequence of the low-threshold design of the site. Contributors need no registration, no approval for editing; their posts are published immediately after submission. There is also a social aspect and a strong community has formed around living wiki-projects. It is a particular community, different from real-world communities because its members do not know each other personally. However, taking part in such a community is astonishingly motivating. Wiki-communities have their mission (yet usually not precisely stated), organization and structure, can solve conflicts and are able to re-engineer themselves. Together with the unusual openness of the site, wiki projects bring relatively new work experience. It is concisely stated in the 'Welcome visitors' page of WikiWikiWeb:

'If you haven't used a wiki before, be prepared for a bit of culture shock. The beauty of Wiki is in the freedom, simplicity, and the power it offers.' [2]

WIKI IN EDUCATION

Some of the principles of wiki put emphasis on cooperation, stimulation of team-work, and critical use of resources, thus akin to the principles practised in higher education. The same can be said about writing well structured, reliable and up-to-date texts. It's no wonder that various wikis have been employed at universities throughout the world. Wikis in general have proved to help in the coordination of student projects and facilitate communication. Over the years, it has become one of the fundamental tools in student-centred and networked learning.

Wikipedia launched its Wikipedia Education Program in 2007. However, there were certain obstacles that made the use of a global encyclopaedia in education difficult in some cases. First of all, articles in Wikipedia are always open for editing by anyone and it can be difficult to distinguish between the contributions of a student and editors from the outside. Wikipedia is also a long-term project in which articles most often take several months or even years, while a university course employing wiki is to be finished in several weeks. Therefore, hundreds of independent educational wikis were started. Compared to Wikipedia, these are usually websites with simple structure and easy-to-use tools. They are usually opened for the benefit of a specific group of students of a certain course. When the course finishes, wiki is emptied and with a new group of students it is started again. This use of wiki serves primarily for activating students, stimulating cooperation and organising team-work. The resulting content is more or less a 'by-product'. Access to wiki is usually restricted in this case. Since openness as an important feature of wiki is missing, these sites are sometimes called 'hybrid wikis' [3].

Long-term projects using wiki for creating and distributing education material are less common. The Wikipedia Education Programme involving students in writing encyclopaedic entries was mentioned above. Another project, Wikiversity, was devoted to learning resources for all types and levels of education, but by this time we already had our own wiki education project

A wiki-based space for medical education material, WikiSkripta, was created for the Czech and Slovak medical faculties. The site runs in local languages. Today, it boasts some 8000 articles and is still growing. An English mutation called WikiLectures was established as well, but it has not reached the dynamism of the Czech and Slovak site.

WIKISKRIPTA—COLLABORATION RATHER THAN COMPETITION

WikiSkripta[1] is an open project designed as a textbook of medicine. It is in the Czech and Slovak languages (these two languages are very similar; most speakers of the Czech language can understand Slovak and vice versa). Today, WikiSkripta is the most visited web site for undergraduate medical education in the Czech and Slovak Republics.

Compared to Wikipedia and many other wiki-projects, WikiSkripta is not intended to become an encyclopaedia. Articles can be linked to larger chapters

1 WikiSkripta: http://www.wikispripta.eu

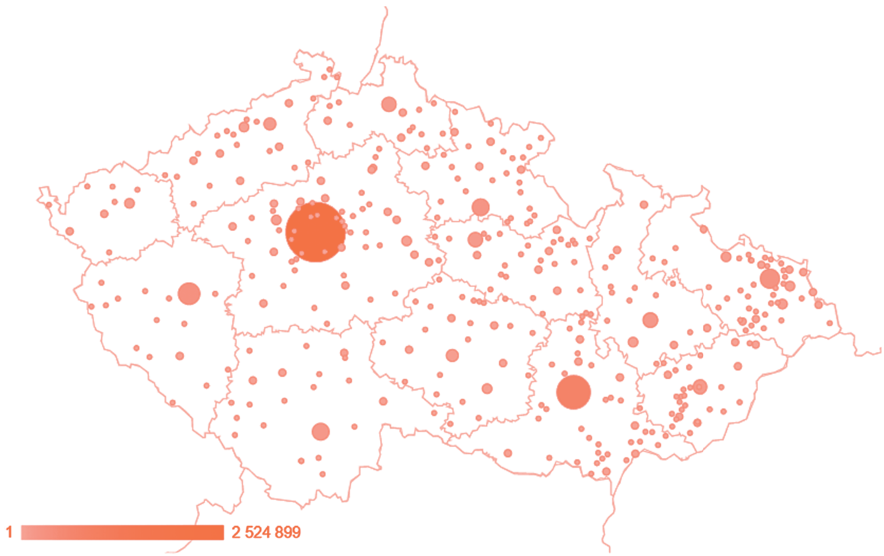
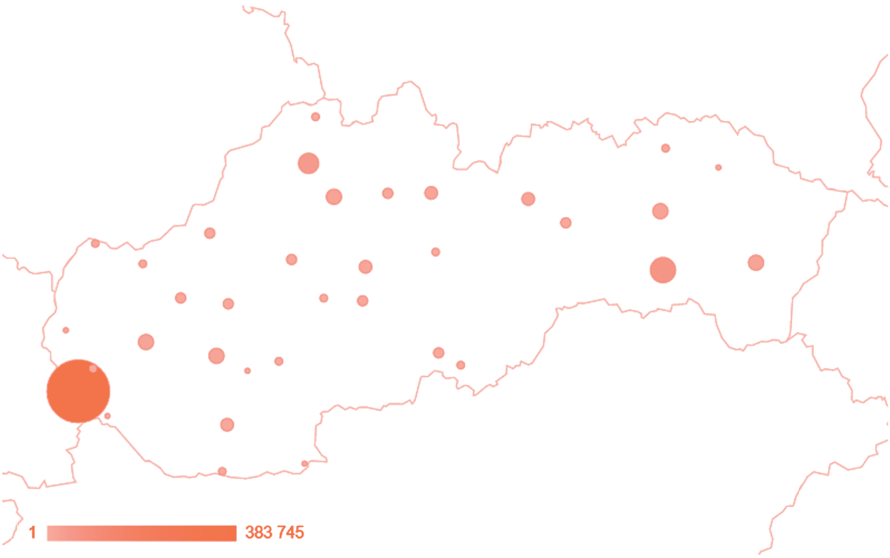


FIGURE C3.1 Number of visits per year from Czech (left) and Slovak (right) towns. Highest numbers correspond to the seats of medical faculties or faculties of health care.

in the same way as in a traditional textbook. It is also not necessary to strictly follow the encyclopaedic style. Instead, some previous knowledge may be assumed, e.g. knowledge of medical terminology, some competencies in basic subjects, etc. The advantage of WikiSkripta compared to Wikipedia is that it has a clearly defined target group: students of medical faculties.

The origin of WikiSkripta dates back to 2007. Originally, it was established as a repository for reusable learning objects. The general idea has remained: education at different medical faculties, and even education in various courses at the same faculty, often needs the same pieces of information. Teachers frequently need to re-arrange such pieces of information and assemble them into a new lecture. It could be useful to have these pieces of information ready-to-use in a repository. At the beginning, teachers, as experts, were expected to be the sole contributors. Since teachers, especially teachers of medical faculties, are extremely busy, students of medical faculties were engaged in the project at the end of 2008 in order to support the teachers.

What happened was fascinating: a couple of students brought so much activity and enthusiasm that WikiSkripta started not only on the path of rapid technical development but also grew very quickly in terms of number of articles. Prior to involving students, the site contained about 100 articles; this number surged to 500 in three months and then to an impressive 1000 mark in 6 months.



Nobody expected in 2008 that the story of Nupedia and Wikipedia would be repeated. In fact, none of the people around WikiSkripta knew the story of Nupedia at that time. But it was exactly so: non-experts, originally supposed to yield support to experts, became the true and powerful contributors and brought new dynamism to the project.

Importantly, a strong community took shape around WikiSkripta. In a few weeks, new methods for maintaining the website, processing articles, communicating with users, etc., were developed by the team. There was strong emphasis on collaboration. Despite the fact that the authorship of any contribution or change is indelibly recorded and anyone can check it, contributors worked 'to improve WikiSkripta' rather than 'to write an article of mine'.

CREDIBILITY

Using wiki for scientific and educational purposes brings some controversies. The concept of a web which is editable by anyone breaks well-established paradigms. Traditionally, knowledge delivered to students is guaranteed by expert-authors and peer-reviewers. In wiki, it is not evident at first sight who is

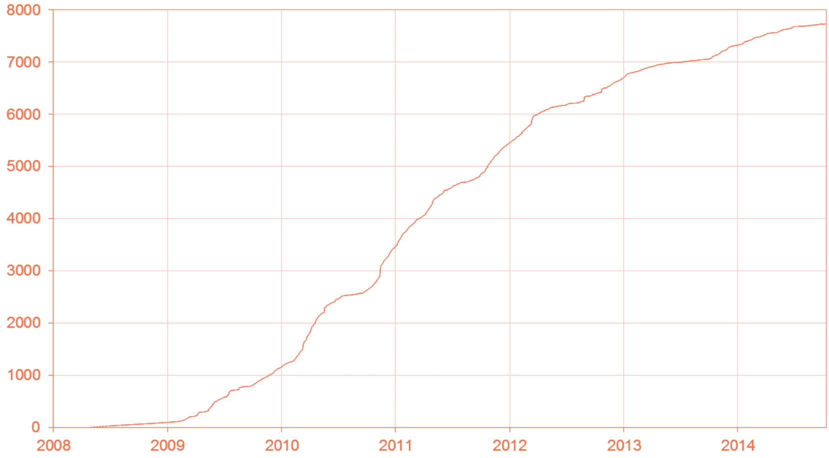


FIGURE C3.2 Number of articles in WikiSkripta from 2008 till now.

the author and which level of expertize they have. Usually, an article was edited many times by different contributors and users (and some edits are sometimes done by a 'robot'). A track of the complete history is kept and anybody can read it, but it is time consuming and users do not check history very often.

On the other hand, the concept of low-threshold is extremely powerful. Any mistake or inaccuracy can be amended very quickly by anyone who can recognize it. Compared to classical textbooks or even traditional websites where the reader must contact the author (which means to find the address, write a letter and send it), this approach is very effective and really leads to continuous improvement of articles. In a wider context, J. Giles compared the accuracy of Wikipedia with Encyclopaedia Britannica in a classical study in 2005 [4]. He concluded that Wikipedia contained fewer flaws than Britannica. Some controversies about the methodology and the study as a whole appeared later, but still it can be said that wiki-based encyclopaedia written by an undefined group of contributors is at least comparably accurate as an encyclopaedia written by top-experts.

In WikiSkripta, articles may be checked by teachers of medical faculties and clearly marked as 'approved'. Users are informed about this feature every time they access the site. Teachers are encouraged to take part in this process but still the proportion of approved articles is about 10 %. Interestingly, more than 60 % of articles were edited by a teacher sometimes during their development.

The fact that the majority of articles in WikiSkripta have not been approved by an expert brings some distrust. In reality, the quality of contributions varies, ranging from those of the quality of the best text books to those which are full

FIGURE C3.3 The first of 'wiki-weekends'—periodic training of students involved in WikiSkripta's team.

of flaws. It can, however, be said that each article is under continuous development. The concept of wiki favours improving rather than corrupting articles: any harmful edit can be reverted by a single click of the mouse. Despite the fact that inaccuracies and mistakes can be found for some time in many contributions, the quality of articles grows invariably.

Moreover, WikiSkripta serves as a mirror of the knowledge of its authors. Notes shared among students and used for exam preparation are frequently full of flaws. Even hand-outs written by teachers and distributed to students as supplementary study materials can contain inaccuracies. When these materials are used for a WikiSkripta article, they become open for review and revision.

Each wiki-based website should be used as a source of information with caution, especially if there was no reviewer who had checked the specific article. However, it does not mean that the content is worthless. In fact, if the article was posted some time ago and was visited by many readers, there were many 'reviewers' and each of them has checked some details of the article. The resulting accuracy can be better than in traditional sources. Unfortunately, you never know whether all important revisions have already been done. On the other hand, the article is live and can be updated according to new scientific results—much faster than any traditional textbook. It is the reader (and only the reader) who must make the critical decision whether the piece of information

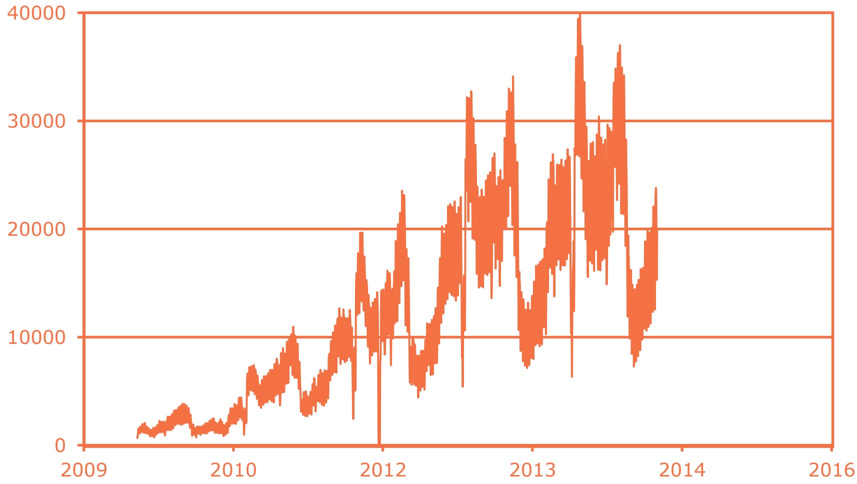


FIGURE C3.4 Number of visitors of WikiSkripta per day. The plot shows typical periodical oscillations: deep valleys correspond to vacations; peaks appear in the exam periods. Most visitors are on Mondays and Tuesdays, least on Saturdays.

is trustworthy or not. This is a weakness of wiki in education—and a big part of the criticism of wikis results from unrealistic expectations. At the same time, this is the strong side of wikis at universities: their use supports critical thinking and evaluation of sources.

'A wiki is not meant to be true, it's meant to be discussed. Wikis are transparent; not only do they show the final product, they reveal the entire creative process. A wiki is one of the tools that are now available to all to become more literate, not only by increasing writing skills but by understanding what this new media literacy really means. They are also a fun and engaging way to develop collaborative and teamwork skills.' [3]

MORE THAN JUST ANOTHER WEB

It seems that WikiSkripta not only helps to spread information in a quick and cost-effective way but has important subsidiary effects too. The non-profit project, based on altruism, attracts enthusiastic students who belong to the best students of the faculty and who are also engaged in the life of the academic community. The project stimulates communication and cooperation among them. Moreover, students taking part at WikiSkripta are encouraged to communicate with teachers.

Communication between the student community of WikiSkripta and people outside the project is quite unique. In many wiki-projects, the community develops its own rules for control of the site that are difficult to comply with for newcomers. In other words, as the project becomes more complex, the community becomes more closed. Tom Simonite characterizes it as 'newcomers unwelcome' [5] and some authors believe that this is an important issue of large open collaboration communities [6].

The advantage of WikiSkripta is that the project is more connected with traditional structures outside it, at least with the medical faculties, and has to comply with their rules. Students are actively trained in positive communication with new contributors, experts and users. WikiSkripta is also actively kept at as low-threshold as possible. Interestingly, the number of newcomers constantly grows.

WikiSkripta is not only an open, free and easily updatable textbook of medicine. It has several other functions and these functions are probably the most important. Participants to the project become familiar with scientific writing, searching for information and critically evaluating it. The 'architecture of participation' [7] brings a shift of learning methods from the traditional model to student-centred learning and social networking. Nevertheless, the education value of articles of WikiSkripta is indisputable and it is still growing. It is reflected by the use of the site: today, about 20 000 unique visitors use the site every day of the semester (which is much more than expected according to the number of medical students in the Czech and Slovak Republics) and this number is doubled during the exam periods at medical faculties.

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▸C4◂

MOODLE COURSEWARE SERVICES FOR MEFANET

JITKA FEBEROVÁ, ALEXANDRA POLÁŠKOVÁ, JAN POLÁŠEK, DANIEL RAJDL

'True genius resides in the capacity for evaluation of uncertain, hazardous, and conflicting information.'
WINSTON CHURCHILL

Summary. MOODLE MEFANET represents courseware services delivered to the MEFANET community with the use of MOODLE learning management system. The services are useful especially in the case of e-learning courses shared by several medical faculties. Besides the fundamental features of MOODLE system implemented into MEFANET, this chapter describes an original approach to evaluating e-learning course quality with the use of a reference framework, including a set of criteria and associated measurable indicators. The presented evaluation model is implemented in the form of a web-based application that delivers useful guidelines for e-course authoring as well as forms for assessing the e-course quality and optional balancing of the applicable criteria.

Keywords:

- learning management system
- virtual learning environment
- quality of e-learning courses
- reference methods and metrics

Reviewer:

- TAŤJANA DOSTÁLOVÁ

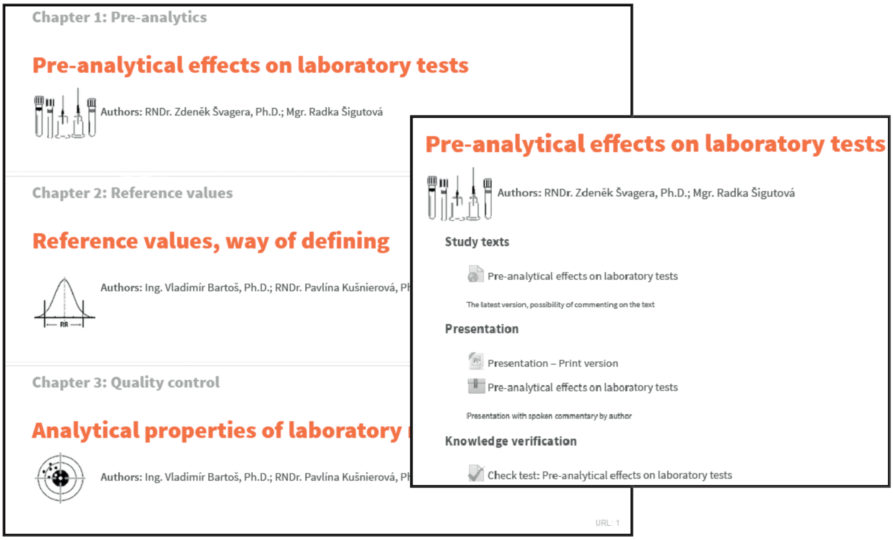

FIGURE C4.1 Lessons of the E-biochemistry course, which was created and is operated within MOODLE MEFANET.

E-learning courses—if designed appropriately—enable educators to apply good didactic principles and to create a comprehensive source of information for students regarding the subject taught. A robust learning management system (LMS) should allow the integration of all available information into individual e-learning courses in the form of links to relevant sources, and to create education materials using inherent system tools. MOODLE, which is an open source learning programme, has been chosen as the platform for the operation and management of e-learning courses within the MEFANET network. The system is operated for all medical faculties in the Czech Republic and Slovakia and here after is referred to as MOODLE MEFANET. It contains a powerful toolkit for e-assessment and subsequent evaluation of test items, as well as a number of tools for collaboration and communication among students or between students and teacher.

The standard MOODLE system has been adapted to the needs of MEFANET; this mainly refers to modification of the MOODLE interface, creation of field categorization relating to the single map of the MEFANET medical disciplines (see the Medical disciplines linker in CHAPTER C1) and implementation of MOODLE's standard modules according to user requirements. MOODLE MEFANET uses authentication services from the eduID.cz academic federation, see CHAPTERS B4 and C1 for details about federated authentication, SAML protocol and Shibboleth technology. The federated authentication ensures that users, who are required to verify their identity in order to use MOODLE

MEFANET services, can log in from their home institution, i.e. the specific medical faculty of the given university.

Many universities operate their own LMS (either MOODLE or other LMS, e.g. various proprietary software products). MOODLE MEFANET services have been created to be used especially in cases when e-learning courses are shared by multiple institutions. One particular example is the E-biochemistry course, which was created within MOODLE MEFANET as an intercollegiate course under the cooperation of five medical faculties. This course completely covers 41 topics of clinical biochemistry for medical students. Each lesson includes instructional text, audio presentation and a self-assessment test, see FIGURE C4.1.

QUALITY EVALUATION OF E-LEARNING COURSES

A unique supporting software application for the authors as well as evaluators of e-learning courses has been developed in order to standardize and improve the quality of e-courses inside MEFANET. This application should help all novice as well as experienced authors as it offers an extensive system of criteria and also the ability to adjust the weight of each criterion according to the focus of the e-course.

QUALITY CRITERIA AND EVALUATION MODEL

The quality criteria is based on a reference framework (recommended guidelines), which was created pursuant to ISO (International Organization for Standardization) standards developed in the field of distance learning, reference methods and metrics. This framework allows setting up a classification system for outlining the basic criteria for categories that should cover the whole area of e-learning course quality evaluation. Five main categories were defined for the evaluating criteria and further divided into several sub--categories, see TABLE C4.1.

Each category and sub-category in TABLE C4.1 contains criteria pertinent to the given area and several associated measurable indicators. Based on this framework that integrates all the criteria as well as the associated indicators, an evaluation model for assessing the quality of e-learning courses was composed. The evaluation model is divided into seven phases (needs analysis, course planning, course design, course implementation, learning process, validation) according to the common education process supported by e-learning (planning, course run, evaluation) and is also based on the international ISO standards [1, 8].

TABLE C4.1 Reference framework for quality evaluation of e-courses created and operated with the use of LMS system.

A. PEDAGOGICAL ASPECTS	**D. MANAGEMENT**
A.1. E-course description	D.1 Strategy and management
A.2. Content quality	D.2 Human resources
A.3. Didactic parameters	D.3 Institutions
B. TARGET GROUP—COURSE RECIPIENTS	**E. VALIDATION**
B.1 Analysis of target group	E.1 Evaluation
B.2 Motivation of participants	E.1.1 Evaluation of the e-course by students
B.3 Rate of demandingness	E.1.2 Evaluation of the e-course by opponents, experts.
C. TECHNICAL SOLUTION	E.2 Revision
C.1 Learning environment	E.2.1. Management adaptation
C.2 E-course graphical interface	E.2.2 Content updating
C.3 Technical requirements	
C.4 Manuals	
C.5 Availability of materials	
C.6 Multimedia Functionality	

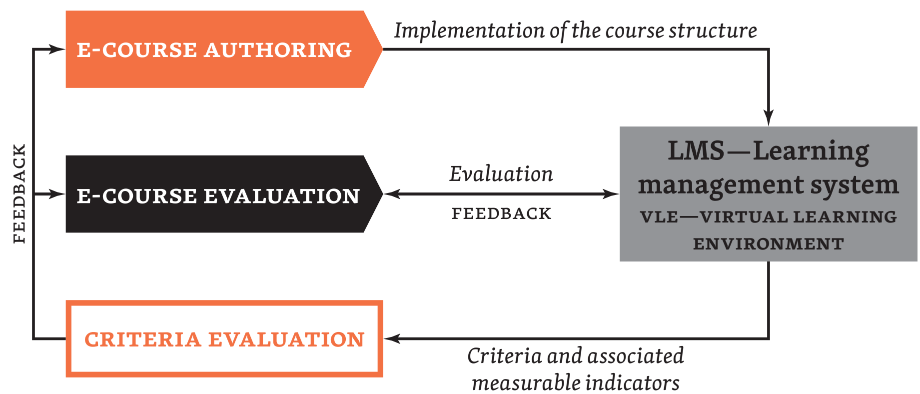

FIGURE C4.2 The basic scheme of the application implementing the model for e-course quality evaluation.

MODEL IMPLEMENTATION

A software application that implements and completes the evaluation model has web interface divided into three main parts (see FIGURE C4.2), focused on the following areas.

1. How to create an e-course (theoretical instructions and useful examples);
2. Quantitative evaluation e-course quality;
3. Criteria balancing.

PART 1—HOW TO CREATE AN E-COURSE

The first part of the application contains four sections: (i) The basic steps of e-course development; (ii) Preliminary information about an e-course; (iii) Introduction to an e-course; (iv) Introduction to a lesson.

(1.i) The basic steps for authoring an e-course.

This section contains steps according to which the author should proceed in order to meet the recommended guidelines for achieving the high quality according to the evaluation model: (A) Needs analysis; (B) Course design; (C) Tools for e-course authoring; (D) E-course evaluation.

(1.i.a) Needs analysis

In the first step, needs analysis should be conducted; it is necessary to 1) specify the objectives, 2) analyse the needs of the target group, 3) analyse the technological demands on an e-course and particularly ascertain whether 4) the institution providing a particular e-course has sufficient qualification resources to run it. The TABLE C4.2 describes the individual parts of the needs analysis.

(1.i.b) E-course design

The second step—e-course design—is divided into individual parts that are directly focused on e-course planning and implementation (see TABLE C4.3): 1) learning outcomes, 2) e-course structure, 3) lesson structure, 4) organization, and 5) adaptation and sustainability of the e-course.

(1.i.c) Tools for e-course authoring

The available tools for developing learning materials and activities as well as the associated teaching practices and methodology are described in TABLE C4.4.

(1.i.d) E-course evaluation

Evaluation should be an integral part of any e-course. The guidelines for evaluating an e-course are summarized in TABLE C4.5.

TABLE C4.2 How to create an e-course—the basic steps—needs analysis

Specification of objectives	The objectives of the e-course are based on its learning outcomes. They contain information on the knowledge and skills that the participants will attain upon completion. They are formulated from the perspective of the participants in the e-course; the verbs used should reflect the level of knowledge the participants should achieve. The objectives correspond to the specific competencies that the participants will gain. The objectives must be measurable and verifiable.
Target group	The requirements and needs of the target group must be taken into account when designing an e-course. The e-course is organized according to the education needs of the target groups, based on their professional orientation, past experience and the possibility of increasing qualification. The e-course content reflects the education needs of the target group based on previous analysis of this target group. Any inhomogeneity of the target group should be balanced by individual learning plans.
Technical requirements	Technological solution of the virtual learning environment (VLE) is the result of the overall analysis developed on the basis of the requirements and needs of the target group, and on the basis of available personnel resources, the defined education goals and the assessment possibilities. VLE is provided to the participants using a specific LMS system. All its modules and programmes should be compatible and interoperable between LMS systems commonly used.
Provider	The institution implementing an e-course has sufficient background in the provision of education and technical support for running the e-course. The institution implementing the e-course has implemented standard procedures, which encompasses the design, creation and implementation of the course. This institution is authorized (through accreditations and certifications) for providing the specific education.

TABLE C4.3 How to create an e-course—the basic steps—design.

Learning outcomes	Individual teaching blocks include the objectives and outcomes that students should achieve after completing the lesson. They are relevant to the topic and content focus of the e-course. Learning outcomes set out what is to be achieved in the e-course and how it will be measured and assessed. The learning outcomes are based on the e-course objectives and requirements of the target group. They correspond to the output competencies targeted at the participants.
E-course structure	The e-course is logically structured into smaller units (modules, lessons) and composed of several learning objects that relate to the overall focus of the e-course. The e-course content is designed to achieve the learning outcomes in the context of acquiring new knowledge and skills (competencies) in a logical structure. Organization and sequencing of the learning objects is relevant to the e-course content and the target group. Single topics relate to the main theme and have a fixed structure.

TABLE C4.3 *Continue*

Lesson structure	Lessons are broken down into several items with simple navigation: 1. Introduction: lesson summary, expected learning outcomes, organizational instructions, details about the author and tutor. 2. Time schedule of lesson activities. 3. Lesson objectives. 4. Learning materials (Preferably, the learning materials included in the e-course should have cross-platform format. This can be achieved by authoring the materials directly inside the VLE or the PDF format can be used as well. Learning materials that are technically more demanding, such as digital videos, should be stored at external sites (e.g. a video-streaming server), and included in the lesson in the form of links. 5. Acquired knowledge assessment. 6. Communication tools. 7. Lesson evaluation.
Organization	E-course participants should obtain precise organizational instructions, such as the time schedule, terms and conditions required to complete the e-course, information about tutoring when available, etc. This information has to be available before the e-course starts as well as during its run.
Adaptation and sustainability of the e-course	The e-course should be peer-reviewed by a qualified expert in the field before its start. All functionality of its elements should be tested, updated and revised regularly. The selected VLE should provide the same functionality in all widely supported internet browsers. The e-course sustainability refers mainly to its interoperability, i.e. it should meet the available standards, such as SCORM, AIC, IEEE.

TABLE C4.4 How to create an e-course—the basic steps—authoring tools

Methodology	The e-course contains a description of the applied teaching methods and didactic procedures. The choice of the pedagogy approach (i.e. teaching methods and didactic procedures) should be related and appropriate to the predefined e-course objectives. E-course participants must understand the benefits of the support in terms of technology-enhanced learning. VLE as well as all the linked resources (multimedia such as digital videos, flash animations, etc.) have to be properly described. The importance of the learning activities taking place through synchronous and asynchronous communication must be clearly explained. The methods of blended learning should be adequate to the target education level of the students, reflecting the needs of students as well as the focus of the e-course. The learning activities based on collaborative work (team-based learning, discussion forums, etc.) are properly planned and organized as an integral part of the e-course..
Learning materials	The learning materials have to be available—any broken links should be avoided. This requires special attention to the learning materials referenced as external resources. The e-course design should clearly distinguish learning materials that are mandatory, recommended and optional. Any copyright infringements must be avoided.

TABLE C4.4 *Continue*

Learning activities, communication and collaborative tools	It is necessary to clearly explain the expectations from any type of learning activity included in the e-course design. The deadlines and penalties have to be defined clearly. The learning activities should be always presented such that they encourage the participants in their learning efforts. LMS or VLE should provide communication and collaborative tools such as discussion forum chat, blog and should support group work activities, such as wiki or workshops. Further, it has to provide a search functionality covering all communication and collaboration activities done during the e-course run (tasks, assignments, discussion forums, chats, blogs).
Evaluation	At the beginning of the e-course, all participants have to be aware of the final assessment method. The number of evaluated activities and the time for their fulfilment should be reasonable. Assessment methods and tools are adequate and appropriate, and relevant to the focus of the e-course content (learning outcomes) and the target group. The difference between continuous assessment using tasks and tests, evaluation of collaborative work and the final assessment in the e-course is clearly defined and explained. The criteria for evaluation (e.g. in the case of collaborative work, participation in discussions) should be always available for e-course participants. The participants are given instructions that describe and explain the tasks (what has to be done, the time frame, and the expected results), the assessment tests as well as the procedure for evaluating the tasks. The tests of knowledge assessment are linked to the learning outcomes, their items are measurable and their content is reasonable. The assessment tests are compiled in accordance with the e-course objectives and its focus; they correspond to the abilities and skills of e-course participants. Their items are measurable, in order to indicate the level of achieving the learning objectives. All evaluated activities are monitored and recorded. Participants' performance is regularly monitored in order to uncover any need for special support during the run of the e-course.

TABLE C4.5 How to create an e-course—the basic steps—evaluation

Methods and types of evaluation	At the end of an e-course, the overall evaluation focuses on the course quality. Feedback from students is collected through questionnaires and other tools. E-course evaluation should cover the following items. 1) Design (used methods, pedagogical approaches, navigation, structure) 2) Management (time schedule and workload, marking policy, testing, tutoring, ability to motivate students, feedback provision and support for participants, collaborative activities versus individual activities, tasks) 3) Content (relevant education content), learning objectives, tests and examples, case studies, discussions, additional learning resources, course documentation, tutorials, course syllabus, information leaflet on the course 4) Multimedia and technical support (registration, accessibility and user experience in virtual learning environment, download time, etc.)
Overall evaluation of an e-course	A report should be composed as a result of the overall evaluation of the e-course quality. Developed on the basis of opponent reviews, expert opinions and the data obtained from feedback forms filled by participants, the report should include recommendations for improvements and innovations for the next run of the e-course. The recommended improvements and innovations should be related to: 1) e-course design, 2) e-course content, 3) linked multimedia and other resources, 4) e-course management and technical support.

PART 2 — QUANTITATIVE EVALUATION OF E-COURSE QUALITY

Quantitative evaluation of e-course quality is divided into different areas covering the proposed evaluation framework. The final score report also includes the possibility that a particular criterion is not suitable for evaluating the given e-learning course, see FIGURE C4.3.

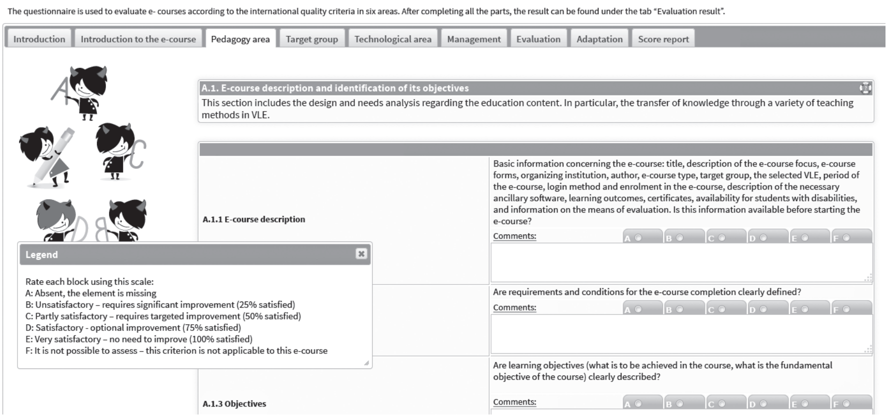

FIGURE C4.3 Qualitative evaluation of an e-course quality.

PART 3 — CRITERIA BALANCING

Within further development towards improving the quality of e-courses, the application, which implements the evaluation model, also comprises an option focused on balancing the criteria applied, i.e. assigning weights to particular evaluation criteria based on the Fuller method of multi-criteria decision making. FIGURE C4.4 shows an example of determining weights for individual criteria and its comparison with other criteria evaluated in the particular e-course.

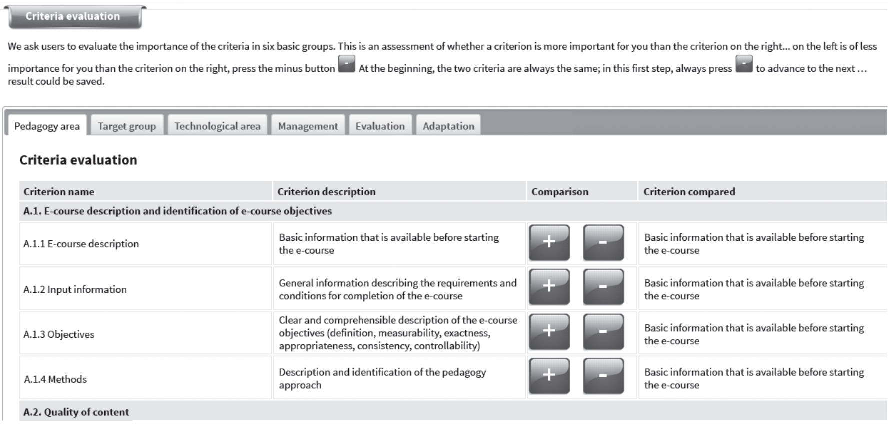

FIGURE C4.4 Criteria balancing.

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▸C5◂

THE OPTIMED PLATFORM: INNOVATIVE TOOL FOR CURRICULUM MANAGEMENT

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JULIE BIENERTOVÁ VAŠKŮ, MARTIN BAREŠ, JAROSLAV ŠTĚRBA, JIŘÍ MAYER

'Harmony makes small things grow, lack of it makes great things decay.'
SALLUST

Summary. The need for a well-balanced curriculum, particularly in medical education, is indispensable. Today, a comprehensive platform that would encompass all necessary instruments for easy in-depth curriculum management remains lacking. Our proposal is a web-oriented platform, which is built on learning outcome paradigm and means a fundamental paradigm shift in the curriculum design for many higher education institutions. The implications of this work can help academics in curriculum reengineering activities and provide a clear overview of the curriculum structure. The presented concept has been developed for the potentially perpetual process of specification and subsequent updates of the curriculum, making it possible for its users to describe the education as effectively and as easily as possible.

/ **Keywords:**

- curriculum management
- web-oriented system
- outcome-based approach
- medical education
- OPTIMED project

/ **Reviewer:**

- JIŘÍ HŘEBÍČEK

MEDICAL CURRICULUM PLANNING

Nowadays, higher education institutions use various technologies to manage different aspects of their daily activities, but none exists for managing the curriculum, despite it being a fundamental activity [1]. Leading representatives of many academic institutions, involved stakeholders as well as the curriculum designers have realized the key role of correctly compiled courses in effective delivery of educational programmes. The need for guaranteed and high-quality curriculum, particularly in medical education, is essential because medicine does not allow any gaps in the knowledge obtained during studies and any error in medical practice may lead to fatal consequences. As modern Information and Communication Technologies (ICT) has seen rapid development, it can now be used for putting forward many innovative tools, which would not only eliminate the poor transparency of curricula but also help to improve teaching as such. The main objective of this chapter is to introduce a web-oriented system, including the planning model, for performing reasonable innovations in the organization of education process, specifically in medical fields. The motivating factor here is the prevailing frequent overlaps in the presented topics as well as by the subjective approach to these topics by different teachers. The mentioned overlaps might be desirable in some cases and undesirable in others. As in other fields and academic institutions, it is also evident in medicine that the overview of the lesson structure and content is not ideal and it often happens that the overlap between theoretical and clinical subjects is either too large or, on the contrary, rather insufficient. Anyway, considerable differences in teaching materials and lectures may emerge in this way resulting in lower clarity and poor comprehension for the students. This is particularly true of medical students who face specific challenges compared to students studying other fields at universities. The reason is that their future job places high demands on the level of knowledge they are expected to achieve, putting great pressure on avoiding errors.

METHODICAL BACKGROUND

The methodology behind our system is based on published solutions and expert attitudes to medical curriculum construction. The Bergen ministerial conference of the Bologna Process in May 2005 discussed reforms concerning degree structures, credit transfer, quality assurance and curricular development, which are transforming the European Higher Education Area. The European tertiary education systems are undergoing radical restructuring in line with the objectives defined by the Bologna Process. Design and structure of new curricula constitute significant change processes and require cooperation and coordination [2]. The entire concept is oriented to the new paradigm according to the conclusions of the Bologna process, which advocates outcome-based education. This performance-based approach at the cutting edge of curriculum development offers a powerful and an appealing way of reforming and managing medical education. Emphasis is on the product—what sort of doctor will be produced—rather than on the education process [3]. Generally, learning outcomes define a set of knowledge and skills that are essential for a student who has finished a specific course/semester/year/field. There appears to be an interesting opportunity for combining outcome-based approach with the relevant application of new technologies, which provides an interface for complex web-oriented system over all available curriculum metadata. Such platform provides essential support during institutional decision-making activities related to the creation of a well-balanced curriculum and also offers innovative presentation of the curriculum itself. For students, such an overview presents a clearer picture of the knowledge he/she is required to acquire during the specified study period, the topics that shall be encountered during the lessons, the areas that shall be repeatedly emphasized and the specific courses linked to a given topic. For teachers and the faculty management, such system enables to effectively administer the concerned education processes, clearly shows who teaches what and to what extent, whether the lectures of individual teachers overlap thematically, whether the overall teaching schedule is appropriate, or whether a certain reform of that schedule would be convenient and helpful.

TECHNOLOGIES FOR CURRICULUM MANAGEMENT

Currently, literature overview shows that the existing web-oriented environments providing miscellaneous functions to help teachers and tutors choose which activities add to their course based on intended learning outcomes for the relevant courses, including the link to assessment agenda [4–10]. These systems are only partially able to cater for the needs of the today's tertiary education. This is due to the fact that the current structure of education domain and harmonization requirements is quite diverse. This is one of the reasons why the issue of innovation has been confronted in many fields as a mere tertiary field by different academic institutions, as the analysis of the current global situation indicates. However, today a coherent solution that would cover user-friendly tools for easy in-depth curriculum management is still missing. In general, published solutions focused on outcome-based curriculum are limited to

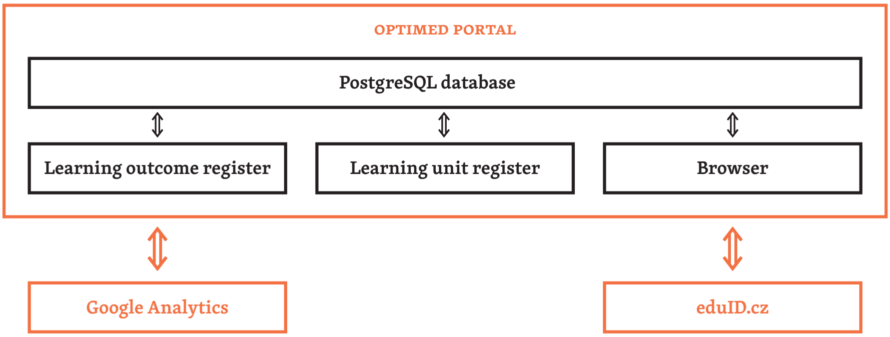


FIGURE C5.1 The OPTIMED platform modular structure.

FIGURE C5.2 Data grid component used in both registers.

a certain perspective, offering the agenda together with selected functionalities (learning outcome management, comprehensive assessment, grades assignment, analytics, reporting, curriculum mapping, etc.) and making an effort to provide them to students and teachers of the respective institution in a transparent format. We aim to make the curriculum guaranteed and more transparent, including approved control mechanisms in the form of deep curriculum inspection. Here, we propose a system that is built on the learning outcome paradigm—i.e. an approach that implies a fundamental paradigm shift in the curriculum design for many higher education institutions at European level [11].

ENGINEERING AND DEVELOPMENT

Software development approaches are continually improved by the need to ensure the best quality of the final product and of course, to save costs during development [12]. Engineers, managers, and other stakeholders are facing these challenges at different levels. We have adopted the Extreme Programming methodology [13], which is a popular method in agile software development. Based on the gathered requirements, a modular structure of the system was proposed (see FIGURE C5.1), where each independent module provides separated functionality according to its use in practice (e.g. content management or search focus): a) Learning outcome register, b) Learning unit register, c) Browser.

The first two modules were built on the data grid component (see FIGURE C5.2), which makes outcomes and units accessible and manageable for curriculum experts. Further, it also offers advanced search and filtering. The Browser module is a search engine designed to present searched results in a clear link to the curriculum. The administrative agenda of the portal covers public information about project intentions, the main goals, the related documents and also the discussion groups.

We used a number of technologies and components during the development process, which rendered easy implementation afterwards. The web-oriented architecture runs on the most-used and widespread web servers—either an Apache server or a Microsoft Internet Information Server (IIS). We use Linux/Ubuntu and Windows Server operating systems for proven performance. All the tools were developed with the use of PHP (version 5.3.10), XHTML, CSS2, JavaScript, AJAX and PostgreSQL. We have also acquired the services of third party frameworks, such as jQuery (JavaScript library used for easier development of web-centric technologies), CKEditor (WYSIWYG text and HTML editor designed to simplify website content creation) and DHTMLX components (JavaScript grid control provides cutting-edge functionality, powerful data binding, and fast performance with large data sets) [14].

The system itself is built on the most widespread software architecture for the today's world web applications, called Model-View-Controller (MVC). This original concept is conceived as a general solution to the problem of users controlling large and complex data sets [15]. The main idea consists in separating an application into three parts, which represent the core functionality: model, view and controller. In order to guarantee a fully debugged final product, we have maintained two separate domains—development and production environments. The environments themselves are nothing more than the sites on which scripts and data reside, including the appropriate servers plus whatever else may be necessary for the scripts and data [16]. The development environment

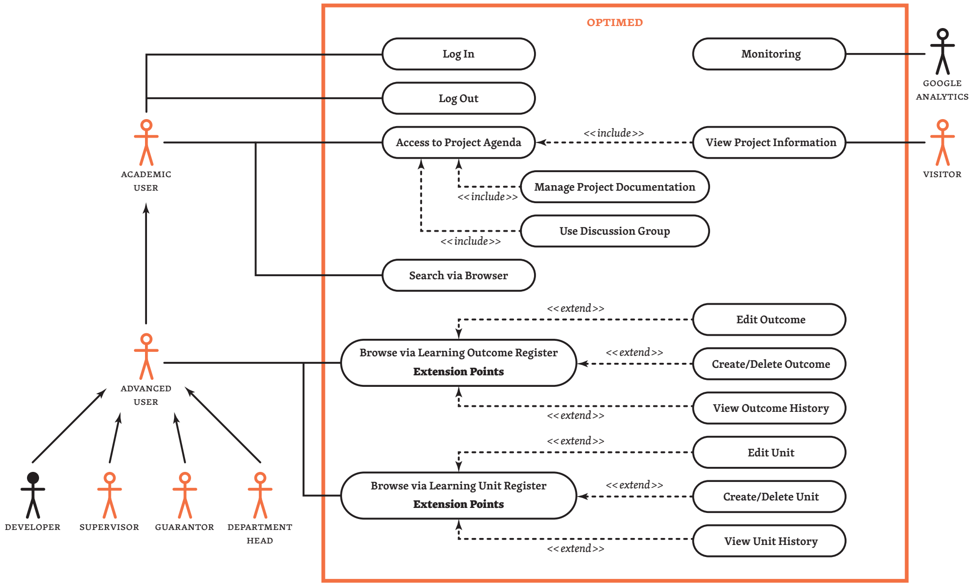


FIGURE C5.3 Use case diagram describing the interactions with the end user or another system.

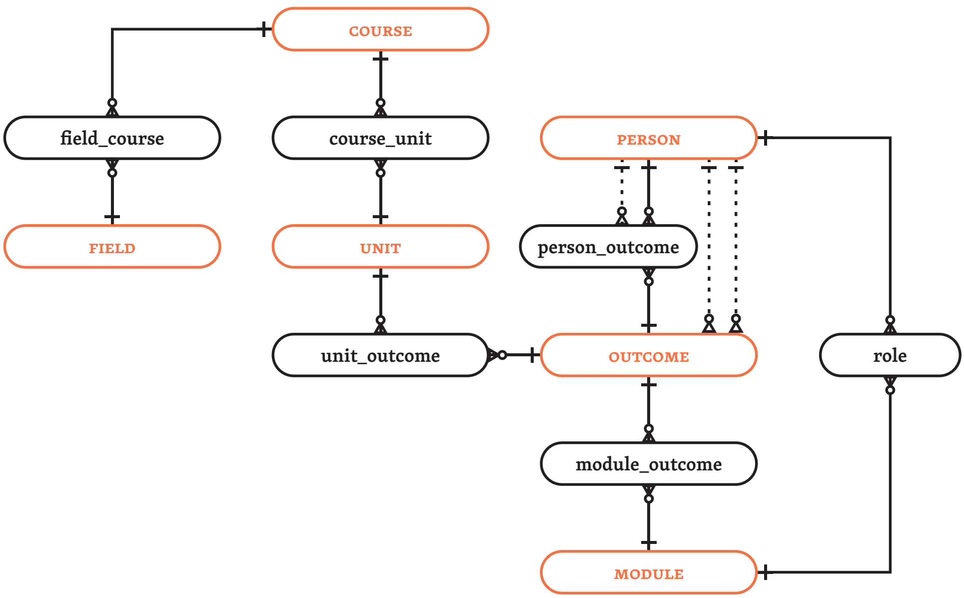


FIGURE C5.4 The simplified proposal of a formal database metadata arrangement describing the curriculum independent of subsequent implementation.

is inaccessible to the public but wide open to all developers and it is dedicated to the phase of testing and measuring the performance characteristics. The production environment is the final endpoint in the release process and always hosts only those applications that have previously undergone the phase of in-depth testing. Unfinished or preliminary versions of applications and data should never be placed here. We have also used GitLab open source software for transparent and safe collaboration on code. It enables developers to work jointly on public or private projects, manage access rules to repositories and perform code reviews. All phases of the system development adhered to the recommended rules and declared standards.

SYSTEM ACCESSIBILITY

The proposed web-oriented system was intended primarily for academic staff (students, teachers and faculty management). To make this platform accessible on the Internet, it has to be equipped with a robust authentication/authorization framework. Thus, federated authentication and authorization services provided by eduID.cz federation [17] was employed. This third party server application is used for central authentication process, which establishes user identity trust and authenticity between disparate universities. The Czech academic identity federation eduID.cz fully provides the means for inter-organizational identity management and access control in tertiary education. The federation is based on one of the available tools for web single sign-on process, named Shibboleth [18]. The primary goal consists in the application of web single sign-on (SSO), which ensures users to access multiple applications using just one password that is generated and used by the users within their home institution [19]. Authentication represents a verification process that someone or something is, in fact, who or what it is declared to be ('I am who I say I am'). The authorization serves to ascertain if the person, once identified, is permitted to have the resource or to do the operation ('what I can see or do based on what my role is') [20]. These federated services are necessary for creating a secure and trusted technology infrastructure for sharing and using information by individuals at multiple locations, see details in CHAPTER B4.

The basic user roles were identified and classified into two groups—visitors (users without authentication) and academic users (users with authentication). The group of academics includes students, teachers, curriculum designers, guarantors and developers. Curriculum designers play an essential role, as they are responsible for the quality of curriculum description including definitions of input knowledge and skills required in subsequent practice. An access control list (ACL) represents a powerful tool for expressing access control policy in terms of the way in which we clearly described the permission attached to any entity involved. The key issue is transparency in the definition

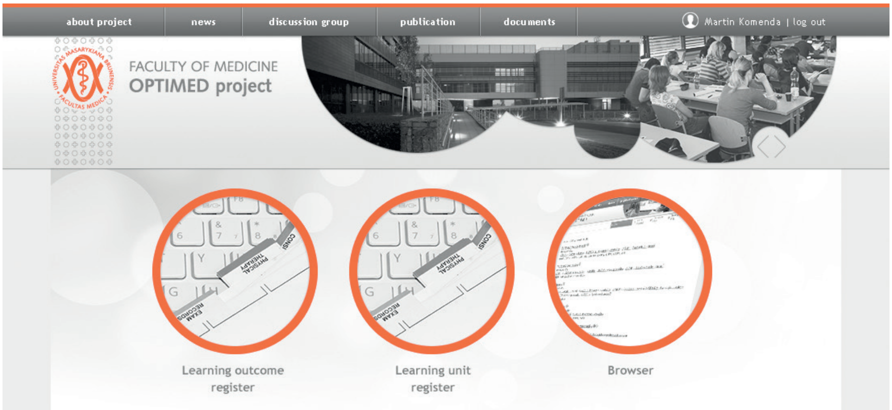


FIGURE C5.5 Screenshot of the homepage of the curriculum management platform implemented at the Faculty of Medicine, Masaryk University, Brno: the OPTIMED project.

TABLE C5.1 The summary of the curriculum of involved case study.

	General Medicine
Total number of modules	4
Total number of courses	144
Total number of learning units	1347
Total number of learning outcomes	7063
Total number of teachers and guarantors	385
Total number of students	over 2000

of access control mechanisms [21,22]. User security attributes in ACL consist of groups to which the user belongs and the roles assigned to the user. Object security attributes in ACL explain the permissions required to perform operations on the object. The ACL exactly specifies which users or external entities are able to grant access to the specific part of the system, as well as what operations are allowed on a given object. FIGURE C5.3 shows the interactions between particular end users and the system in accordance with the unified modelling nomenclature.

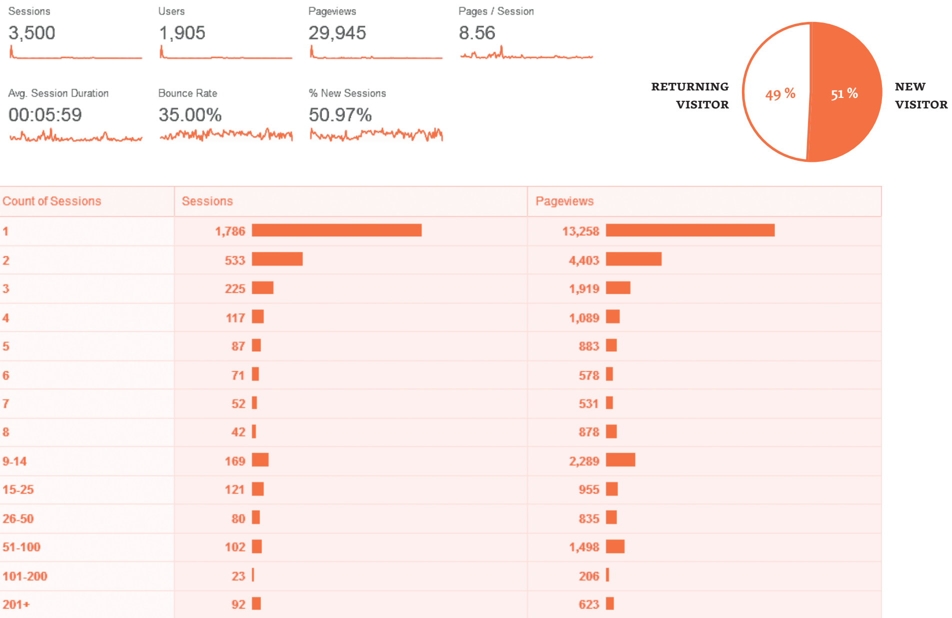
FORMAL DESCRIPTION OF CURRICULUM

As stated above, there does not appear to be any solution for parametrically describing, effectively managing and clearly and in-depth visualizing the curriculum and all related information under one system to date. This is the basic impetus for designing a new original portal for curriculum innovation, which supports an outcome-based approach. A similar solution based on the aforementioned parametric description of curriculum, including all appropriate metadata details (i.e. attributes of learning outcomes, units and objects), has not been widely seen. The benefit of the development is also represented by a new concept resting on the following formal curriculum proposal—a concept that has not yet been implemented in similar solutions [23]. It covers all elements pertaining to global curriculum harmonization, including detailed formal metadata specification down to the level of learning units and interconnections to the learning outcomes. It opens the possibility of reforming the curriculum structure effectively, as all elements are available in the form of parametric description. The organization of the data and its linking are provided in the curriculum model, which can be implemented without any restrictions within any database technology. FIGURE C5.4 describes a simplified conceptual data model of the fundamental attributes in the proposed solution.

IMPLEMENTATION ISSUES AND RESULTS

The portal platform is based on parametric description of the curriculum using outcome-based approach. It provides an interface for curriculum metadata creation and editing, a user-friendly tool for transparent browsing supporting fast and accurate search, and a technology for graphic visualization of the curriculum relations. The pilot curriculum reform and harmonization was implemented in the OPTIMED project (Optimization of Medical Education) at the Faculty of Medicine of Masaryk University in Brno [24]. The primary effort of the OPTIMED project is comprehensive innovation of the General Medicine study field and strengthening of lessons by focusing on the solution, matching the future clinical or academic job of the graduate [14]. A correctly compiled and balanced curriculum across medical fields is an essential prerequisite for medical education. A suitable combination of theoretically focused courses and clinical teaching base is certainly the key to a successful draft curriculum. As in other fields and faculties, also in medicine it is evident that the overview of lesson structure and content is not ideal and it often happens that the overlap of theoretical subjects with clinical ones is too large or, on the contrary, insufficient. The key element of the project is horizontal innovation of compulsory and compulsory-optional subjects taught by the outcome-based approach and modules available within the curriculum management platform (Learning outcome register, Learning unit register, Browser—see FIGURE C5.5).

The OPTIMED strives to create an innovative dynamic platform to make orientation in the lessons easier for students and teachers alike, and make the knowledge and skills of students in practice more efficient. The key parameter



Count of Sessions	Sessions	Pageviews
1	1,786	13,258
2	533	4,403
3	225	1,919
4	117	1,089
5	87	883
6	71	578
7	52	531
8	42	878
9-14	169	2,289
15-25	121	955
26-50	80	835
51-100	102	1,498
101-200	23	206
201+	92	623

FIGURE C5.6 The OPTIMED portal: Google Analytics overview (from 1 April to 1 August 2014).

in the system is its dynamism, i.e. its ability to absorb new knowledge in medicine and incorporate it rationally into patient-oriented learning. The primary task is not radical change in learning, but rather to map the current state at the Faculty of Medicine and allow better orientation and transparency across learning thanks to a suitable choice of ICT [25,24]. TABLE 1 gives the summary in numbers describing the particular study field.

Since 1 April 2014, the OPTIMED system has been fully opened to all students and teachers of the Faculty of Medicine at Masaryk University. Depending on various user roles in accordance with the access control list, academics are able to use individual modules for global curriculum overview and also for managing the learning units and all descriptive attributes such as annotation, meaning, MeSH keywords or related learning outcomes. We have integrated Google Analytics—a 3rd party service that measures and generates up-to-date statistics, reports and analyses based on the traffic and visitor's behaviour. FIGURE C5.6 demonstrates the latest Google Analytics summary overview, where audience behaviour is reported.

DISCUSSION & CONCLUSIONS

The OPTIMED project represents a pilot curriculum reform activity using an outcome-based approach. In this project, a brand new and original harmonization system within tertiary education was developed by adopting approved methodical background and using modern development trends. The presented platform helps academics in their curriculum reengineering efforts, as it provides a transparent overview of the curriculum structure. We proposed a system for curriculum innovation that has been successfully implemented into practice in the General Medicine field of study. Its primary objective is to make all efforts expended by users more efficient, as regards the creation, editing and control mechanisms in the form of deep content inspection. It is used in practice by senior teachers and professional guarantors within the content inspection of medical curriculum. The target group of the proposed system involves the broader academic community: primarily students, followed by all teachers and the faculty management. The basic idea is to create an innovated, elaborated and dynamic system based on the above-mentioned concept of standardized definition of the learning outcomes.

ACKNOWLEDGEMENTS

The authors were supported from the grant project OPTIMED—OPTImized MEDical education: horizontal and vertical connections, innovations and efficiency in practice reg. no: CZ.1.07/2.2.00/28.0042, funded by the European Social Fund and the state budget of the Czech Republic.

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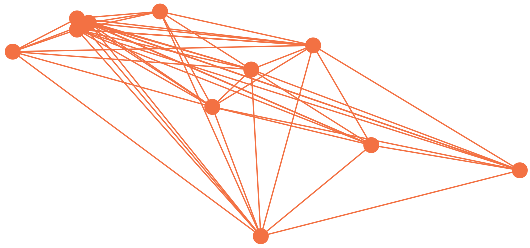
D1 FACULTIES OF MEDICINE

The MEFANET network covers all medical faculties based in the Czech Republic and Slovakia, and it is driven by the MEFANET Coordinating Council, which is composed of representatives of all participating members. The MEFANET project is a voluntary initiative, which promotes equal and unbiased cooperation among the medical faculties. It 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 faculties. This inter-university project was accomplished as early as in 2006. The network of medical faculties (MEFANET) was finally established on 20 June 2007 at the constitutive meeting of the Coordinating Council in Prague. In 2012, the health care faculties joined MEFANET and they are coordinated by an independent Health Care Sciences Coordinating Council (see CHAPTER D2).



‣D1.1‹

MASARYK UNIVERSITY, FACULTY OF MEDICINE

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Kamenice 5
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- Assoc. Prof. Ladislav Dušek, PhD
- Daniel Schwarz, MSc, PhD
- Martin Komenda, MSc

/ **Representatives in the MEFANET Coordination Council for health care sciences:**

- Assoc. Prof. Miroslava Kyasová, MSc, PhD

© Jakub Gregor, MSc, PhD

ABOUT THE UNIVERSITY/FACULTY

The Masaryk University was founded in 1919 and proudly bears the name of T.G. Masaryk, the first President of Czechoslovakia. It is the second largest university in the Czech Republic with more than 43 000 students. Today, the University comprises of over 1200 fields of study at nine different faculties—Law, Medicine, Science, Arts, Education, Economics and Administration, Informatics, Social Studies, and Sports Studies. The University premises is primarily concentrated close to Brno's historical centre, with parts of the faculties of natural science, medicine and sports situated in the new campus in the south of the city. The Faculty of Medicine was founded in 1919 as one of the first faculties of Masaryk University. It currently includes 66 institutes and clinics, employing 1077 personnel. The two teaching hospitals (Bohunice and St Anne's Teaching Hospitals) boast a 3000-bed capacity accessible for teaching, giving students excellent opportunities to see a wide variety of cases and thereby, ensuring rich education experience.

At the Medical Faculty of Masaryk University, 8 non-medical departments were established in May 2005: Nutritional Department, Dental Department, Department of Physiotherapy and Rehabilitation, Department of Laboratory Methods, Department of Optometry and Orthoptics, Department of Nursing, Department of Midwifery and Department of Radiological Methods). These departments are responsible for 10 Bachelor's degree and 4 subsequent Master's degree programmes. All types of study programmes are attended by approximately 1250 students.

VIEW ON MEFANET AND ITS ACTIVITIES FROM INSIDE OF THE FACULTY

PROF. ANNA VAŠKŮ, MD, PHD
Vice-Dean for External Relations
Head of the Department of Pathological Physiology
Editing Committee Chair

Digital versions of education works (i.e. textbooks) are ranked at our Faculty in the same way as the works published in printed form. In order to recognize a digital education work as part of author's teaching activities during the career development process, the digital publication must meet the following requirements:

1. The work must be published on the official education web portal of the Faculty, http://portal.med.muni.cz [ISSN 1801-6103].
2. Prior to publishing the digital education work officially, it must go through the standard approval process controlled by the Editing Committee of the Faculty, which selects appropriate reviewers.
3. The header of the digital education work must contain:
   a. names of the authors, their affiliations, phone numbers and e-mail addresses;
   b. names of the reviewers, their affiliations, phone numbers and e-mail addresses.
4. In case of a digital education work by multiple authors, its recognition in their career development process is controlled by the same rules as for similar education works published in printed form.

The above rules were duly approved by the Scientific Board of the Faculty in October 2005 and shortly after they were implemented with the use of editorial processes in the administration interface of the Faculty education web portal—the MEFANET portal instance. Since then, the Editing Committee has discussed selection of reviewers for a wide range of completed digital education works. Quality assessment in printed and digital textbooks as well as setting and monitoring annual editorial plans of the Faculty—these are the main activities of the Editorial Committee—an advisory body to the Dean of the Faculty. The digital textbooks are published especially in cases where it is, in terms of the expected consumption and sale for a particular title, economically unfeasible to publish textbooks in printed form. Currently (August 2014), there are 30 digital education works in the Czech language and 5 such works in the English language published on the Faculty education web portal with the Editorial Committee logo and most of them are available not only for medical students in Brno but for all students of the faculties involved in the MEFANET.

Our Faculty has been coordinating the MEFANET education network since its founding in 2006/2007. With the growing interest of our educators on effective e-publishing of education materials, many important questions and concerns have surfaced. In the first workshops organized by MEFANET at our Faculty, the educators-authors were particularly interested in the ethical and legal issues resulting from the specifics of teaching at medical schools. In the following years, the workshops and other MEFANET events organized at the faculty were focused primarily on quality assessment of digital education materials and the possibilities of their e-publishing. The activities of the MEFANET education network at our Faculty are in synergy with other education projects, such as OPTIMED (Optimization of Medical Education)—the main education project focused on comprehensive innovation of the General Medicine study programme. The innovations strive towards smoother continuity between theoretical and clinical phases of the study and are driven by the need to deliver graduates with 21st century skills. One of the key points of the project is the use of ICT tools, such as comprehensive registries and browsers in parallel with visual analytics, in order to achieve a horizontally innovated structure of compulsory and compulsory-optional subjects. The objective is not a radical change in learning or teaching, but rather exploratory mapping of the current state of the General Medicine curriculum with the prospect of innovations towards more transparent education environment.

ASSOC. PROF. MIROSLAVA KYASOVÁ, MSC, PHD
Vice-dean for non-medical specialties
Member of the MEFANET coordination council for health care sciences

In December 2011, steps were taken to include the Czech and Slovak institutions of tertiary education in charge of non-medical health care professions in the MEFANET network. In February 2012, the Coordination Council of Non-Medical Health Care Professions was established. The members of the Council checked the content of existing learning materials that were published for non-medical professions on the MEFANET portal for various professions. In this context, an independent Group of Non-Medical Health Care Science was established. This group includes the following subgroups: nursing, midwifery, rehabilitation-physiotherapy, rehabilitation-occupational therapy, intensive care, rescue (paramedic), radiology technician, laboratory technician, public health care, bio-medical technician, nutrition therapist, orthotics-prosthetics, optometry-orthoptics, dental hygienist, and health care social worker. Guarantors were nominated for each of the subgroups. The task of the guarantors is to propose publication activities within the electronic learning, which includes proposing the professionals to review the learning materials. The reviewed e-learning texts will contribute to the development of individual professions and will meet the requirements of the Accreditation Committee of the Ministry of Education when applying for accreditation of the education in combined form. The representatives of the individual specialties are addressed now to develop the portal platform for learning materials. The individual non-medical health care professions will be gradually included in MEFANET. Currently, the most learning materials are stored in the nursing subsection.

D1.2

CHARLES UNIVERSITY IN PRAGUE, FIRST FACULTY OF MEDICINE

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- Martin Vejražka, MD, PhD
- Čestmír Štuka, MSc, PhD, MBA

ABOUT THE UNIVERSITY/FACULTY

Charles University was founded on 7 April 1348 by the Bohemian King and Emperor of the Holy Roman Empire, Charles IV. *The First Faculty of Medicine in Prague* has been part of Charles University since its founding, making it the oldest medical faculty in Central Europe. Currently, it includes 80 institutes and clinical departments where it provides the six-year Master's study programme in general Medicine and the five-year Master's programme in dentistry. The faculty also provides Bachelor's study programmes in nursing, medical technology and informatics, nutritional therapy, ergotherapy, physiotherapy and addictology, and also joint Bachelor–Master's programmes in some of these fields. Medicine and Dentistry is taught in the Czech and English languages. Currently, 1700 teachers impart teaching to 4500 Czech and 800 English speaking students. The largest teaching base of the First Medical Faculty is the General Teaching Hospital with 5800 employers and 1900 beds. The hospital is responsible for medical care in the four districts of Prague and in some specialized fields it serves the whole Czech region. The faculty cooperates in the form of joint workplaces with other Prague hospitals

In addition to the significant teaching tasks, the faculty is also an important research center. Thanks to the well-established research workplaces and the scientific staff and the highly amicable research cooperation with the General Teaching Hospital, the First Medical Faculty has been repeatedly evaluated as one of the most effective institution in biomedical research in the Czech Republic. It successfully competes for grant projects and other foundations. More than 2000 titles and original research articles of total IF 23 000 are published per year. About 800 PhD students are engaged in these scientific activities.

VIEW ON MEFANET AND ITS ACTIVITIES FROM INSIDE THE FACULTY

ASSOC. PROF. MARTIN VOKURKA, MD, PHD
Vice-Dean for Study Affairs and Theoretical and Pre-clinical Education
Head of the Institute of Pathological Physiology

The teaching of a dynamic discipline, such as medicine, certainly brings many challenges. Among them, the availability of high quality and mainly up-to-date information for students is one of the most difficult tasks. Lectures and seminars are the obvious methods of presenting the latest information, but they are merely 'fifteen minutes of fame' with low retention. We need something that is constantly and immediately available. We often remind and reproach the students that they have forgotten or even neglected what has been taught/told to them but ... It is very difficult not only to remember but also to give each knowledge the good proportion and the relevant priority it merits. Even the top-ranking textbooks rarely contain the newest information; in addition, they are not always available and sometimes really very heavy ...

Computer aided learning brings an excellent opportunity to overcome these problems. It was true from the very beginning when we started to display our hand-outs and presentations on the newly and proudly prepared web pages of our departments for the purposeful creation of teaching texts and interactive models directly for internet publication, almost on everyday basis.

This brought new problems and challenges for the IT departments as well as for the teaching staff. MEFANET is certainly an excellent response to most of these challenges. It is a functional platform that coordinates with all medical faculties in the Czech and Slovak Republics and not simply cyberspace for sharing education materials. It enables peer reviews, user feedback, and motivates the students, the teachers and the authors to innovate—think, believe, innovate. The interdisciplinary Wikiskripta project is an excellent example of such interaction among teachers and students. MEFANET is dynamic system in the best sense of the word.

Obviously, it is not an 'all-inclusive' method that can totally replace a good and charismatic teacher; however, it gives the teachers more options of working and cooperating with students. We should pursue this method further and expend efforts towards integrating it into our daily professional work and in new teaching and communication methods.

▸ D1.3 ◂

CHARLES UNIVERSITY IN PRAGUE, SECOND FACULTY OF MEDICINE

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/ **Representatives in the MEFANET Coordination Council:**
- Jitka Feberová, MD, PhD

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ABOUT THE UNIVERSITY/FACULTY

The Second Faculty of Medicine (Second Medical School) follows the history of Charles University in Prague, which was established in 1348, and continues the nearly fifty-year old tradition of the former Faculty of Paediatrics of this University. The Motol-based Second Faculty of Medicine offers pregraduate and postgraduate education to students, doctors and other professional staff working in all fields of medicine. About 1000 students are presently studying at the Faculty.

The clinical base of the Second Faculty of Medicine is the Motol University Hospital (http://www.fnmotol.cz), which is one of the largest hospitals in Europe. The total number of beds is approximately 2300, of which 690 are in paediatrics and the remaining 1230 beds are for adults. A total of 800 medical doctors work in the hospital, forming part of the 3000 medical personnel, as well as another 900 employees contributing to the running of the hospital. All departments in paediatrics are highly specialized, and some of their activities are unique in the Czech Republic (oncology, haemodialysis, epileptology, etc.).

VIEW ON MEFANET AND ITS ACTIVITIES FROM INSIDE THE FACULTY

ZUZANA DOBIÁŠOVÁ, MSC
Head of the Library
Editorial Committee

The educational web portal (http://mefanet-motol.cuni.cz), which is part of the MEFANET portal platform, is the main tool for accessing electronic teaching material at our faculty. Within the teaching of Bachelor's and Master's degree programmes, students create WikiSkripta content. The LMS MOODLE-MEFANET is employed as well; for example, it was used to create the 'Nursing Course' encompassing the teaching of the whole subject and also includes author videos available at the Medical Media stream server.

The Second Faculty of Medicine greatly appreciates such MEFANET activities since electronic resources allow teachers to prepare educational resources in formats required by the current generation of students. Our students become familiar with all of these tools within the Medical Informatics course, guaranteeing effective utilisation.

‣ D1.4 ‹

CHARLES UNIVERSITY IN PRAGUE, THIRD FACULTY OF MEDICINE

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ABOUT THE UNIVERSITY/FACULTY

The Vinohrady health care campus started its development in the beginning of the 20th century, then at the city periphery. In 1902, the Emperor Franz Joseph I inaugurated the Vinohrady Hospital as the primary hospital for citizens of the Královské Vinohrady and Žižkov districts. In 1925, the State Health Institute was opened in its vicinity. Both institutions soon started playing key roles in the development of health care in Prague, Bohemia and Czechoslovakia. Prior to the division of the Faculty of Medicine in 1953, both institutions served for training medical students based on the systematic and professional approach of their noteworthy staff.

Our Faculty is the bearer of the tradition of medical studies at Charles University, being one of the four basic subjects taught from its very founding in 1348. As of the academic year 1882/83, the Faculty of Medicine, just as the rest of the University, was divided into two parts—German and Czech. On 17 November 1939, together with all other Czech schools, the Czech part of the University was closed. This temporary cessation of Czech education lasted till 1945. Then, along with the whole of the German University, the German Faculty of Medicine was abolished and its premises were handed over to the Czech Faculty of Medicine. In 1953, the Ministry of Higher Education divided the Faculty of Medicine in Prague into three separate faculties: the Faculty of General Medicine (including stomatology), the Faculty of Paediatrics, and the Faculty of Hygiene. The latter was transformed into the current Third Faculty of Medicine in 1990. The fact that a new independent Faculty of Hygiene was created in 1953 brought about some fundamental changes: this Faculty preserved the basic medical focus, although it specialized in the fields of hygiene and prevention. On the one hand, this specialization enabled to develop all branches of hygiene in our post–war medicine but, on the other, it at the same time restricted and limited the scope of students' realization in clinical practice.

The Third Faculty of Medicine conferred its teaching degrees to many outstanding personalities in the last three years, among the most prominent were: Prof. Zdeněk Neubauer in biology, Assoc. Prof. Ivan M. Havel in artificial intelligence, and Prof. Luboslav Stárka in endocrinology. At the same time, several lectures by well-known foreign specialists took place on the very premises of the Faculty. Let us mention at least the Nobel Prize winner in neurophysiology Prof. J. Eccles, the famous specialist in psychiatry Prof. P. Grof, and the dasein-analytic Prof. Condrau. As proposed by the Scientific Council of Faculty, Sir Karl Raimund Popper (1902–1996), an epistemologist, open society proponent and one of the greatest philosophers of the twentieth century, was awarded the degree of doctor honoris causa in medicine on 25 May 1994. The Third Faculty of Medicine was party in awarding honorary doctorate to one of the discoverers of DNA, the Nobel Prize winner, Prof. James Watson. Likewise, on the occasion of the 650th anniversary of Charles University, we suggested that another Nobel Prize winner, a world-wide known neurophysiologist, Professor Huxley from Great Britain, be also awarded honorary doctorate in 1998.

MULTIMEDIA EDUCATION ALIAS EDUCATION IN ANOTHER WAY

HANA SVOBODOVÁ, PHD
Vice-Dean and head of Department of Nursing
Lecturer at Department of Ethics, Secondary Nursing School,
Institute of Medical Ethics and Nursing
Chief editor of the journal 'Diagnosis in Nursing'

The main education projects focused on comprehensive innovation of bachelor education at the Third Faculty of Medicine, Charles University, are projects developing multimedia study tools placed on MOODLE. One of the first tools introduced the project of developing multimedia education material for teaching the students of the baccalaureate programmes in nursing, physiotherapy and public health care. The material is used in teaching the subject medical nursing. The topic of the project, funded by RP MSMT (2008, 2009), is multidisciplinary care of patients with cardiac diseases. The motivation behind developing the project was the necessity to rationalize the teaching process, particularly in part-time baccalaureate programmes, and the fact that some medical fields develop rapidly and it is not appropriate or technically feasible to teach many bedside examination and nursing procedures. We have to respect the condition and feelings of the patients in various types of facilities, namely the teaching hospitals.

With the FRVŠ 2012 project, the authors managed to create multimedia teaching aids for teaching nursing practice in intensive care. They focused on the issue of hygiene care for comatose patients, which includes not only the actual execution of this demanding performance but with the help of digital videos to acquaint with the various stages of the exercise, the importance of respecting the principles of barrier nursing care, prevention of damage to the musculoskeletal system and the prevention of immobilization syndrome in immobile patients. In the teaching of nursing in intensive care, there are only a handful of multimedia visual teaching aids and it is often impossible in such patients to practically demonstrate hygiene care—the large number of students and serious condition of patients. The combination of image and text allows students to realize the situation in intensive care and thus, be more practically and emotionally prepared for this environment when in actual practice.

Since 2011, we have been using MEFANET for medical students in 'Introduction to clinical medicine' with many presentations on the basic nursing procedures and also as an interactive method of teaching during their placement in community care facilities (first year of study) and in the practice of intensive care in hospitals (second year of study).

‣ D1.5 ◂

CHARLES UNIVERSITY IN PRAGUE, FACULTY OF MEDICINE IN PLZEŇ

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- Assist. Prof. Martin Navrátil, MSc
- Petr Míka, MSc

ABOUT THE UNIVERSITY/FACULTY

Charles University (Karlova univerzita) was founded in 1348 and is one of the world's oldest universities. It is not only the largest but also the most famous and best internationally assessed Czech university. The university has over 7900 employees, including nearly 4500 academic and research workers. It educates over 53 000 students (which is roughly one-sixth of all students in the Czech Republic) studying in more than 300 accredited degree programmes in 642 fields of study. At present, the university comprises 17 faculties spread over Prague, Hradec Králové and Plzeň; five of them are faculties of medicine, one of which is in Plzeň. The Faculty of Medicine in Plzeň was founded in 1945. From humble beginnings, the Faculty of Medicine in Plzeň has developed into a modern university that already produced almost 10 000 practitioners operating across the country as well as abroad, and 500 bachelor graduates. Currently, more than 2000 students are studying at the faculty, including approximately 500 foreigners. One of the most important actual events from the life of the faculty is the completion of its new building of theoretical institutes and biomedical research centre.

VIEW ON MEFANET AND ITS ACTIVITIES FROM INSIDE THE FACULTY

ASSIST. PROF. LUKÁŠ BOLEK, MD, PHD
Head of the Department of teaching and IT application (OVAVT)

The history of e-learning at the Faculty of Medicine in Plzeň began with teaching of the basics of computer engineering, roughly 22 years ago. Throughout this period, the training of computer engineering was an integral part of teaching biophysics. About 16 years ago, the Institute of Biophysics established the Department of Computer Engineering Education and Applications (OVAVT) whose task was mainly to develop e-learning, initially in the field of IT, and then gradually in almost all areas of education at the Faculty of Medicine. Shortly after the formation of OVAVT, its team presented 'The system of gradual development of e-learning at the Faculty of Medicine in Plzeň'. The basic idea behind this system was to introduce and use uniform educational support for e-learning (LMS), not only to support all types of studies but also the education of academic as well as non-academic staff of the faculty. Education of the two groups, i.e. both students and employees, was considered important in the context of maintaining the mutual level of knowledge, especially in the field of modern electronic communication and presentation techniques and, of course, also in the field of information retrieval and processing. After all, this applies today more than ever. In 2003, for these purposes and on the basis of consensus within the university, all faculties of Charles University were recommended to adopt the MOODLE system, inclusive of our faculty. For us, this step was the first turning point that led to the first actual E-learning courses. The system was then systematically used and further developed thanks to the efforts of OVAVT workers.

Another turning point in the field of e-learning was the entry of the Faculty of Medicine in Plzeň into the MEFANET project in 2007; this project aimed at developing a single and common platform for creating and sharing electronic education materials among all medical faculties in the Czech Republic and Slovakia. The project, focused mainly on developing the MEFANET infrastructure network, was then financially supported by OPVK (2009–2012). It, thus, received the financial support for all medical faculties in the Czech Republic outside Prague and significantly helped stabilize and develop the MEFANET network. Before the funding of this project was closed, OVAVT workers prepared the project OPVK 'MODIM' to support further development of MEFANET goals at the Faculty of Medicine in Plzeň and received a grant in the amount of CZK 36 million, which is incidentally the largest financial grant to an education project that the faculty ever obtained. The project was, and is, primarily focused on supporting author activities in the field of e-learning and promoting cooperation between the Faculty of Medicine in Plzeň and the Faculty Hospital in Plzeň in the area of creating and sharing electronic education materials for students of all types of studies as well as for academics of the Faculty of Medicine. The project also supported the education of faculty staff. This project is still in progress and ends in March 2015.

In hindsight, it is necessary to state that the application and development of the network of MEFANET portals, which are the final product of the project of the same name, exceedingly raised the level of e-learning at our faculty, accelerated the emergence of a large number of current education materials and also greatly simplified access to these materials for both students and teachers. Another significant advantage of the MEFANET platform is its complementarity with the MOODLE system; indeed, this system is a very good platform for the creation and operation of electronic courses but it is not an ideal resource for sharing electronic publications, which is the domain of MEFANET portals.

At our faculty, the enthusiasm of most teachers for electronic education was initially very reserved; due to the MEFANET project and supporting MODIM project, however, their attitude gradually changed over time. Today, it can be said that a large group of authors of electronic publications emerged at the faculty, accounting for nearly two thirds of our faculty teachers (about 200). Many of them create works in collaboration with authors from other faculties, which is in line with one of the objectives of the MEFANET project aimed at promoting an inter-faculty team of authors.

Currently, our faculty portal contains 370 materials, mostly high-quality materials, and we expect that this number will increase significantly over the next year as the MODIM project continues to run, to about 440. It is a fact that the authors, and especially students, are already familiar with using the portal (in principle, they are already addicted to it!); we are, therefore, convinced that the contents of the portal will continue to develop even without subsidies. It is necessary to realize the major advantage of the portal—the portal allows students to find educational works of their teachers who update them continuously. Students thus have the certainty that they educate themselves using valid, current and verified materials, which is highly attractive. Already now, we can document the interest in using the portal through the access statistics stating an impressive figure of 73 000 only for this year. Another advantage of MEFANET portals consists in the fact that students as well as their teachers have access to works that are on the portals of all other faculties.

We can conclude that the MEFANET project certainly contributed to the development of e-learning at our faculty (and I am convinced that also at all the others) in many ways. In my opinion, the greatest benefit of MEFANET is represented by a gradual change in the conservative approach of the academic environment to e-learning and the acceleration of the production and availability of educational materials for students, which allows us to increase the overall quality of education at our faculty.

▸ D1.6 ◂

CHARLES UNIVERSITY IN PRAGUE, FACULTY OF MEDICINE IN HRADEC KRÁLOVÉ

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- Prof. Aleš Ryška, MD, PhD
- Assist. Prof. Vladimír Mašín, MD, PhD
- Assist. Prof. Tomáš Nosek, MD, PhD

ABOUT THE UNIVERSITY/FACULTY

Charles University, the oldest university in central Europe, was founded on 7 April 1348 by Charles IV, the Holy Roman Emperor and King of Bohemia. The Faculty of Medicine in Hradec Kralove is the oldest institution of higher education in East Bohemia. It started its educational activities on 25 November 1945. Initially, the Hradec Králové faculty was established as a part of the Prague Faculty of Medicine of Charles University. Due to their co-operation and assistance it was immediately possible to establish both a high quality teaching staff and an effective departmental structure in Hradec Králové. The first post–war Czechoslovak president, Dr Edvard Beneš, confirmed this successful development during his visit in 1946. Because of the 'Cold War', the faculty was transformed into a Military Medical Academy for several years. However, in September 1958, the Faculty returned back to Charles University. For its nearly 70 years of existence, the Faculty of Medicine in Hradec Kralove has been among the top Czech university institutions. To date, the studies have almost 10 000 general and dentists doctors. The clinical instruction for General Medicine and Dentistry students takes place in the University Hospital Hradec Králové. Scientifically and pedagogically the University Hospital closely cooperates with the Faculty of Medicine. The University Hospital was founded on the basis of one of the most advanced district hospitals at the same time as the Faculty of Medicine (in 1945). It can be proud of being a leader in many aspects of medical development. Faculty of Medicine in Hradec Králové was the pioneer among Czech medical schools in the application of information technology to the education and research.

EXPERIENCE OF INTRODUCTION ICT INTO THE TUITION— BACKGROUND FOR PRESENT MEFANET ACTIVITIES

PROF. PRAVOSLAV STRÁNSKÝ, MD, PHD
Emeritus Dean, Emeritus Vice-Dean for Study,
Emeritus Head of the Department of Medical Biophysics
and Computer Technology Centre

The first digital computer in the area of medicine in the Czechoslovakia was installed at Charles University Medical Faculty at Hradec Králové at the end of 1964. It was of a Polish origin, ODRA 1003 and in 1968 was replaced by ODRA 1024. The computer became a part of the Center of Medical Cybernetics, which belonged to the Department of Medical Physics (nowadays Medical Biophysics). The workers of the Center produced a number of programs for applications in medicine, e.g. computer aided diagnosis and therapy, teaching models of different diseases, pharmacokinetics and a package of programs for statistical analysis of data from biology and medicine. The application of these programs was demonstrated to students during practical classes. The computer was also used for the evaluation of results of multiple choice tests. According to the percentage of correct answers a weight of each question was calculated and the total result of the test was given by a sum of each weight. This algorithm is based on the fact that questions which are replied correctly by all or no students do not differentiate among the students of a tested group and therefore they bring no information about the knowledge of a tested matter.

In the next step personal eight bit microcomputers IQ 151, produced by a Factory of Industrial Automation in Nový Bor were used. A special program was written for each laboratory measurement, which enabled to record the results of measurement and their processing (statistics, calculation of corresponding mathematical models etc.). These computers used audiocassettes as an external memory. The cassettes were replaced by 8inch diskettes. The era of those microcomputers ended at the 1990 and they were replaced by IBM compatible personal computers. These PCs were used to build up a computer room, which was freely accessible to the students. The faculty was connected to the CESNET (Czech academic version of internet in 1993 and teaching was broaden to applications, which could be found at various web pages. During the following next years the CESNET was installed also at students hall of residence, which were able to access internet without any limitation.

There are two elective courses in the study plan of a General Medicine, Program Equipment for General Practitioners and Introduction to Medical Informatics. In postgraduate study programs the computer lab is used the Biostatistical Course and an Excel macro, named Excel3 and written by J. Bukač, MSc, PhD, is used for a calculation of parametric statistical tests.

Present MEFANET activities consistently continue in tradition. The Scientific Board of the faculty approved (2006) the rules for publication of digital study materials on the Faculty education web portal http://mefanet.lfhk.cuni.cz and established the Editing Committee. The publication and education portal of Medical Faculty in Hradec Králové currently contains 53 educational works from seventeen departments. Simultaneously the LMS Moodle http://moodle.lfhk.cuni.cz was selected as the only one supported platform for e-learning courses presentation, online teaching and self-study.

ACTIVITIES AND PROJECTS RELATING TO MEFANET—ITMEDIK

(INNOVATION AND DEVELOPMENT OF GENERAL MEDICINE STUDY PROGRAMME AT THE CHARLES UNIVERSITY MEDICAL FACULTY IN HRADEC KRÁLOVÉ USING IMPLEMENTATION OF INFORMATION TECHNOLOGIES)

ASSOC. PROF. JOSEF HANUŠ, MSC, PHD
Vice-dean for technical development and informatics,
Member of the MEFANET coordination council
PROF. ALEŠ RYŠKA, MD, PHD
Coordinator of the project ITMedik, Member of the MEFANET coordination council

The Mefanet ideas cover many different aspects of application of information technology in medical education. The Faculty of Medicine in Hradec Králové joined to the family of users of LMS Moodle. Fast expansion of knowledge in biomedical sciences requires adaptation of the teaching process to enable medical students the access to the most important recent information.

Within the spectrum of the tuition tools plays more and more important role teaching using modern IT methods—e-learning. Although this type of tuition cannot replace the traditional teaching methods with direct contact between the teacher and students, it can certainly increase the effectiveness of the teaching process.

The aim of the project was to expand and improve the quality of teaching in the General Medicine undergraduate program through the creation of electronic study materials (1500 hours) and e-learning courses (500 hours) and further extension of tuition by the newly introduced elective interactive e-learning courses. The secondary objective was to improve the professional competencies and skills of teaching staff of the medical faculty, particularly in the field of information technologies.

In the production of electronic study materials has been actively involved 30 centers (some 160 authors from various departments), over 1500 teaching hours in General Medicine have been supplemented by electronic materials. In the production of e-learning courses was actively involved 16 centers (a total of 60 authors from various departments), this resulted in support of 547 teaching hours in 38 subjects of General Medicine study program. Number of supported/innovated subjects reached 25, a total of 195 academic staff members have been successfully trained in IT skills.

In the course of the project was included also the evaluation of the results, where students and teachers were addressed. In the survey 87% of students consider e-learning materials as a useful material for their preparation. According to the survey, 69% of teachers believe that the material which has been prepared can improve the quality of teaching.

▸D1.7◂

PALACKÝ UNIVERSITY OLOMOUC, FACULTY OF MEDICINE AND DENTISTRY

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- Jarmila Potomková, MSc, PhD

ABOUT THE UNIVERSITY/FACULTY

The city of Olomouc is a prominent centre of education and culture. The history of higher education in Olomouc began in 1566 with the establishment of a Jesuit college and in 1573, this college was granted University rights identical to those of other European institutions of higher education. The university in Olomouc is the second oldest university in the Czech lands, which was secularized after abolishing the Jesuit order in 1773. Commencement of medical studies can be traced back to 1778 majoring in surgery and midwifery. In 1872, the Emperor Franz decided to restore the university and it was renamed in his honour to Franzens University. In 1946, the university was re-established and named Palacký University. Gradually, the faculties of Theology, Medicine, Philosophy and Education were established and in 1947 the university was officially opened. At present, it has about 24 000 students, over 1800 teaching staff and eight faculties: St Cyril and Methodius Faculty of Theology, Faculty of Medicine and Dentistry, Faculty of Health Sciences, Philosophical Faculty, Faculty of Science, Faculty of Education, Faculty of Physical Culture, and Faculty of Law.

The Faculty of Medicine and Dentistry, in its present form, has been offering instruction since 1947. It comprises of about 540 teachers, 1750 undergraduate students and 400 PhD students. In the USA, the Faculty was approved by the US Department of Education for participation in Federal Student Financial Aid Programs and is listed in the Directory of Postsecondary Institutions published by the US Department of Education. In Canada, it is approved in similar manner by the Canadian Ministry of Education and Training and is listed under the code QUSF.

VIEW ON MEFANET AND ITS ACTIVITIES FROM INSIDE THE FACULTY

PROF. MILOSLAV DUDA, MD, DSC
Second Department of Surgery

In the new history of Palacký University, medical education has undergone remarkable transformation worthy of mention. As a surgeon, I will try to outline some of the milestones in this specialty. It has always been a challenge to satisfy the expectations of students to participate in practical training. I can remember the very first attempts at introducing audio-visual aids by my teachers. Professor V. Rapant was the first to make a surgical film in the mid-fifties of the 20th century. Later on, I was lucky to collaborate with professional film-makers to produce educational surgical movies for medical students. Since the 1990s, we have witnessed breath-taking new opportunities in medical education due to the emergence of information technologies, the Internet and web applications. In telemedicine, which has its roots in the 1970s, the digital revolution brought about further enhancement in healthcare information dissemination for diagnosis, treatment and education. All aspects of telemedicine share the same goal, namely to accelerate and improve communication among healthcare professionals and patients through information technologies. Two-way live transmission of audiovisual data between surgical departments came true, including videoconferencing and workshops supplemented with online access to health sciences information databases. All of these tools have been used in undergraduate, postgraduate and continuing medical education. We adopted telesurgery as a new education tool in 2002. Students could watch live broadcasts from operation theatres and a controlled study performed in the period 2002–2006 (n = 143) confirmed significant increase in the level of student knowledge by about 8%. Telesurgery can be recommended as an efficient supplement to standard surgical instruction. This experience triggered our interest in e-learning courseware development funded by different grant projects over the years 2006–2011. The outcomes comprised multimedia versions of the key chapters covering general and special surgery that are now available as e-textbooks on the education portal MEFANET. Despite the plethora of web-based medical information resources, it is important to offer students original, peer-reviewed multimedia products developed by their teachers to make medical education more complex. MEFANET has long been a convenient, safe and popular place for e-publishing of native education materials.

ASSOC. PROF. ČESTMÍR ČÍHALÍK, MD, PHD
First Department of Internal Medicine

The last decade of the 20th century, which witnessed unprecedented expansion of information and communication technologies, brought about vast possibilities of using digitized clinical data for the development of education materials. A suitable model example can be digitizing paper electrocardiograms (ECGs) that belong to fundamental diagnostic procedures in cardiology, but they are difficult to preserve, categorize and archive for long duration. Modern instruction in clinical electrophysiology requires lectures followed by repeated student analysis and interpretation of multiple ECG records with the same phenomenon. In the late 1990s, clinician-teachers of the First Department of Internal Medicine launched a project to build a database of categorized original ECG records that currently comprises around 2000 items. The archival collection covers nearly all ECG abnormalities and offers a search key to easily look up a relevant ECG to be used for education purposes. From the very beginning of its existence, the MEFANET education portal has been hosting ECG training multimedia modules developed by cardiology teachers to promote independent self-study as part of the undergraduate as well as continuing medical education. The ECG Atlas Online published on the MEFANET portal has been a challenge for the creation and validation of further web-based audiovisual education materials in clinical electrophysiology.

▸D1.8◂

UNIVERSITY OF OSTRAVA, FACULTY OF MEDICINE

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ABOUT THE UNIVERSITY/FACULTY

The University of Ostrava was founded on 28 September 1991. Its origins can be traced back to 1953, when a training college for future primary school teachers was opened. Currently, the University comprises over 350 fields of study at six faculties (Faculty of Social Studies, Faculty of Fine Arts, Faculty of Arts, Faculty of Medicine, Pedagogical Faculty and Faculty of Science) and two independent research institutes (Institute for Research and Applications of Fuzzy Modelling and European Research Institute for Social Work). The Faculty of Medicine was established in 2010. Its history is linked to the Medical-Social Faculty of the University of Ostrava, which was established in 1993. In 2008, the Medical-Social Faculty was divided into two faculties, the Faculty of Social Studies and the Faculty of Health Studies. The latter was transformed into the Faculty of Medicine in 2010. The Faculty currently has more than 1700 students in 11 bachelor's, 6 master's and 2 doctoral degree programmes. The Faculty's teaching and research activities are carried out by 16 departments and institutes. Students' medical practice courses are provided at specialized departments of the University Hospital Ostrava. The Faculty of Medicine collaborates with 29 European universities and 10 institutions outside Europe.

VIEW ON MEFANET AND ITS ACTIVITIES FROM INSIDE OF THE FACULTY

ASSOC. PROF. DARJA JAROŠOVÁ, MSC, PHD
Vice-Dean for Foreign Affairs
Head of the Department of Nursing and Midwifery
Editorial Committee Member

The Faculty of Medicine has been involved in the MEFANET (MEdical FAculties NETwork) project since 2009 in two main areas, an education network of general medicine and an education network of non-medical health care studies. The Faculty's local MEFANET Coordination Council has 4 members. The process of publishing education materials is supervised by two coordinators, one for medical and one for non-medical specialties. At the same time, each field of study or specialty has its own coordinator who is in charge of developing and publishing specific education materials. Most frequently, these include distance learning texts, e-books, e-learning courses and digital videos.

Any education material (including a brief annotation, keywords, an annotation image and review reports) is submitted by the author to the particular coordinator. He or she makes a decision (if need be, after consultation with an expert in that field) about the quality of that material and its publication on the local and/or central MEFANET portal. Each education material is accompanied by a table filled in by the coordinator and, in case the material has not been recommended for publication, a brief explanation. Recommended materials are sent by the coordinator to a contact person of the Faculty's local MEFANET Coordination Council. As needed, the Coordination Council is convened to make a final decision about whether the assessed education material is accepted for publication. Education materials not recommended for publication on the central MEFANET portal can only be uploaded to the Faculty's local portal.

▸D1.9◂

COMENIUS UNIVERSITY IN BRATISLAVA, FACULTY OF MEDICINE

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/ **Representatives in the MEFANET Coordination Council:**
- Prof. Daniela Ostatníková, MD, PhD
- Assoc. Prof. Eliška Kubíková, MD, PhD
- Katarína Soroková, MSc
- Michal Trnka, PhD

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ABOUT THE UNIVERSITY/FACULTY

The history of higher education in Bratislava dates back to the 15th century. In 1467, King Matthias Corvinus following the order of his era and aiming to increase the splendour of his empire signed the founding chapter of the first University, baptized as Academia Istropolitana.

Today's university, established in 1919, carries the name of the famous pedagogue and philosopher, Jan Amos Comenius (Komensky)—'the teacher of nations', which is rooted in this progressive spiritual heritage and the leading Slovak university. During the last eight decades, thousands of physicians, lawyers and students of humanities graduated from our University.

The Faculty of Medicine was the founding faculty of the Comenius University and the first medical school in Slovakia, contributing considerably to establishing other faculties of medicine in Slovakia later on. The Faculty of Medicine, Comenius University, serves as the anchor for the large academic community aiming to provide the best medical education, conduct innovative biomedical research and provide the best evidence-based patient care. While its tradition of excellence remains constant, the Faculty of Medicine and its reputation for academic achievement continue to grow.

Since 1920, the faculty has graduated more than 23 000 medical doctors. Currently, there are almost 2800 undergraduate medical students studying medicine and dentistry at our faculty; more than 800 of them are international students studying medicine in the English language. The Faculty of Medicine offers postgraduate studies and training, which are completed at PhD level, in full time or part-time study programmes. The faculty holds accreditation for diverse residency training programmes. It currently includes 71 institutes and clinics in eight teaching hospitals, employing more than 900 personnel.

VIEW ON MEFANET AND ITS ACTIVITIES FROM INSIDE OF FACULTY

PROF. DANIELA OSTATNÍKOVÁ, MD, PHD
Vice-Dean for International Relations
Editorial Committee Chief

The Faculty of Medicine, Comenius University, Bratislava, joined the inter-university project MEFANET (MEdical FAculties NETwork) in December 2007. Since then, the portal has become the official platform of the faculty for publishing electronic education works of authorship and multimedia teaching tools, thus supporting both full-time and part-time study in clinical and health care disciplines.

Students of General Medicine and Dentistry have access to content categorized according to the particular field of medicine, and each form of learning material has its own category and approval of the Editorial Committee. The most challenging goal for the faculty staff and the students is to contribute to the portal with high quality materials—publications, videos, presentations, that will contribute to the most convenient and efficient learning according to the personal schedule of the students.

Each published material includes a brief annotation, keywords and an illustration. To facilitate the process of uploading and publishing materials on the MEFANET portal for authors and teachers, the faculty provides professional support through 3 IT specialists. They prepare manuals and instructional video on how to sign in into the portal and how to upload education materials, inclusive of the method of effectively using and working with the portal. However, the main role of the IT support group is to assist the authors and teachers in creating their contributions from the technical perspective; the IT specialists willingly resolve each problem in the publishing process.

Students of the faculty are not just passive users of MEFANET contributions. They contribute themselves and thus actively influence the quality of their education process. The faculty and its students are in a true partnership, working and supporting each other's intentions and activities, moving towards the common goal—high quality medical education for undergraduate and postgraduate students who play the most important role in the health care system.

▸D1.10◂

COMENIUS UNIVERSITY IN BRATISLAVA, JESSENIUS FACULTY OF MEDICINE IN MARTIN

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- Assoc. Prof. Oto Osina, MD, PhD
- Miroslav Bórik, MSc
- Katarína Korenčiaková, MSc

ABOUT THE UNIVERSITY/FACULTY

The Comenius University in Bratislava (CU), founded in 1919, is the oldest and largest university in the Slovak Republic. It follows the university tradition of Academia Istropolitana established in Bratislava in 1465 by the Hungarian king, Matthias Corvinus. The University is named after an outstanding personality of world history—John Amos Comenius, the father of modern education. CU is a public university of classic humanitarian type. It has 13 faculties where about 30 000 students, including more than 1000 students from more than 40 different countries, are trained. Approximately 20 000 students are enrolled in full-time study.

The Jessenius Faculty of Medicine (JFMED CU) is the only Faculty of CU located outside Bratislava in the City of Martin. The beginnings of graduate training of medical students in Martin date as far back as 1962. In 1969, the Faculty of Medicine with its seat in Martin was officially established as the 8th faculty and the Second Faculty of Medicine of Comenius University. In 1991, the Faculty was renamed to the Jessenius Faculty of Medicine in honour of an outstanding medieval physician and humanist, Jan Jessenius, the Rector of Charles University in Prague, whose ancestors had their roots in Martin. JFMED CU belongs to medical faculties with lower number of students. Moreover, the ratio of students to full-time teaching staff is low (presently 801/175). With exception of lectures, all education activities (practical sessions, seminars, tutorials, etc.) are carried out in small study groups—no more than 8 students per teacher. This provides conditions for individual approach to students with the aim to achieve high standard of their knowledge and skills. Clinical training of students is carried out at the University Hospital in Martin (UHM). Its clinics are designated as teaching centres for medical students. The hospital was founded in 1889 and belongs to the oldest hospitals in Slovakia. It has 895 beds, 42 clinical workplaces and departments and annually more than 26 000 patients are hospitalized there.

VIEW ON MEFANET AND ITS ACTIVITIES FROM INSIDE OF FACULTY

ASSOC. PROF. OTO OSINA, MD, PHD
Vice-Dean for Educational Activities in Nursing, Non-Medical Study Programs and Information technologies
Head of the Clinic of Occupational Medicine and Toxicology

The portal of Jessenius Faculty of Medicine (JFMED CU) in Martin enables presentation of a wide range of didactic tools created by the Faculty's specialists so as to support the education process. These encompass simple presentations, digital videos, education websites, e-learning courses as well as complex pedagogical works. Pedagogical work is a comprehensive material that relates to at least one of subjects taught at JFMED CU. It's possible to recognize electronic pedagogical works published at Faculty's portal as a standard publication work within the Faculty. Prior to publication of pedagogical work, it is required to have the work approved by the Editorial Commission of JFMED CU, which was established in 2009. All activities on the portal are managed by the coordination council of MEFANET JFMED CU.

All published materials are available to students of all study programmes—General Medicine, Stomatology, Dentistry, Nursing, Midwifery and also Public Health.

Published materials are classified into various medical disciplines. Each medical discipline is managed by guarantors who review and assess the quality of education materials prior to their publication.

PAVOL JOZEF ŠAFÁRIK UNIVERSITY IN KOŠICE, FACULTY OF MEDICINE

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- Jaroslav Majerník, MSc, PhD

ABOUT THE UNIVERSITY/FACULTY

The Pavol Jozef Šafárik University in Košice was founded in 1959 as the second classical university in Slovakia based on the legacy of the historic UNIVERSITAS CASSOVIENSIS, having continuously operated in Košice from 1657 until 1921. At the time of its establishment, it consisted of the Faculty of Arts and the Faculty of Medicine, which is 11 years older than the University itself, and had until then been part of the organizational structure of the Comenius University in Bratislava. Currently, the University consists of five faculties, those of Medicine, Natural Sciences, Law, Arts, and Public Administration. The University offers about 220 study programmes in Bachelor, Master, and doctoral forms. Teaching of medical students at the Faculty of Medicine began in 1948, and since then it has educated over 12 thousand of them for their prospective profession. The Faculty of Medicine consists of 60 units—institutes, departments, scientific research and experimental workplaces, and special-purpose facilities. Its modern high-rise building is located in close proximity to the L. Pasteur University Hospital, where students take the bulk of their practical training. Its teaching base represents a total of 11 medical institutions that allow students direct contact with patients and employment of modern treatment methods.

VIEW ON MEFANET AND ITS ACTIVITIES FROM INSIDE OF FACULTY

PROF. VILIAM DONIČ, MD, PHD
Vice-Dean for Research Activities
Head of the Department of Medical Physiology
Editing Committee Chair

As vice dean for science and research at the Faculty of Medicine in Košice, Slovakia, I found MEFANET a very interesting platform for networking between motivated teachers of medicine across the medical faculties in the Czech and Slovak republics.

As important and common pints of interest I see in electronic publishing (e-pub), in the exchange of PowerPoint lectures and in cooperation with the examination process, including creating and sheering databases with high quality questions from different topics (as for instance Pathophysiology, Physiology, etc.). Such collaboration brings benefit to teachers as well as to our students.

PROF. DARINA KLUCHOVÁ, MD, PHD
Vice-Dean for Education
Head of the Department of Anatomy

I have a notably positive relation to using the faculty portal. I give lectures in Human Anatomy and at the beginning, it was a pretty hard to convince me as well as my colleagues to use it. At that time, we all felt that sharing our lectures 'without any consequence' will be the mere forwarding of our know-how. Finally, as the head of Department, I put myself forward as the first one to try the portal and published one of my lectures. I was very surprised by the positive reactions of my students, which made me add more presentations on regular basis. I find that the students finally understood the difference between relevant and irrelevant facts, and I am also finally able to request what is important from them. Even bigger surprise for me was the fact that providing the presentation in advance helped students to understand the requested material during my lectures and that it was not true that their interest in attending the lectures waned after this facility, as previously feared. On the contrary, they were more interested in the details and assimilation was better.

Last but not the least, sharing our presentations using the faculty portal has brought satisfaction in the sense of the possibility to prepare objective questions for examination, as no one of the students was able to say that he/she had no opportunity to study the requested material. Furthermore, the students also appreciated the fairness of this approach. Consequently, other teachers began to follow suit and uploaded their presentations on the portal as well. Nowadays, we cannot imagine education without this convenience, nor our students who require and benefit from it. I believe that the better results of their education can be attributed to the possibilities offered by the portal.

PROF. MÁRIA MAREKOVÁ, MSC, PHD
Head of the Department of Medical and Clinical Biochemistry

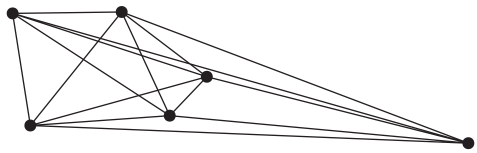
MEFANET has made the information environment very convenient for medical students at our faculty for several years running and together with WiKiSkripta, it has become one of the most searched source of information by the students of the medical faculties in the Czech Republic and Slovakia. The portal of Faculty of Medicine at the Pavol Jozef Šafárik University in Košice has become an inseparable part of this information environment, availed by the teachers of the Department of Medical and Clinical Biochemistry to present lectures, and e-versions of books and textbooks. Students are now accustomed to this form of information source and appreciate, first of all, the topicality of available tutorials for practical lessons and, last but not the least, also the fact that the tutorials need not to be laboriously written but the results and observations are noted in prepared printed version.

DANIELA DŽUGANOVÁ, PHD
Head of the University Library

The portal of the Pavol Jozef Šafárik University's Faculty of Medicine for multimedia support in the education of clinical and health care disciplines is used by the University Library in editorial work to search and register electronic publications prepared by the authors of the Faculty of Medicine. My colleagues are authorized to use it and this makes the process easier and faster. However, some of the older publications are not available that may be a pity for students and this system as well.

D2 FACULTIES OF HEALTH CARE SCIENCES

Besides all medical faculties in the Czech Republic and Slovakia, MEFANET involves also the faculties of health care sciences focused on non-medical healthcare professions. Increasing the MEFANET-related activities of educators from these faculties resulted in the creation of an independent Coordinating Council for health care sciences under the MEFANET umbrella in 2012. The representatives from the faculties of health care sciences as well as from those at the faculties of medicine, who are responsible for study programmes related to non-medical health care professions, work in tandem with the MEFANET Coordinating Council on extensions to the medical disciplines linker and multidimensional quality assessment (see CHAPTER C1). The faculties of health care sciences (see their list and profiles) do not have to operate their own instances of the MEFANET portal—their non-medical education content is published on portal instances of the allied medical faculties.



▸ D2.1 ◂

PALACKÝ UNIVERSITY OLOMOUC, FACULTY OF HEALTH SCIENCES

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- Petra Bastlová, MSc, PhD

ABOUT THE UNIVERSITY/FACULTY

The Faculty of Health Sciences is the eighth and the newest faculty at the Palacký University in Olomouc. It was established in 2008 and focuses on the education of healthcare professionals whose specifications comply with Act No. 96/2004, Coll. The Faculty of Health Sciences was separated from the Palacký University Faculty of Medicine and Dentistry, which was providing healthcare programmes until then. The idea for an independent faculty came from the differences in the profiles and competencies of the graduates and from the different research areas of the study programmes.

The Faculty offers eight specialties in the study programmes Physiotherapy, Nursing, Midwifery and Radiology, and a doctoral Nursing programme. The main focus in scientific research is on evidence-based practice in healthcare, multidisciplinary teams in healthcare, life-style limits resulting from chronic disease, reproductive health, international classification in nursing care and midwifery, rehabilitation, physiotherapy and kinesiotherapy, non-medical healthcare profession management, and health and social care systems for the elderly. The faculty participates in the organization of conferences and the academic staff is often invited to lecture at domestic as well as international conferences; the faculty also organizes specialized education workshops for interested professionals. The faculty supports the scientific research of their own students. Each year students from all departments present and defend their work at the faculty's SVOČ conference (Student Scientific and Professional Activity).

▸ D2.2 ◂

PREŠOV UNIVERSITY, FACULTY OF HEALTH CARE PROFESSIONS

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- Assoc. Prof. Štefánia Andraščíková, MSc, PhD

© Presov University, Faculty of Health Care Professions

ABOUT THE UNIVERSITY/FACULTY

The Faculty of Health was established on 1 September 2002. The founding project was based on the National Plan of Nursing Development, which is part of the continual transformation process of planning in the Slovak Republic and of the Slovak Government Announcement. The Faculty of Health Care Professions offers education in nursing, midwifery, physiotherapy, dental hygiene, laboratory diagnostic and therapeutic methods, and paramedics in 3-year full-time and 4 year part-time study programmes. The Faculty of Health Care Professions has the right to award the academic degree of 'Bachelor'. There are two study programmes at the Master's level—nursing and physiotherapy, and also the possibility to study at PhD level—in Nursing. The contents of the study programmes comply with the European Commission Directives applicable to regulated and partly regulated professions. The mission of the faculty is education and development of harmonic and creative personalities. The faculty staff leads students to tolerance, health confidence and respect, development of science, culture and health. All types of study are attended by approximately 980 students.

▸ D2.3 ◂

UNIVERSITY OF SOUTH BOHEMIA IN ČESKÉ BUDĚJOVICE, FACULTY OF HEALTH AND SOCIAL STUDIES

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- Prof. Valérie Tóthová, MSc, PhD

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ABOUT THE UNIVERSITY/FACULTY

The University of South Bohemia in České Budějovice is a public university with more than 13 thousand students. It was established in 1991 and has eight faculties now; the oldest of them is the Faculty of Education with a history dating back to 1948. The University of South Bohemia presents itself as a research university with particular focus on natural and social sciences and humanities. Close cooperation with institutes of the Academy of Sciences of the Czech Republic constitutes a significant part of the scientific and research activity. The Faculty of Health and Social Studies with more than 2000 students is the second largest faculty of the University of South Bohemia. It holds a significant position within the Czech Republic, particularly due to the fact that as one of few universities of this country, it interconnects closely health and social issues. It has been existing as an independent faculty since 1991, offering interconnection of health and social topics to offer the graduates extensive opportunities of finding employment in practice. It offers thirteen Bachelor's and four subsequent Master's branches of study, as well as two Doctoral programmes, and it has also the right of habilitation and professorial proceedings. The Bachelor's branch of nursing can be studied in English. The programme of 'joint degree' type and the subsequent Master's branch of nursing care in geriatrics has been accredited recently.

CZECH TECHNICAL UNIVERSITY IN PRAGUE, FACULTY OF BIOMEDICAL ENGINEERING

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- Dagmar Brechlerová, PhD

http://commons.wikimedia.org/wiki/File:Krocehlavy_Kladno_KL_CZ_KOKOS_013.jpg

ABOUT THE UNIVERSITY/FACULTY

The Czech Technical University in Prague (CTU) is one of the largest and the oldest technical universities in Europe. It was founded on the initiative of Josef Christian Willenberg on the basis of a decree issued on 18 January 1707, by Emperor Josef I.

CTU educates modern specialists, scientists and managers with knowledge of foreign languages to dynamically and flexibly adapt to the requirements of the market. CTU offers a very broad and attractive range of study programmes. For the 2014/2015 academic year, students can choose from 110 study programmes within the framework of which 441 study specializations are offered. Currently, CTU has eight faculties (civil, mechanical, electrical, nuclear and physical engineering, architecture, transportation, biomedical engineering, and information technology) and a capacity for over 23 000 students.

The Faculty of Biomedical Engineering (FBME), Kladno, is the second youngest faculty of the Czech Technical University in Prague being, at the same time, the only public institute of higher education in the Central Bohemian Region. It was founded in 2005 and its allocation to Kladno proved highly beneficial from the very beginning. FBME, in its short period of existence, has created eleven research teams responsible for a large proportion of the scientific-research activities of the faculty. All research teams work on projects where the common denominator is biomedical engineering, impacting many areas of our daily lives.

Designed and typeset by RADIM ŠUSTR—Institute of Biostatistics and Analyses, Masaryk University

Composed in Skolar, typeface designed by DAVID BŘEZINA—Rosetta Type Foundry

Czech and Slovak

medical faculties

network

ISBN 978-80-904731-9-5