MEFANET report 05

Technology enhanced learning in medical education

Editors:
Daniel Schwarz
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Masaryk University

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PREFACE

Dear colleagues and students,

the network of Czech and Slovak medical faculties and cooperating institutions has been growing quickly and so has tradition of the MEFANET conference. We are pleased that by means of the MEFANET Report 05 we can look back at the 5th year, which took place in November 2011 in Brno. And while reading it, we can look forward to the 6th year, which will be held at the same place on November 27–28, 2012.
MEFANET 2011 confirmed rising interest in implementation of modern information and communication technologies (ICT) into education of medical students and physicians. Efforts of several enthusiasts have gradually turned into an official cooperation of all Czech and Slovak medical faculties and other institutions involved in education of health care professionals. Our exciting educational network MEFANET (Medical Faculties NETwork) has been recently supported by several projects funded by the European Education for Competiveness Operational Programme.
The 5th year of the MEFANET conference brought again together researchers in the multidisciplinary areas of Medical/Health Education, educational technology and technology-enhanced learning. Academics, medical teachers, health professionals, clinicians, computer scientists involved in medical education enhanced by ICT innovations were the core participants of the conference as well as our students who provided us with a very valuable feedback during the conference.
Contributions published in the proceedings illustrate a wide range of modern technologies and tools that have become a standard part of teaching at our medical faculties – from e-courses and virtual patients over 3-D technologies to systems for evaluating students' knowledge. The MEFANET report 05 is divided into two main parts:

- A: Informatics in Medical Education,
- B: Effective teaching and learning environments.

We hope that you will find content of this Report beneficial and inspiring for your work and, last but not least, we are looking forward to seeing you in November in Brno at the 6th conference MEFANET 2012.

Daniel Schwarz | Martin Komenda | Ladislav Dušek | Stanislav Štípek | Vladimír Mihál

01 FIVE YEARS OF MEFANET: PROGRESS AND DEVELOPMENTS

L. Šnajdrová, J. Gregor, M. Komenda, D. Schwarz, L. Dušek

The 5th MEFANET Conference took place on 24–25 November 2011 on the premises of Voronez Hotel in Brno, Czech Republic. This annual meeting of representatives from all Czech and Slovak medical faculties is focused on the issues of e-learning and health informatics in the education of medical disciplines. Conference participants had again the opportunity to learn about the latest trends in electronic tools employed in the education of future doctors in the Czech Republic and Slovakia, as well as about the latest developments in the MEFANET (MEdical FAculties NETwork) project.

The number of participants has been growing each year, suggesting that the conference has been increasingly popular among teachers at medical faculties. MEFANET 2011 welcomed more than 130 participants, which is the highest number in the history of this event. As usual, all Czech and Slovak medical faculties were represented; in addition, there were representatives of several other institutions dealing with the education of non-medical health care professionals. Last but not least, invited students across the MEFANET network have also participated, using this unique opportunity to share their own experience with e-learning and to provide their feedback to teachers who created many e-learning materials.

Quality of e-learning at medical faculties guaranteed by MEFANET

The conference was opened by Assoc. Prof. Ladislav Dusek, Ph.D., from the Faculty of Medicine at Masaryk University in Brno, who welcomed the invited guests and expressed his delight at the ever increasing number of participants. He reminded the audience of three interactive workshops and of parallel lecture sessions which were inevitable due to a tight schedule. Prof. Jaroslav Sterba, M.D., Ph.D., then took the word to emphasize the importance of high-quality education of future doctors and to mention that it is necessary to keep up with the times when creating and employing new educational materials.

In his opening lecture, Dr. Ladislav Dusek summarized briefly the history of the MEFANET project (http://www.mefanet.cz). In 2006, an idea was born about a mutual cooperation between the 1st Faculty of Medicine at Charles University in Prague (1. LF UK) and the Faculty of Medicine at Masaryk University in Brno (LF MU), with the primary objectives to facilitate the cooperation between teams of teachers from these faculties and to make electronic learning materials available for students and teachers from both faculties. Soon afterwards, the Faculty of Medicine at Palacky University in Olomouc (LF UP) joined the project and the first MEFANET conference took place on the very same year: during this event, all remaining Czech and Slovak medical faculties were invited to join. Nowadays, all eight Czech and three Slovak medical faculties are involved in the MEFANET project, providing a huge potential for mutual sharing of electronic teaching materials; cooperation of the involved faculties in this area allows to develop the Czech and Slovak medical e-learning more quickly and effectively. Dr. Dusek indicated that more than 44 000 potential users nowadays work or study at the eleven involved faculties, and therefore outputs of this educational network already have a significant impact on the education of future doctors. He also noted that the MEFANET project was already brought to teachers' notice – even to such an extent that many consider MEFANET as a guarantor of quality of e-learning teaching materials; therefore, involved medical faculties cannot afford to publish educational materials of poor quality on the central gate of the MEFANET portal platform (http://portal.mefanet.cz). "Apart from medical faculties, several faculties dealing with the education of non-medical health care professionals have started to participate actively," added Dr. Dusek. "Namely, the Faculty of Health and Social Studies at the University of South Bohemia in Ceske Budejovice, the Faculty of Health Sciences at Palacky University in Olomouc, and the Faculty of Biomedical Engineering at the Czech Technical University in Prague. Senior representatives of these three faculties are today among us and will have presentations in a lecture session dedicated to new members of the MEFANET project." In the closing part of his lecture, Dr. Dusek expressed his hopes that future developments of the MEFANET would be as promising as they were so far, and wished all present teachers much success in their pedagogical activities.

Personalized medicine vs. predictive models of human physiology

The following session of invited lectures was focused on the modelling and simulations of human physiology. The first speaker was Prof. Radu Iliescu, Ph.D., Associate Professor at the University of Medicine and Pharmacy "Gr. T. Popa" Iasi (Romania) and Affiliate Assistant Professor at the University of Mississippi (USA). Prof. Iliescu acquainted the audience with the HumMod project (http://hummod.org) that he has been recently solving with his American colleagues. In brief, HumMod is an extremely complex model of human physiology that takes into account a large number of variables and employs about 4 500 equations to describe the physiology of cardiovascular, nervous, excretory, endocrine, gastrointestinal and respiratory systems. The model is based on differential and/or algebraic equations and its outputs involve specific values and changes of monitored variables with time. Prof. Iliescu accompanied his lecture with a number of specific examples of how this model can be applied: for example, massive haemorrhage usually leads to significant changes in blood pressure, body temperature etc., which is a sign generally known from daily clinical practice. However, HumMod can quite reliably simulate even fatal developments which should not happen in clinical practice, as doctors make every effort to avoid them. HumMod can be therefore employed for the simulation of interventions which cannot be performed on patients for ethical reasons. Prof. Iliescu expects that one day, HumMod will be taken to such perfection that it will be possible to verify the impact of proposed procedures without damaging the health of real patients.

The next lecture was presented by Prof. Stephen Randall Thomas, Ph.D., from the US who nowadays works at the Institut Gustave-Roussy in France. Prof. Thomas is widely recognized as an expert on biomedical modelling and simulations of human body, and his research focuses mainly on mathematical models in the area of renal and cardiovascular physiology. In his lecture, Prof. Thomas introduced a very interesting international project entitled "Virtual Physiological Human" (VPH) in which he also participates. The aim of this comprehensive project is to "foster, harmonise and integrate pan-European research in the field of i) patient-specific computer models for personalised and predictive healthcare and ii) ICT-based tools for modelling and simulation of human physiology and disease-related processes". This definition inevitably implies that the project objectives simply cannot be met in a single research centre. At the present time, individual parts of the project dealing with specific groups of diseases have been solved in 14 centres in the UK, France, Belgium, Spain, Sweden and Italy, and even at the University of Auckland in New Zealand. The project is open for other centres which can contact the organizers and explain their intentions. More information about the project can be found at http://www.vph-noe.eu.

And finally, Assoc. Prof. Jiri Kofranek, M.D., the last speaker in the session of invited lectures, presented his interactive Atlas of Human Physiology and Pathophysiology, the development of which has been under way for a number of years now. Dr. Kofranek started his presentation with a modest note that his impressive multimedial atlas is essentially based on the findings of noteworthy researchers such as the legendary US physiologist Arthur C. Guyton, and that he and his colleagues have only extended and applied those findings. The atlas is nowadays available to anyone at http://www.physiome.cz/atlas and is particularly helpful to medical students who need to understand the functions of individual physiological systems as well as the causes and manifestations of their disorders. The authors of the atlas wrote: "The Comenius' credo Schola ludus is nowadays widely applied in interactive educational programmes that are based on simulation games. In fact, the interconnection between multimedial environment and simulation models makes it possible to thoroughly examine a specific issue in virtual reality. A simulation game allows users to test the behaviour of a simulated object, such as landing a virtual plane, treating a virtual patient, or – as in the case of this project – examining the behaviour of specific parts of the respiratory, circulatory, excretory and other systems." The atlas has been primarily developed in the Czech language, which is an undeniable advantage for Czech and Slovak medical students.

Active participation of non-medical faculties in the MEFANET project

The following session was dedicated to the expansion of the MEFANET project. The main speakers were Assoc. Prof. Jiri Hozman, Ph.D., vice-dean for pedagogical activities at the Faculty of Biomedical Engineering at the Czech Technical University in Prague, Assoc. Prof. Jana Mareckova, Ph.D., dean of the Faculty of Health Sciences at the Palacky University in Olomouc, and Assoc. Prof. Vojtech Kamarad, M.D., member of the Scientific Council at the Faculty of Medicine at the University of Ostrava. The three above-mentioned institutions have joined the MEFANET project only recently, and their representatives came to the MEFANET conference to outline what they were focusing at and to explain their ideas on how these institutions could be actively involved in further development of this common Czech and Slovak project. The session was ended by Dr. Dusek who warmly welcomed the active participation of "newcomers" and invited them not to hesitate and to share their educational materials as soon as possible.

The subsequent session entitled "Electronic teaching in study programmes with extended education of paediatrics" was dedicated to specific educational materials, like most other thematically focused sessions. A detailed description of all lectures would be far beyond the scope of this article.

Symposium on electronic testing

A 90-minute symposium on electronic testing was chaired by the panel of experts involving Prof. Eva Taborska, Ph.D., and Andrea Pokorna, Ph.D., from the Faculty of Medicine at Masaryk University in Brno, Assoc. Prof. Ivan Reznak, Ph.D., from the Jessenius Faculty of Medicine in Martin, Dr. Tamara Vanova from the Faculty of Education at Masaryk University in Brno, and Jitka Feberova, M.D., from the 2nd Faculty of Medicine at Charles University in Prague. The participants shared their experience and opinions on examining the students' knowledge using electronic tests. Although a positive attitude to the employment of such tests during the semester and at final exams largely prevailed, many pointed out various limitations and disadvantages, such as time-consuming efforts to create those tests and the requirement of a database of questions large enough which would be subsequently used to generate final sets of questions. In this context, the question of the so-called "magic number" was also discussed, that is the number of questions at which students give up their efforts to memorize answers to specific questions and rather learn the issue as a whole. It came as no surprise that symposium participants agreed that such a number does not exist, and that many factors (such as the subject, way of asking questions, etc.) would always play their role. In conclusion, this modern way of testing cannot be applied universally, but it can save teachers' time and provide immediate feedback to students when used appropriately, such as in theoretical and more general subjects, which mainly involve factual knowledge. In many subjects, however, oral exams simply cannot be replaced by electronic tests – a matter of fact which was approved not only by teachers, but also by attending students' representatives.

Three pillars provide a stable support to MEFANET

The opening session on the second day of the conference was dedicated to the assessment of main MEFANET subprojects from the point of view of teachers and students. The MEFANET project nowadays involves three main pillars: MEFANET portal platform (http://portal.mefanet.cz), Wikiskripta (http://www.wikiskripta.eu) and MoodleMefanet (http://moodle.mefanet.cz), providing together a comprehensive e-learning background for a wide academic community formed by the Czech and Slovak medical faculties.

The introductory lecture of Dr. Daniel Schwarz was dedicated to the present state of development of the portal platform for e-publishing, which involves the so-called "central gate": this "gate" actually serves as a guidepost to high-quality educational materials which were previously published at local portals of involved medical faculties. Dr. Schwarz emphasized that the central gate primarily works as a search engine which aims to facilitate the users' orientation in an ever increasing number of published articles. Dr. Schwarz highlighted that educational articles published at the central gate must meet three basic criteria: (1) their extent and quality must be adequate, (2) metadata such as annotation, keywords and other parameters must comply with previously defined rules, (3) the article must be accessible at least to the so-called "mefaperson" – that is, to users from all medical faculties involved in the MEFANET project. There strict criteria provide an explanation for a sharp fall in the number of articles published at the central gate, which was observed in mid-November 2011. The process of "mentally active check" led to a rapid elimination of articles that did not meet the above-mentioned criteria, resulting into a high-quality and guaranteed contents of educational materials published at the central gate. Dr. Schwarz added that less ideal article were by no means removed from educational portals of individual faculties: everything was left in place, changes were only done at the level of the central gate, which should represent the entire MEFANET project.

In the following part of his lecture, Dr. Schwarz demonstrated an improved system for the assessment of electronic teaching contents, the so-called "4D quality asssessment". As its name implies, the model is represented by four dimensions: (1) a review, written by external examiners who are experts on a specific topic, (2) the level of users for which the teaching materials were intended (undergraduate, graduate, advanced, complex), (3) the type of material, i.e., whether it is a textbook, a website, a video etc., and (4) the self-study score created by users themselves, partly suggesting to what extent

a specific material is suitable for self-study. Dr. Schwarz noted that the quality of each educational material which is published at the portal should be ideally guaranteed by a so-called guarantee responsible for a given medical discipline – although many non-guaranteed articles are still kept on the portal in order not to limit the availability of previously created educational materials. Efforts should be made, however, to make guarantees gradually review and approve all previously published articles, thus ensuring the quality of the contents, as it was mentioned on the previous day by Dr. Dušek.
Martin Vejrazka, M.D., Ph.D., from the 1st Faculty of Medicine at Charles University in Prague, then presented the current state of the second pillar, called simply the “Wikiskripta” (in translation, “wiki-textbooks”). At the very beginning of his lecture, Dr. Vejrazka mentioned that Wikiskripta were created for another purpose than two other subprojects, which are aimed at the publication of elaborate e-learning courses and educational materials. Contrary to two other pillars, Wikiskripta make it relatively easy for users to edit virtually anything that they need at a given time. Although Wikiskripta primarily contain teaching texts, users can also insert illustrative images, flash animations and other multimedia. Wikiskripta are based on openness: both students and teachers can contribute. Although some people might find this approach rather controversial, past experience suggests that the quality of teaching texts does not decline, quite the contrary. The credibility of information is guaranteed by a symbol of “green tick”: if it is present at the webpage, it means that the contents of that article was checked by a participating teacher from the medical faculty and it can be therefore assumed that the information is correct. An article marked with a “green tick” is not locked and unavailable for further editing: it can still be updated. However, the “green tick” disappears at the moment of any edit, and the article is subsequently reviewed by authorized editors who will decide whether to accept the changes – and if so, whether these changes are so important that they need to be sent to the corresponding teacher for further review.
Jitka Feberova, M.D., from the 2nd Faculty of Medicine at Charles University in Prague, then briefly explained purpose of the third pillar, Moodle-Mefanet, which is based on the idea of the Learning Management System (LMS). More information (in Czech language only) about this subproject can be found at http://moodle.mefanet.cz.

What do experts expect from the MEFANET project?

The following discussion panel “Copyright in practice” was very well attended, suggesting that copyright is a hot issue for everyone who needs to “borrow” figures, tables or texts from another author in order to use them in his/her own presentation. Two experts on copyright were invited to answer numerous questions from the audience: Dr. Radim Charvat from the Faculty of Law at the Masaryk University in Brno, and Radek Policar, M.Sc., from the Masaryk Memorial Cancer Institute in Brno. A lively discussion emerged just after the

introduction of both lawyers. Interesting topics were not exhausted even after 90 minutes reserved for this discussion panel, and both experts were bombarded with questions after the formal end of the debate.
The conference was ended in late afternoon by a public session of the Coordination Council of the MEFANET project. Members of the Council expressed their satisfaction with this year's conference and unequivocally agreed that the next year should take place in November 2012 in Brno again. Dr. Dusek noted that despite all achievements reached so far – or possibly thanks to them – the oncoming period will bring a lot of work for all involved faculties if they want to convince the experts on medical teaching that they are indeed able to set the standards for the creation of electronic learning materials. To conclude his speech, Dr. Dusek wished the conference participants a lot of energy and enthusiasm which would be essential if the next year of the conference is to be at least as successful as this year's one.

MODELING AND SIMULATION IN MEDICAL RESEARCH AND EDUCATION: THE EXPERT'S VIEW

02

The same as in past years, the MEFANET 2011 conference presented attractive lectures of world-known speakers. This year was focused on modern methods used for modeling and simulation of a human body in pre-clinical fields of medicine. Both of invited speakers, prof. Radu Iliescu and prof. Stephen R. Thomas, are interested in many activities oriented on sophisticated physiological models based on mathematic expressions and computer processing. Among others, they introduced two significant projects: HumMod and Virtual Physiological

Assoc. prof. Radu Iliescu, M.D., Ph.D., FAHA
University of Medicine and Pharmacy, Romania; University of Mississippi Medical Center, US

Associate Professor of Physiology Dr. Radu Iliescu received his M.D. at the University of Medicine and Pharmacy "Gr. T. Popa" Iasi, Romania and his Ph.D. in Pharmacology at the Max Delbruck Center in Berlin, Germany and the University of Medicine and Pharmacy "Gr. T. Popa". He was a postdoctoral fellow in the Department of Physiology and Biophysics at the University of Mississippi Medical Center in Jackson, MS, and then became an Assistant Professor of Physiology. His areas of interest include neural regulation of blood pressure and kidney function and application of mathematical modeling of integrative physiology. He has published over 35 peer reviewed papers in this field and his research has been funded by European and US research organizations.

Topic:
HumMod – integrated multilevel mathematical modeling of physiology for research and education

Abstract:
Multilevel, integrated mathematical modeling of physiology allows examination of a multitude of variables which may not be amenable to direct experimental testing or measurement. We have developed HumMod, a model composed of ~4,500 equations describing human physiology, which includes cardiovascular, neural, renal, endocrine, metabolic, and respiratory physiology. Variables are described by differential and/or algebraic equations and numerical solutions are computed simultaneously for increments of the inde-

pendent variable, time. All variables and equations are organized in XML files, which can be opened by any text editor and are directly readable and interpretable by users as the local names are self-descriptive. The model structure is parsed, equations are solved and results are displayed graphically by a compiled executable file. In addition, by way of XML files, users can add or modify existing content (variables and relationships), making HumMod a user-friendly, interactive modeling platform. The major advantage of the HumMod, besides its complexity, is that it allows evaluation of dynamic changes in physiological variables in response to perturbations. Such an approach is currently used for conveying complex physiological processes in medical education and also for research hypothesis generation and testing. We present mathematical simulations using HumMod describing normal and pathophysiological behaviors in both steady state and dynamic conditions.

Prof. Stephen Randall Thomas, Ph.D.
Institut Gustave-Roussy, France

S. Randall Thomas is a workpackage leader in the Virtual Physiological Human Network of Excellence (FP7) and international coordinator of the Renal Physiome and he was also a partner in the STEP Roadmap project (FP6). He received his M.A. in Biology in 1973 (Swarthmore College), Ph.D. in Physiology in 1977 (Medical College of Virginia, Richmond), and the HDR from Univ. Paris 5 in 1990. After postdocs at the French Atomic Energy Commission (Biology Dept.) at Saclay (1979) and in the Dept. of Physiology at Univ. Texas Med. Center, Houston (1980–81), he became a Chargé de Recherche with the CNRS, France, in 1982, where he is now a Director of Research. He currently works at IR4M UMR8081 CNRS & Univ. Paris-Sud at Orsay and Villejuif. His research deals with/is focused on mathematical modeling of integrated transport systems in renal and cardiovascular physiology and on the development of related databases and physiome infrastructure. He is a member of the Executive Board of the joint CNRS-INSERM Stic-Santé GdR (Groupement de Recherche) (he was also a Director from 2007–2010), and is a founding member of the Institute of Theoretical Medicine (Lyon). He is a member of the Editorial Board of the journals Frontiers in Computational Physiology and Medicine, Systems & Synthetic Biology, and is used to be a member of editorial boards of Nephron Physiology, and Philosophical Transactions of the Royal Society A. He is also the Section Head of Integrative Physiology/Homeostasis in the Faculty of 1000.

Topic:
The Virtual Physiological Human (VPH) project, with focus on an integrated core model of blood pressure regulation

Abstract:
European Physiome activity is currently supported under the 7th Framework Program VPH call Virtual Physiological Human (Hunter et al. 2011), which has now funded one Network of Excellence (NoE) and more than thirty targeted projects. The mission of the NoE is to coordinate these efforts, explore training possibilities, disseminate information about VPH resources and projects, and furnish a VPH ToolKit. The aim of the VPH ToolKit is to foster interoperability among the plethora of models at different scales through the use of markup languages, shared reference ontologies, model repositories, databases, and so on. I will briefly summarize this activity and then focus on progress in the Renal Physiome (Thomas 2009), which is linked to the VPH NoE through the SAPHIR Exemplar Project (Thomas et al. 2008) treating blood pressure regulation and renal physiology in a Guyton-inspired modular modeling environment (Guyton et al. 1972, 1987). Among other items, I will describe the Quantitative Kidney DataBase (QKDB) of experimental measurements and anatomical details relevant for kidney physiology, and preliminary results from an extensive sensitivity analysis of the Guyton models (Hernandez et al. 2011).

Radu Iliescu

You are one of the world-renowned experts, could you shortly introduce and describe your present activities in virtual human simulations and modeling area including HumMod project – model describing human physiology?

"Systems Biology" has emerged to describe the overall goal of approaching biological information from "reductionist" models in an effort to provide insight into the integrated workings of cells, tissues, organs, and whole organisms. Mathematical models and simulations have become an important tool in understanding the key causal relationships in normal and pathophysiological human processes. There are numerous efforts directed at developing a human physiome, an extensive integrative model of human physiology that can be used for both hypothesis testing and medical education. For such a system to work there has to be a comprehensive development of multiple systems, and importantly a linkage with these cellular and organ systems that will provide implementation of the appropriate feedback systems. We have developed a model of integrative human physiology called HumMod consisting of ~5000 variables describing cardiovascular, renal, respiratory, endocrine, neural and metabolic physiology. One of the major advantages of this multilevel, integrated mathematical model of physiology is that it allows examination of a multitude of variables which may not be amenable to direct experimental testing or measurement. In addition, the set of variables and relationships described by the integrated model at any given moment of its development is not exhaustive, but provides a backbone for further addition and refinement. HumMod allows the user to provide clinical treatment, including pharmacological agents, placing the patient on a ventilator, administering IV fluids, and performing a blood transfusion. HumMod allows the user to adjust many characteristics of the patient's physical environment, from global conditions such as altitude to local qualifiers such as temperature, humidity, and barometric pressure. In conclusion, HumMod provides scientists with a modeling environment to understand the complex interactions of integrative physiology.

Do you have any experience with using HumMod in curriculum?

We have used HumMod for teaching physiology to medical students. It provides a "hands-on" learning experience as it allows the student to interact with the "human-on-chip". The basis for the use of HumMod for medical education is currently physiological and pathophysiological "scenarios". Although various scenarios are already available, many more can be developed and implemented using the HumMod as a modeling environment. The students benefit from an integrated perspective on many physiological variables and this develops their capacity to think globally about physiological concepts. We are currently introducing HumMod for teaching pharmacological principles and we are developing new concepts for interfacing with the end-user, such as "avatars". The aim is to have a comprehensive educational environment for a wide range of healthcare professionals.

What were you feelings after your lecture in plenary session on MEFANET 2011 conference, which was focused on modeling and simulation in preclinical fields of medicine?

I was impressed with the interest of the audience for the conceptual aspects presented. This is especially important since the participants represented different areas of medical and scientific expertise at large. Also, the session was attended by experts in different areas in modeling and simulations and this provided an excellent platform for discussion. I was pleasantly surprised to have members of the audience be familiar with the tradition of our modeling efforts going back to Dr. Arthur C. Guyton.

What do you think about the MEFANET project and about the MEFANET community covering all Czech and Slovak medical faculties.

As I was largely ignorant of the MEFANET project before the meeting, the ideas and experiences shared with the people directly involved in MEFANET gave me the perspective of a great vision greatly put into reality. I strongly believe that the MEFANET can become a model of cooperation in education and research for universities not only in Europe but anywhere in the world. Importantly, way beyond an e-learning platform, implementation of the MEFANET creates value by strategic utilization and sharing of resources. It was high time the academic community applied these concepts emerged from the economic world and the MEFANET is an excellent example of this effort. The conference was a good illustration of the MEFANET success and appreciation by the academic community in both countries.

Have you ever been in Czech Republic? How did you spend a rest of free time in Brno? Could you mention any interesting things, which you visited and enjoyed during your stay?

This was my first visit to Czech Republic, and long overdue. I was glad to have the opportunity to visit the city of Brno which transpires a rich history and an elegant life. Strolling during the day through the old city center and the Castle and enjoying the Christmas atmosphere in the evening in the markets was an excellent addition to a very good meeting.

Stephen Randall Thomas

You are one of the world-renowned experts, could you shortly introduce and describe your present activities in virtual human simulations and modeling area including HumMod project – model describing human physiology?

I am a kidney physiologist. My main research activities are centered on the modeling of kidney physiology, especially the mechanism of urine concentration by the renal medulla and the role of the kidney in blood pressure regulation. I am also a partner in the VPH-NoE (Virtual Physiological Human Network of Excellence), in which I am a work-package coordinator. One of the principle activities of the VPH NoE is the creation of a VPH ToolKit, consisting in particular of resources for interoperability of physiology models and datasets. At the heart of this ToolKit are markup languages (such as CellML and SBML) and a set of reference ontologies that can be used to tag not only the contents of genome and proteome databases but also the parameters and variables of integrated physiology models. In this way, it will be possible to establish common features from the molecular to the whole organism level. My colleagues and I participate wholeheartedly in these developments, and we have especially used the early Guyton models as demonstrator applications for these tools. Concerning the HumMod project, we have not had any direct collaboration with the HumMod team, but this will hopefully arise, thanks in part to the MEFANET conference, which gave us an opportunity to discuss directly with Radu Illiesco (and of course with Jiri Kofranek, whom I have known for several years through the VPH).

Do you have any experience with using HumMod in curriculum?

I have a strong interest in the models developed by Arthur Guyton and colleagues, and with my colleagues in the SAPHIR project (funded by the French National Research Agency, and linked to the VPH NoE as an Exemplar Project) we have re-implemented and extended two of his early models, dating from 1972 and 1992. In this endeavor, our purpose has been to build an open source "core model" as a set of basic building blocks for physiology modeling, especially using the tools of the VPH ToolKit for interoperability. When we undertook our project, the models QCP and QHP (predecessors of HumMod) were in use in Jackson, and we were of course aware of them – they are much more evolved version of the early models, developed by Arthur Guyton's colleagues over the years. However, the underlying code was not accessible or documented, so we preferred to work with the early ones since their code was available. In the meanwhile, the QCP/QHP developers have made the code available as a collection of XML files, along with extensive technical documentation and tools for adjusting the underlying equations. This new version is called HumMod, and it was a pleasure to meet Radu Illiesco at the MEFANET meeting, since he has extensive experience with HumMod during the years he spent in the Jackson laboratory. Furthermore, we know from your colleague Jiri Kofranek that they have a collaboration in progress with the Jackson group to adapt HumMod to the Modelica environment. This raises exciting prospects for a future open source platform based on the HumMod program, which is a much more complete and up-to-date model than the early Guyton models. For our part, some of our Masters students have used it with success to simulate clinically relevant "virtual patient" scenarios, but as I explained in my talk at the MEFANET conference, we have not used HumMod in our curriculum.

What were you feelings after your lecture in plenary session on MEFANET 2011 conference, which was focused on modeling and simulation in preclinical fields of medicine?

I was very happy to have the opportunity to present our work at the MEFANET conference and especially to see the impressive tools you have assembled.

What do you thing about the MEFANET project and about the MEFANET community covering all Czech and Slovak medical faculties.

I think your web tools are an excellent and impressive example for other networks of medical schools to use. It would be good to establish some kind of regular exchange.

Have you ever been in Czech Republic? How did you spend a rest of free time in Brno? Could you mention any interesting things, which you visited and enjoyed during your stay?

This was my first time in Czech Republic. My wife and I had a great time visiting Brno for several hours, and had the good luck to share the incredible enthusiasm of what seemed like the whole population of the city at the lighting of the Christmas tree in the city center. Very friendly city. We also visited Prague; Professor Kofranek very kindly took us on a long walk through the city on the day of our departure, and we hope to be able to return on vacation sometime soon so we can visit some of the sites and museums.

Interviewed by Martin Komenda

A INFORMATICS IN MEDICAL EDUCATION

mefanet

03 STRENGTHENING THE COOPERATION IN EDUCATION AMONG MEDICAL FACULTIES: THE MEFANET PROJECT EXPERIENCE AND ITS EXTENSIONS

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Abstract
The MEFANET project (MEdical FAculties NETwork) has initiated international, effective and open cooperation among all medical faculties in the Czech Republic and Slovakia. One of the elementary goals of the project is to advance medical teaching and learning with the use of modern information and communication technologies. As an instrument for that, MEFANET has decided to develop an original and uniform solution for educational web portals which are used, together with a central gateway, to offer and share digital educational content. Recent developments have focused on extending the set of tools for multidimensional assessment of the published contents quality. The original assessment was based on the following four dimensions: A. review, B. typological classification, C. the level of the target groups, D. users' self-study score. In addition to that, the new editorial processes now include also mentally active monitoring of the published contents. Three new ICT tools have also been introduced to the MEFANET community besides the common e-publishing portal platform. These new tools provide higher level of interactivity for students during their self-study process. The paper shows how the new three tools SANDBOX, WIKILECTURES and MOODLE-MEFANET are related to the already established and standardized CENTRAL GATEWAY of the portal platform.

Keywords
MEFANET, medical education, e-learning, e-publishing, quality assessment

Introduction

The idea of cooperation of medical faculties in the Czech Republic and Slovakia on sharing their educational digital contents appeared in 2006 for the first time. Early after that in 2007 all seven Czech medical faculties as well as all three Slovak medical faculties have formally joined the brand new network.

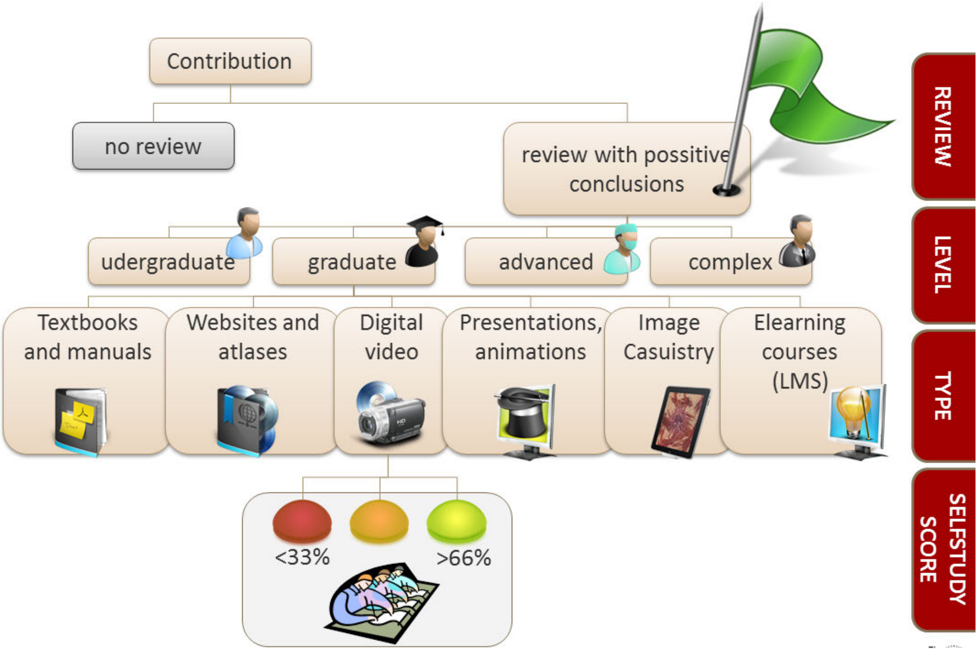

Figure 1. Four-dimensional quality assessment of the contributions involves the following four dimensions: 1. expert review, 2. educational level of target users, 3. classification by type, and 4. self-study score.

The MEFANET (Medical FAculties NETwork) project [1] aims to develop cooperation among the medical faculties as regards the progress in education of medical and health care disciplines using modern ICT by means of a common platform for sharing the educational digital contents.
MEFANET arose as a logical consequence of the shift from traditional to more modern methods of teaching including the methods involving the applications of ICT. This trend is also reflected in higher education, and even in the field of medical education, which is usually supposed to be quite rigid. Potomková et al. in their survey [2] show that “Medicine is a sophisticated mix of knowledge, skills, behavior and attitudes”. Learning goals can be achieved by different modalities from face-to-face lecturing, bedside teaching/learning, mentoring, small-group learning, self-study, self-assessment etc. Since 1990, the rapid spread of internet-based technologies has been leading to the breath-taking metamorphosis of medical curricula, particularly due to e-learning.

MEFANET portal platform

The idea of the shared e-publishing system [3–4] is based on a set of standalone web portals rather than on a centralized application hosted for all medical schools, what might be an inflexible and more vulnerable alternative solution. Each portal instance represents an independent publication media with its ISSN code and an editorial board. Local metadata describing the digital educational contents are replicated regularly to the central gateway, *see Fig. 3*. There are three fundamental elements which have to be kept rigid on the

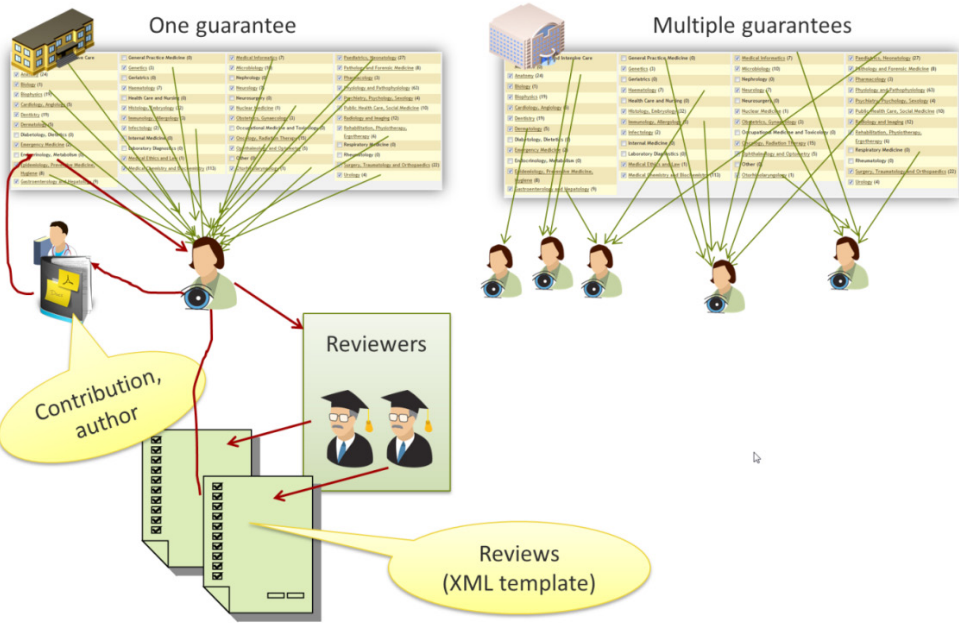

Figure 2. A contribution workflow basic scheme. 1. Author and technical editor finishes the contribution. 2. Guarantee, who is associated with particular medical disciplines, is notified about a new contribution in his/her area of interest. 3. The guarantee alone or with the help of faculty's editorial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

parts of the local administrators: 1. medical disciplines linker, 2. authentication/authorization framework and 3. multidimensional quality assessment. The other features, properties, functionalities can be adapted or localized to meet the needs of the particular schools. Detailed description of the three fundamental elements follows. See [5] for full and comprehensive information.

Medical disciplines linker

The medical disciplines linker represents taxonomy of the contributions. At the beginning single-level or multilevel list of medical specializations were considered as well as the possibility to adapt an existing scheme from the National library of the Czech Republic, which is based on the standard Conspectus method [6]. However, the medical disciplines mapping according to the Conspectus method showed to be inapplicable for MEFANET purposes. Thus, an own medical disciplines linker was composed, based on various taxonomies adapted from significant medical publishing houses. It is a single level list of 49 medical specializations. Medical disciplines linker is the only obligatory structure of a portal instance and any change to it is a subject to approval of the coordinating committee of the MEFANET project.

Authentication/authorization framework

The access to portal instances is not restricted anyhow. All pages and contributions are accessible for anyone. Thus, everyone interested can get an overview

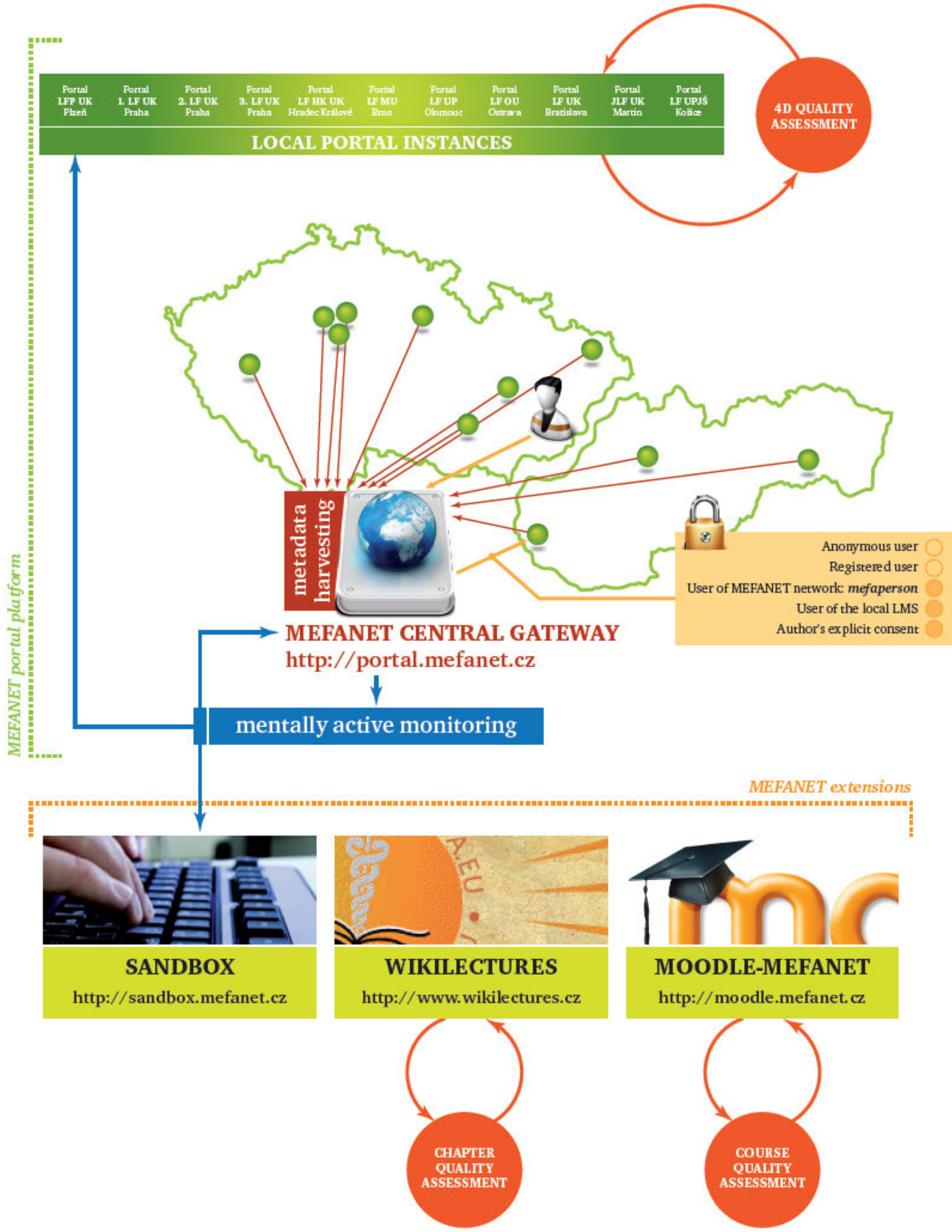

Figure 3. MEFANET portal platform and its extensions: publishing scheme.

of digital educational contents available in the given medical school or even in the whole MEFANET network. The educational contents itself is included in attached files or hypertext links. Each attachment and/or link contains information on a group of users who have access to these materials.

The authors of the teaching materials (i.e., published attachments) can choose from the following user groups, in order to permit or deny access to their materials: 1. nonregistered anonymous users, 2. registered anonymous users, who accepts the terms of use within his/her registration, 3. user of

MEFANET network, i.e., student or teacher from any Czech or Slovak medical school, 4. user of local university, whose affiliation to that university has been verified at the portal via the local information system of that university, 5. user to whom attachments are made available only on the author's explicit consent.
Services of the Czech academic identity federation eduID.cz [7] are used, in order to check affiliations of the users of the portal instances. This federation uses Shibboleth technology which is one of many authentication frameworks allowing sharing web resources among institutions using the SAML (Security Assertion Markup Language) protocol standard. The portal instances behave like service providers in this federation, whereas the information systems of the involved schools behave like identity providers.

4-D quality assessment
There are four dimensions which are of crucial importance when evaluating the quality of electronic teaching materials, *see Fig.1*.
The first of them is an expert review. The review includes binary questions as well as open questions. The structure of the review-form can be localized by modifying an XML template file. The second dimension is represented by the educational level of the target group of the teaching material, which is a useful piece of information for users as well as for reviewers. Next dimension is represented by a multiple-choice classification according to the types of attachments – the enumerated scale includes static files for web-based learning as well as interactive e-learning courses encapsulated in learn management systems (LMS). The last dimension – a self-study score – shows what users think about usability of a particular contribution for their self-studies.
Values of the first three dimensions of the 4-D assessment of are composed by authors, guarantees and reviewers. Their activities as well as the workflow of a contribution are explained in *Fig. 2*.

Mentally active monitoring
Besides the 4-D quality assessment, all contributions sent to the central gateway undergo an additional editorial process called "mentally active monitoring". It focuses on the following issues: 1. metadata are filled properly, 2. granularity of attachments is suitable, 3. all attached documents and the links are accessible for users with the Mefaperson role at least. Monitoring of these three important issues is done not only at the level of syntax, but also semantically, and is therefore carried out by a team of human editors in cooperation with the editors responsible for local portal instances.

MEFANET Central Gateway
Besides eleven portal instances, the central gateway is another web-based application which collects all metadata from the web portals in the MEFANET network. A complete image about the available digital contents is constructed

in this way. Students and academic staff can search and browse the contributions sorted by medical disciplines, authors, schools or multidimensional quality assessment criteria. For details, see http://portal.mefanet.cz.
The data format of a shared contribution is based on XML-based RELAX NG schema language [8]. XML documents representing the contributions without their attachments are imported regularly with 24-hour period. The XML validation procedures are based on matching patterns specified in own RELAX NG schema.

MEFANET extensions

Recently new ICT tools have been introduced to the MEFANET network besides the common e-publishing portal platform. These new tools or platforms complement the portal platform suitably, as they provide higher level of interactivity for students during their self-study process.
Fig. 3 shows how the new three tools SANDBOX, WIKILECTURES and MOODLE-MEFANET are related to the already established and standardized CENTRAL GATEWAY of the portal platform. The SANDBOX and the CENTRAL GATEWAY share the same data model (the same entities and their relations) and their contents is differentiated only by the editorial processes. The other two extensions act as rather stand-alone platforms and utilize third-party (open source) software: MediaWiki [9] and LMS Moodle [10]. However, any resulting teaching materials which undergo the multidimensional quality assessment can be (and should be) published on the central gateway. Detailed description of the particular extensions follows.

Sandbox

MEFANET Sandbox was created in response to the procedures for mentally active monitoring. These procedures set very strict rules for the published contributions – all their metadata have to be completed, contributions' granularity is checked for deficiency or excess of attached documents and all the attachments or external links have to be available at least for users with Mefaperson role. It is not always possible to keep all these rules, as the teaching materials published electronically go through various stages of development. It would be a pity not to offer them for students as supplementary material, although without guarantee of quality. In addition to that, such teaching materials should be offered to potential co-authors from other schools. Thus, Sandbox may potentiate collaborative creation of electronic teaching materials among teachers.
Sandbox is available at http://sanbox.mefanet.cz.

WikiLectures

WikiLectures provide collaborative Web2.0 space for production and storage of medical teaching materials. This platform is aimed mainly for continuous creation and editing of texts for pre-gradual education by students them-

selves. An editorial team has been designed to provide support for authors as well as quality monitoring. The most important property of the WikiLectures is simplification of the production of learning materials, easy updating, and inspiring cooperation among people interested in the same topics. Texts are not created in the form of encyclopedia contributions, but rather short chapters of a textbook are produced.
WikiLectures are available at http://www.wikilectures.eu.

LMS Moodle-MEFANET
Moodle belongs to learning management systems and is available as open source software under the GPL open licence. It integrates various tools for study management and sharing of teaching/learning materials. Among others, the system allows to control access rights, to provide tools for administration of courses, study plans, students' activities. Further, it contains tools for communication, for creation, operation, and evaluation of teaching courses and objects, students' examination, etc.
Moodle-MEFANET is available at http://moodle.mefanet.cz.

Conclusions

High-quality digital educational contents production has become a matter of prestige at medical schools in the Czech Republic and Slovakia and the volume of teaching/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 during last six years.
Three new MEFANET extensions, which complement the standardized e publishing portal platform, were described here. Each of them is usable independently; however a complex use of them together 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 MEFANET extensions as well as a broader integration of the digital educational contents among the MEFANET community.
Further development will aim to encourage publication of materials for the teaching of clinical reasoning based on the concept of virtual patients. Development of another ICT extension of the MEFANET portal platform, focused on the clinical cases for medical education, has been already started.

Acknowledgements

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The project "MEFANET clinical reasoning" reg. n.: CZ.1.07/2.2.00/28.0038 is supported by the European Social Fund and the state budget of the Czech Republic.

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04 USE FLASH PRESENTATION ON MEDICAL PORTAL OF SLOVAK MEDICAL CHAMBER (WWW.I-MED.SK)

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Abstract
Slovak Medical Chamber in the year 2010 started the first medical portal (www.i-med.sk) [1] of this kind in Slovakia. The portal includes complete medical branches and is addressed to the primary contact physicians – general practitioners for adults and general practitioners for children and adolescents. It is funded under the EU Operational Programme Education. In the first pilot projects was created also flash presentation on the topic "Bronchial hyperreactivity". This presentation was determined to understand and learn the lung function tests and respiratory disease problems – ARDS (acute respiratory distress syndrome) and followed irritation asthma. The whole flash presentation is in the form of interactive case report. Also at the presentation are incorporated current tests and educational issues, allowing the reader at the end the evaluation of the correct answers. The entire flash presentation in a playful way forward and educate readers about the various areas of diagnosis, differential diagnosis and therapy of respiratory disease.

Keywords
MEFANET, medical education, e-learning, e-publishing, quality assessment

Introduction

Slovak Medical Chamber in the year 2010 started the first medical portal (www.i-med.sk) [1] of this kind in Slovakia. Project is funded under the European Union Operational Programme Education for modern education for educated society. The aim of i-med project is to create system of continuous long-life education of physicians in Slovakia through e-learning portal. For coordination of educational activities will be saved all activities realized by Slovak Medical Chamber on the portal (date, time, lectors, topic etc.). Structures of educational activities are 3 types:
1. E-learning reviews,
2. E-learning excerpts,
3. Audio-PowerPoint presentation from congresses.

Figure 1. I-med portal.

The portal includes complete medical branches and is addressed to the primary contact physicians – general practitioners for adults and general practitioners for children and adolescents.

Activities for support of i-med portal

In first phase of implementation of i-med there was necessary analyze state of continuous long-life education of physicians in Slovakia provided by e-learning system. After that we created new e-learning portal for slovak physicians, now days continue implementation of i-med in practice. Other co activities will be education of e-learning portal users. However there will be crucial actualization of e-learning content (already in November 2011 we have 76 published e-learning contribution, 150 contributions in recension and over 900 physicians connecting to e-learning portal. On figure 1 you can see outlook of i-med portal.
Portal i-med allows insert e-learning contribution. There is automatic recension process. Physicians study contribution on portal and after study part they can online fulfil credit tests, which are automatically recorded to Slovak Medical Chamber as was described by Mesko. [2]

Methods

In the first pilot projects was created also flash presentation on the topic "Bronchial hyperreactivity". This presentation was determined to understand and learn the lung function tests and respiratory disease problems – ARDS (acute respiratory distress syndrome) and followed irritation asthma. The whole flash presentation is in the form of interactive case report. This interac-

Figure 2. Multichoice and feedback questions and answers.

tive case study was firstly seen on webpage of New England Journal of Medicine. [3] Adobe Flash® is a multimedia authoring tool. Paton has described how learning objects can be used to create and publish interactive learning objects. [4] It is possible to use in flash presentation interactive tools like questions with multichoice answers and also feedback *(see fig. 2)*. In case of multivalent answers in flash animation you can apply more scopes of answers *(see fig. 3)*. In our flash presentation we have green coloured suitable answers, orange coloured possible answers and with red colour wrong answers.

Interactive flash animations allow using auscultation founding such as respiratory wheezing, but also it is described. In our interactive case we have used also moving subject like spirometry, which was educatory colour differentiated of inspirium and exspirium during providing expiratory manoeuvre *(see fig. 4)*. Students can found there also measured and normal values of spirometry according to patient anthropometric parameters.

Web based environment enable use of other interactive tools such as drap and drop question with answers. For students it must intuitive manoeuvrability for using drap and drop *(see fig. 5)*. Correct answers flash animation should be marked – in our case we use green circle in case of correct answer and incorrect answer are marked with red cross.

In flash animation you can have also video with comment. At the end of flash animation educational course on web is possible have evaluation of course with percentage and correct answers *(see fig. 6)*.

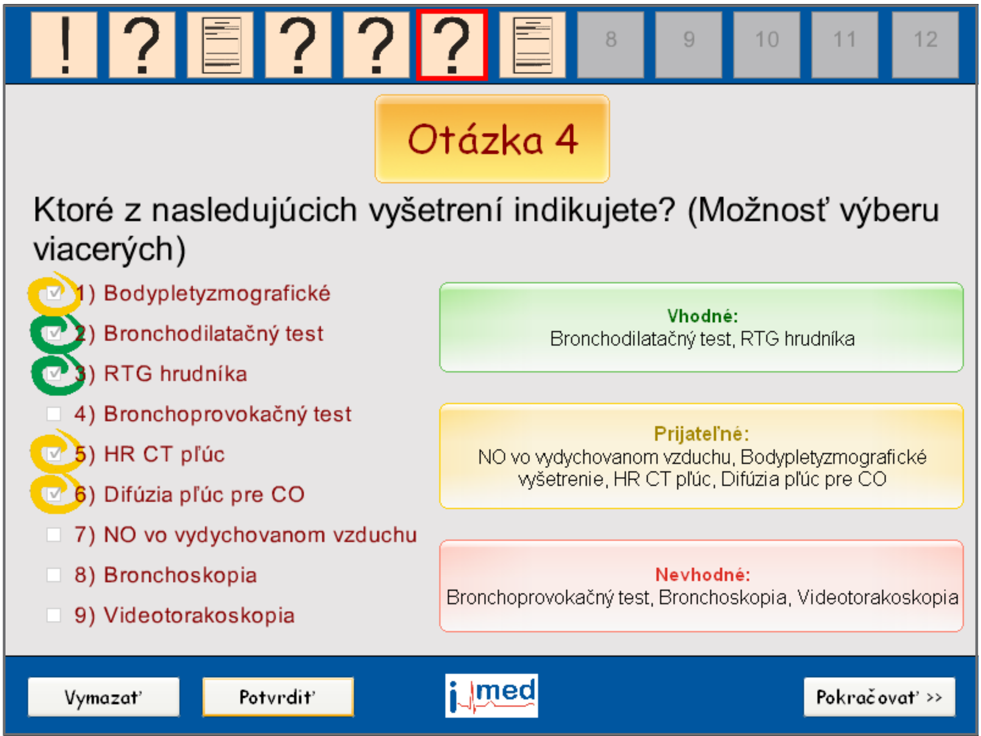

Figure 3. Multivalent answers question.

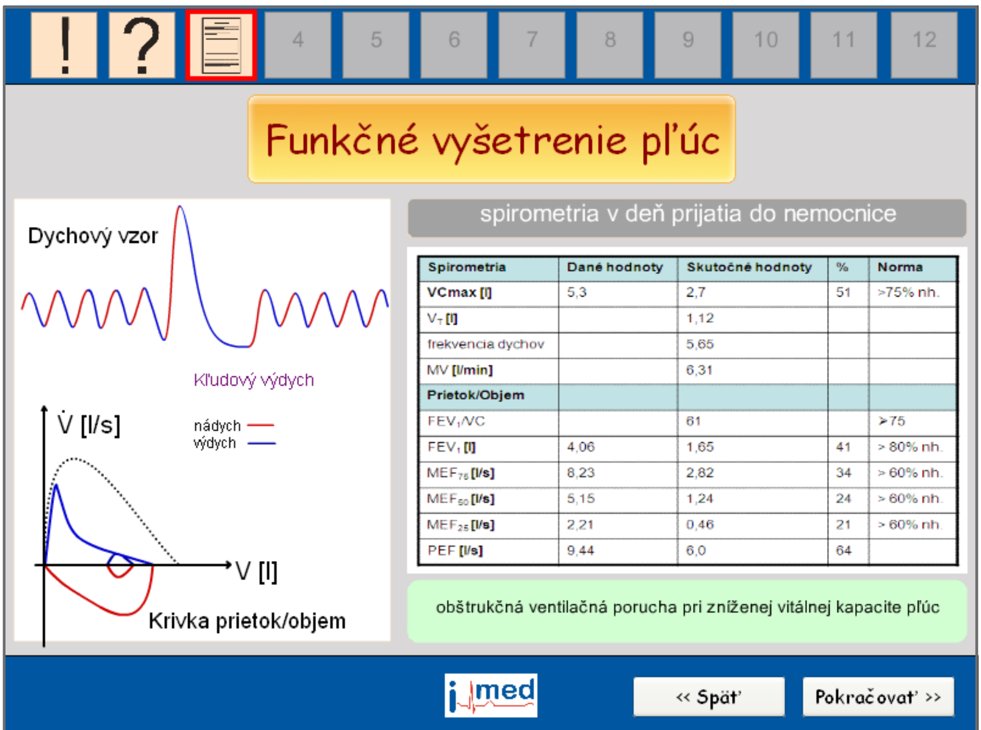

Figure 4. Spirometry in flash animation.

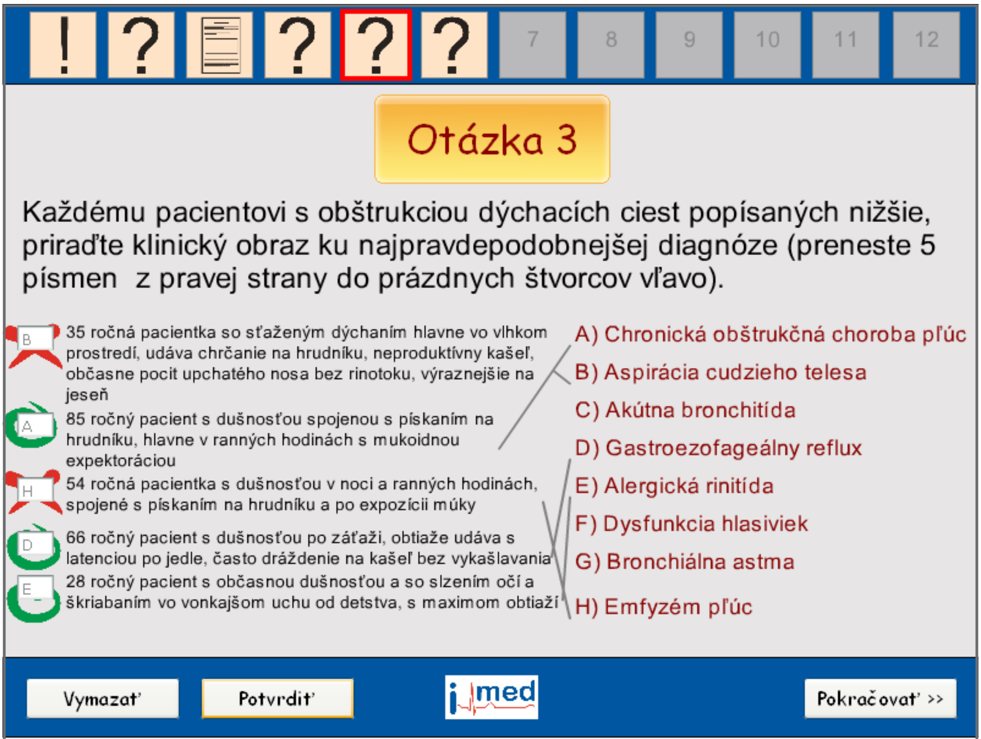

Figure 5. Drag and drop web flash tool.

Figure 6. Evaluation form of flash course.

Discussion

Advantages of e-learning are: [5]

- Individualization of education
- For students it is more comfortably and also cheaper as present study
- Saving time
- Cheaper for teacher
- More unprejudiced evaluation as during oral examination
- Realization immediate feedback, activation and motivation of students
- High level of presentation of learning topics, archiving and innovation
- Global opportunities, geographic unreserved

E-learning in few words … **comfortable, cheap, flexible, fast, more interesting, superior…**

Disadvantages and minuses of e-learning are: [5]

- Absence of motivation, motion and ability of students for independent self study
- Health problems during using PC
- Decreasing of chance for education (for poor people)
- Problem of student's development in emotion area
- Problems with development of some crucial competences (interpersonal, communication and cognitive)
- Some components of education is not possible acquire (mainly psychomotor skills)
- In this time reality show for low quality, mostly for absence of skills and professionalism of e-learning courses authors in our region

Mihál et al. described that in spite of technological advances in the digital era (e-learning), which not allowed knowledge with all sense (touch, smell), medical education should retain its traditional humanistic feature and peer-guided format – alternative is "blended learning". [6]

Conclusion

In information-communication technologies era the medical educator should be the mediator or facilitator between knowledge and the student; should be lifelong learner, partner for students. [7] Medical teacher should be also creator of for student's attractive educational materials with high quality. Nowadays it is quick and a lot of information in every branch of medicine and for this reason it is necessary to have quick update of educational materials. Also it is requisite to have playful form for students, which allows flash presentation.

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INNOVATION OF UNDERGRADUATE EVIDENCE-BASED PAEDIATRIC CURRICULUM: A CASE STUDY

05

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Abstract
The aim of the paper is to outline an innovative project of the existing evidence-based paediatric course at a 'bench to bedside' learning platform. Three-year experience based on the feedback gathered from students has demonstrated that the students' actual clinical cases may improve uptake of EBM knowledge. The current curriculum includes formal training for use of online search skills by medical librarians as well as interactive web-based tutorials. Students work in pairs, they are assigned an actual patient case, ask a clinical question, and select an article that would assist in answering their question. The online curriculum consists of self-learning as well as facilitated units. Each pair of students has to go through evaluation afterwards. In general, students have confirmed the value in the curriculum, but many of them cited the time commitment as a weakness. Based on the results of SWOT analysis we have defined a set of innovative parameters to eliminate the weaknesses: online collection of peer-reviewed students' paediatric cases with repeated common diagnoses but different complications; lecture podcasts; PICO seminars for group discussion of clinical questions and their relevance; (e)-mentoring.

Keywords
evidence-based paediatric curriculum, case-based learning, blended learning, e-mentoring

Background

In 2008, Palacky University Olomouc (Czech Republic) paediatricians launched a project with the goal to involve 5th year general medicine students in an evidence-based healthcare approach around real-life scenarios. This required a sound methodology including web-based learning materials to make a new course attractive, acceptable, and viable.
3-year-experience has confirmed that the idea of using actual clinical cases during the students´ paediatric clerkship can facilitate uptake of EBM skills and knowledge. A new feature of the curriculum is a two-layer architecture, combining clinical education and information skills training provided by a multiprofessional team od educators with the involvement of medical libar-

ians. In the end of the clerkship, students present their EBM case reports at a mini-conference being evaluated according to a set of pre-defined criteria by a committee nominated by the head of the Paediatric Department Online learning materials are available through the Czech National Medical Education Portal MEFANET [1].

Surveys & Feedback

In two consecutive academic years 2008/2009 and 2009/2010 a total of 226 medical students who had completed the paediatric clerkship were surveyed by a questionnaire consisting of structured questions (1-to-5 rating + open-ended). The trainees were asked to express their opinion about perceived values of the curricular features, in particular the value of practical training, teachers' willingness, and impact of instruction on increased interest in the discipline. The results showed the following best scored instructional features : teachers' willingness (score 1 by 72 % respondents), quality of practical training (score 1 by 44 % respondents), and increasing interest in the specialty (score 1 by 32 % respondents).
There was a separate questionnaire survey among the same cohort of the students (n = 226) focused on their perceptions of 3 modes of information skills training, namely: mandatory non-interactive demonstration of a PubMed search, elective interactive small-group hands-on classes, and online tutorial with animations, fulltext examples of various study designs, templates for study design interpretation etc. Up to 70 % of the students self-reported their post-training level of search skills as average, but satisfactory to accomplish the task. Nearly 82 % of the respondents were fully satisfied with the hybrid instruction package consisting of a non-interactive PubMed search demonstration, supplemented with the web-based search skills tutorial, whilst 14 % did not find this package sufficient without subsequent interactive hands-on sessions. In this context, the survey data showed that about 62 % of the respondents regarded the subsequent hands-on training as important, whilst a total of 45 % did attend the sessions. Fisher's exact test confirmed the statistically significant correlation ($p < 0.0001$) between these two perceived values: 89 % of the hands-on session participants agreed on its efficiency, as well as up to 39 % of those who had not actually attended the interactive classes.
Open-ended questions produced some thought-provoking verbatims:

"I found this learning activity refreshing, illustrative, enriching, BUT extremely time consuming…"

"For me, it was a waste of time, not a very efficient educational tool… I prefer textbooks."

"In the beginning, I was hopeless, because I had no idea what it was going to be about. Later on I understood that searching databases should be always inevitable to find the best treatment option for my patients. Having completed the clerkship, I decided to become a paediatrician…"

"I was especially fond of the EBM workshop, including demonstration how and why to search for relevant literature."

"I am very happy that I had an opportunity to be trained how to search PubMed, even if the beginnings were not very easy. Now I feel competent enough to find what I need."

SWOT Analysis

A SWOT (Strengths – Weaknessess – Opportunities – Threats) analysis [2] was used to interpret the results of the surveys including verbatims with a special attention to weaknesses of the educational procedures. There were three main areas deserving reasonable improvements: time management & (e)-mentoring, formulation of PICO questions, and model solutions with Web 2.0 apps.

Innovations

Time Management and Mentoring

Originally, there had been one student per patient that was later considered an enormous teaching and learning load. According to a new arrangement, one patient is allocated to a pair of students. More mentoring is offered by educators, librarians, and online through asynchronous communication service run by the university for registered users as part of the courseware [1].

PICO Workshop

The practice of evidence-based medicine supports the 21st century healthcare and involves asking questions, searching, appraising and applying best available evidence.

Questions arising during patient care include general (background) and complex (foreground) questions. Background questions dealing with a clinical problem or a disease process are best answered by internal evidence, expert opinions, relevant review articles, pre-filtered EBM knowledgebases (e.g., UpToDate) [3], or respected evidenced-based textbooks. On the other hand, foreground, patient-centered problematic questions require consideration of primary studies in the literature. These can be approached efficiently and effectively by formulating a searcheable question in a PICO format. PICO is an acronym for Patient – Intervention - Comparison – Outcome.

The literature reports [4] that many clinical questions remain unanswered due to lack of skills in formulating relevant questions and searching. In this context and based on students' surveys a PICO workshop supported by online templates was introduced to help trainees accomplish this difficult, but a most important step of the EBM process. Under guidance of clinician-teachers and librarians, students share and finetune suggestions how to formulate relevant PICO questions before searching PubMed.

Model Solutions

The paediatric clerkship is held in the Paediatric Department of the University Hospital in Olomouc. The profile of the department can be characterized by the following features: (a) patients within age categories 1–18; (b) acute and chronic diseases; (c) specialized care in the fields of emergency medicine, onco-haematology, gastroenterology, respiratory diseases, nephrology & urology, surgery, endocrinology, neurology, etc.

For 3 years now, we have been archiving all case reports elaborated by the students in the format of PowerPoint presentations. Some of them have been peer-reviewed and published online on the MEFANET portal [1], other are being categorized by basic diagnoses to be ready for further use.

Our goal is to show medical students a complexity of paediatric care for each patient as a multi-layer individual clinical problem with potential complications. Future doctors must be aware of the existence of current guidelines and recommendations for disease management, but in parallel they should respect the patient-oriented evidence that matters (POEM). In practice it may happen that published evidence on disease complications of the individual patient is very weak (study designs such as case reports, case series etc.). Some authors [5] go too far claiming that "the only thing that actually changes practice is adverse anecdote". From the theoretical point of view this idea is closely related to experiential learning [6] that practically helps better understand and remember new events [7].

Modern information technology, in particular Web 2.0, brings about new opportunities to improve cognitive impact of learning materials, e.g., podcasts accompanying web-based courses. For this purpose, the portal MEFANET is an ideal site to post such multimedia learning materials [8].

Conclusion

The paper describes innovation of the existing evidence-based paediatric course at a 'bench to bedside' learning platform. The SWOT analysis had revealed some weaknesses that were alleviated in terms of time management & (e)-mentoring, training in PICO questions formulation, and model solutions including Web 2.0 apps.

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06 IMPLEMENTATION OF ON-LINE TECHNOLOGY IN POST-GRADUATE TRAINING OF NURSES

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Abstract

General nurses represent the largest group of workers in health care. They have two options of carrying out their profession which is given by the law No. 96/2004. They either work under specialist supervision or unsupervised. In order to obtain the license for unsupervised work, they have to submit a proof of having passed educational activities. For the license renewal every nurse needs 40 credits from educational activities pertaining to their specialization. The work of a general nurse is both physically and mentally demanding. Combining the roles of a professional worker, a mother and a wife is exceptionally difficult. Nurses have to integrate their professional and private duties with the post-graduate training program. Research findings have shown that the main obstacles to the post-graduate training perceived by the nurses are the financial demands and a lack of time. Another significant problem is the local accessibility of the training activities. These obstacles can be removed by the implementation of live on-line lectures for nurses. On-line lectures are accessible all over the Czech Republic eliminating the need to commute. In a virtual classroom the student can see the teacher and is able to communicate with him or her on-line. The lecturer can respond to the students the same way as in classic teaching. The virtual classroom contains many interactive elements and the lecturer may support their presentation by audio-visual features and can engage the students in the learning process. In the retrospective evaluation of the on-line lectures, the students acknowledged this form of study as inspirational, they expressed their satisfaction and they are interested in continuing their learning through the virtual environment.

Keywords

nurse; education; online technology

Introduction

This article deals with the issue of registration of non-medical health care workers as the system of documentation of lifelong education. Contemporary world lays increased demands in all disciplines, particularly in health care. In order to ensure provision of high-quality nursing care by competent work-

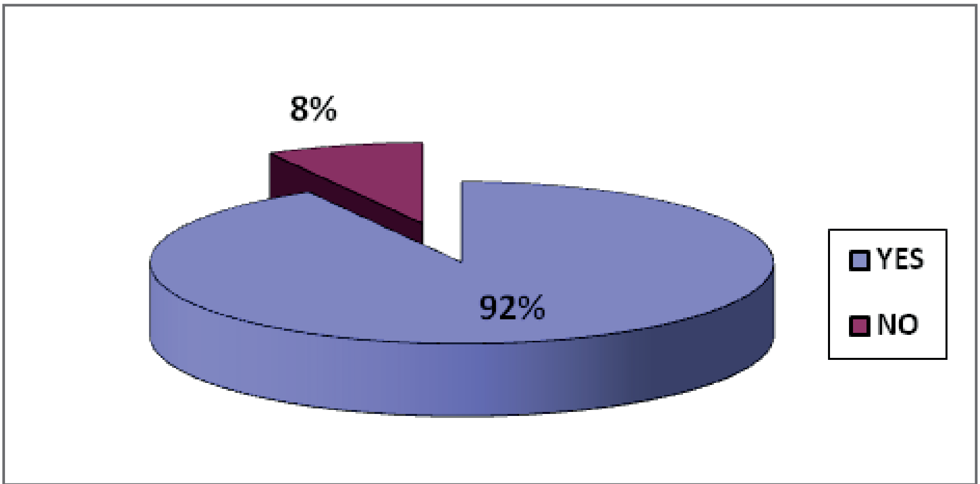

Figure 1. Would you be interested in trying out online education?

ers, conditions for authorization to execute health care profession independently without professional supervision had to be set. And those conditions are defined by the registration system specified by law.

Current Situation

General nurses represent the largest group of workers in health care. [4] They have two options of carrying out their profession which is given by the law No. 96/2004. [7] They either work under specialist supervision or unsupervised. In order to obtain the license for unsupervised work, they have to submit a proof of having passed educational activities. For the license renewal every nurse need 40 credits from educational activities pertaining to their specialization. [6] The work of a general nurse is both physically and mentally demanding. Combining the roles of a professional worker, a mother and a wife is exceptionally difficult. Nurses have to integrate their professional and private duties with the post-graduate training program. Research findings have shown that the main obstacles to the post-graduate training perceived by the nurses are the financial demands and a lack of time. [2] Another significant problem is the local accessibility of the training activities. [1]

Solution Proposal

These obstacles can be removed by the implementation of on-line live lectures for nurses. On-line lectures are accessible all over the Czech Republic eliminating the need to commute. In a virtual classroom the student can see the teacher and is able to communicate with him or her on-line. The lecturer can respond to the students the same way as in classic teaching. The virtual classroom contains many interactive elements and the lecturer may support their presentation by audio-visual features and can engage the students in the learning process. Online lectures take place in the certified virtual environment ONIF, that is operated by the Company iCORD International Ltd. [3]

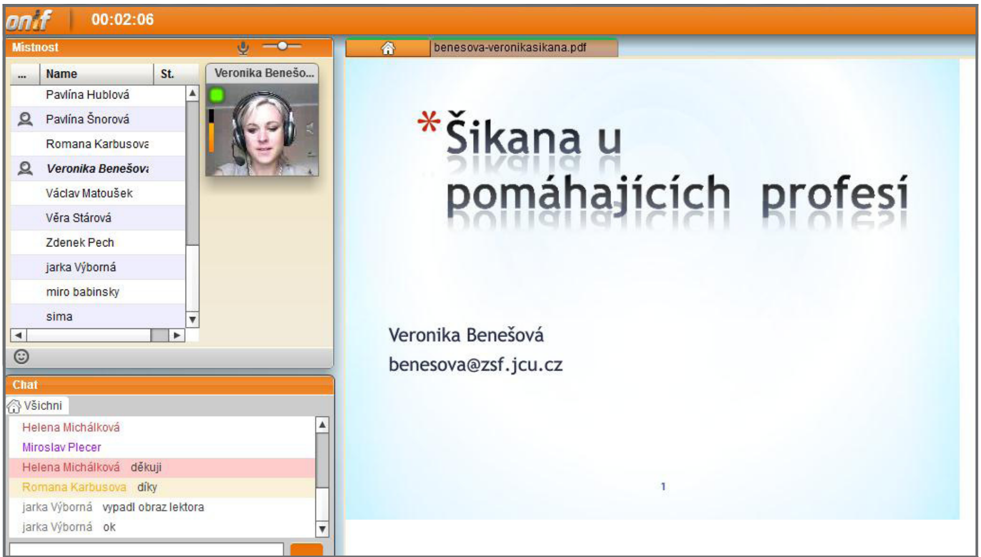

Figure 2. Virtual Lecture Room Onif.

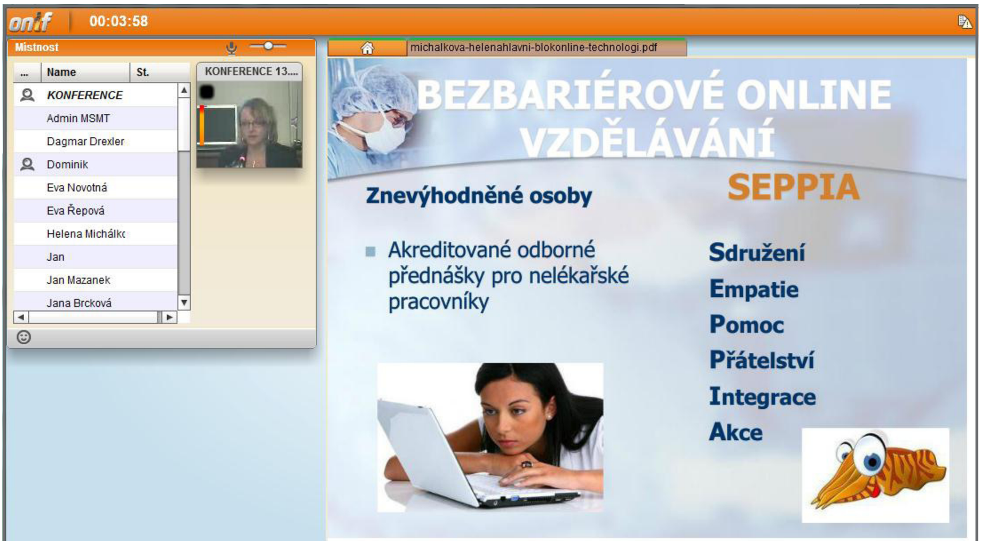

Figure 3. Virtual Lecture Room Onif.

Pilot Survey

A questionnaire survey has been carried out, in which 184 respondents from all regions of the Czech Republic have been approached. 24 % of those questioned have stated that their place of work is at emergency and the remaining 76 % respondents at inpatient wards. The most acceptable form of education for 48 % of the respondents is passive attendance and for 15 % it is active participation in conferences and seminaries. 21 % of the respondents have stated that for them the most acceptable is taking part in certified courses. Some experience with e-learning form of education has 30 % of respondents as opposed to the remaining 70 % who have not had any opportunity to try this out. 92 % of those asked have expressed their interest in trying out online schooling and 8 % have not. (*Figure 1*) When choosing an educational activity, the venue is the biggest priority for 30 % of respondents, the topic for 38 % and for 23 % it is affordability. When asked whether the respondent has access to the internet at home, 97 % of the questioned replied in the affirmative and 3 % in the negative. From the survey it seems to be apparent that the vast majority of respondents are interested in online education and that is the reason why we have started our cooperation with the non-profit organization SEPPIA Citizens Association, which has embarked on putting these lectures into practice.

SEPPIA Citizens Association

SEPPIA is a citizen's association which dedicates itself to aid and integrate disadvantaged persons such as the handicapped and disabled, women on maternity leave, elderly people and home carers of related persons. This association had, by 1st April 2012, carried out 62 accredited lectures with 487 students participating. An assessment questionnaire for evaluating of the lectures by students has been made and 48 students in total have responded. 100 % of those who submitted their replies stated that they are fully satisfied with the online schooling and all have described the entry into the interactive classroom as very easy. 80 % of the replying students are satisfied with the interactive features in the online environment, 96 % found this environment inspirational and 76 % are satisfied with the quality of the lectures.

Students' Verbal Evaluation:

"an excellent idea"

"that's exactly the form of schooling that's been missing here"

"I'm looking forward to the following lectures"

"I'll definitely recommend it to my fellow students/colleagues"
"the form is perfectly suitable, it's possible to respond to everything and join in"

"it also suits me because I can stay at home without having to commute, I can communicate my opinions right off"
"this form of lectures should have been here a long time ago, for those who have little kids as well as those working shifts – it's ideal"

Why Online?

- LIVE lectures
- without any need to travel
- low financial expenses
- available on the whole territory of the Czech Rep. and Slovakia

- lecturer teaches from home – saves travel time
- mothers do not require babysitting
- innovations in the field readily available

Conclusion

The article has provided prove for the fact that in further education nurses give preference to passive participation in events such as seminars and conferences and that the vast majority of nurses find it necessary to educate themselves in their field. The biggest obstacle for nurses consists in financial and time demandingness of the educational events. These barriers can be removed by implementation of live on-line lectures for nurses.

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B EFFECTIVE TEACHING AND LEARNING ENVIRONMENTS

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07

3D TECHNOLOGIES AND EDUCATION

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Abstract

This paper presents basic principles of tree-dimensional (3D) technologies and possibilities of their utilization in education. A brief history, present state and future trends are outlined here. Main objective is to contribute to discussion about positive and negative impacts of this progressive part of virtual reality on teachers and their students. Recent development and increasing accessibility of such technologies shows that they play a considerable role in teaching concepts for both distance and traditional classroom learning environments.

Keywords

3D technology, virtual reality, education

Introduction

Nowadays, the teachers of modern information society often face the questions regarding the ways to improve education and explanation of their specialized topics. In that sense, we may think of questions “What is a good teaching?” and “What is a good learning?” The answers are usually subjective, barely measurable, and strongly dependent on education content. However, many teachers agree that the students should be involved in active form of teaching, they should discuss particular themes, and they should propose possible solutions of discussed problems. A good learning includes topics designed as real situations and/or simulations of real contexts, project-based learning, abilities of national or international collaboration between students and many others. What the teachers still oppose is, whether the students really do the things outside of the classrooms, whether they do the tasks on their own, whether the contact between teachers and students can be primarily virtual, etc. It is not easy to find answers, but a combination of face-to-face and distance forms of education seems to be the best way how to satisfy both groups. Especially when modern technologies offer new opportunities to present education content and the students are quite familiar with them.

Evolution in education

Both the teaching and the technology have overcome a long way of development and improvements. The history asked teachers to understand new technologies and to apply them in the classrooms. This required searching for

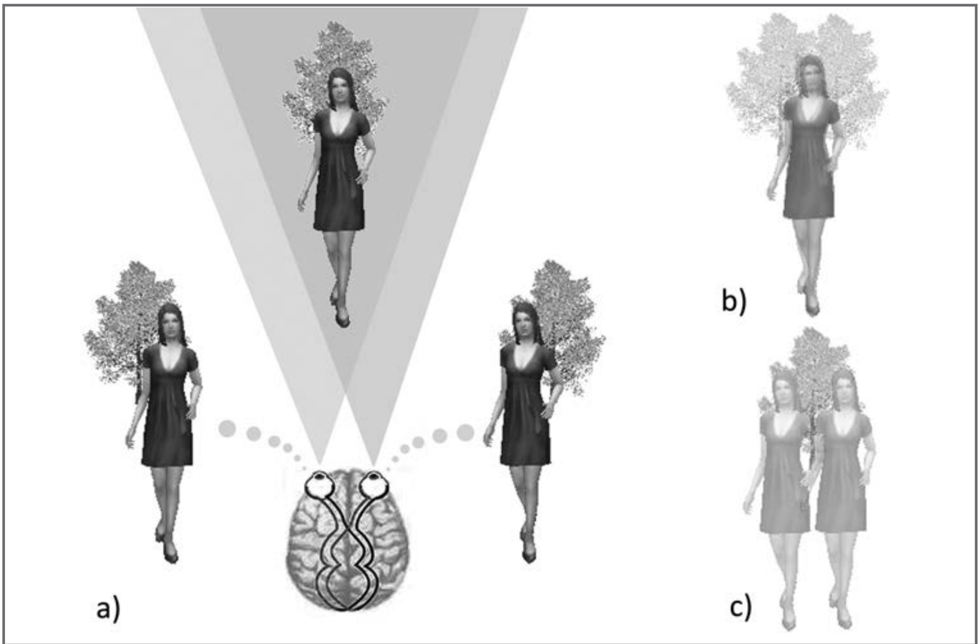

Figure 1. a) Stereoscopic vision analyzed by human brain. b) Views focused on woman. c) Views focused on tree.

meaningful ways of their utilization as well as for arguments that proved the teaching objectives will be achieved in more effective and more demonstrative manner. Naturally, the goals of lessons may be achieved also without recent technologies, but the students ask for them due to the todays' availability.

It is clear that the education aims are always almost the same. It is also clear that some teachers are opened to implement best teaching practices, while others worry to think about any change in the traditional form of education. However, this second group includes many teachers that are specialists in their scientific areas, and therefore they may use assistance of their more skilled colleagues to create effective technology-teaching relationship. Most frequently used technologies include virtual reality tools, simulations, interactive and dynamic teaching content, multimedia, but also educational games and social networks.

There may be specified several factors that have to be considered while thinking of innovation using new technologies in the classroom. These factors include for example technological background, teacher's skills, innovation technology and target group of students. Technological background should offer information about technology infrastructure (i.e., computer network) in the school, possible usage of existing technological support, potential cooperation with other members of pedagogical staff etc. Teacher's skills consider possibilities to use innovative technologies, motivation to adopt new methods in education, preferred teaching style, and accessibility of supported teaching materials, manuals, and books related to the preferred modern technology etc. Innovation technology gives us information about the place of implemen-

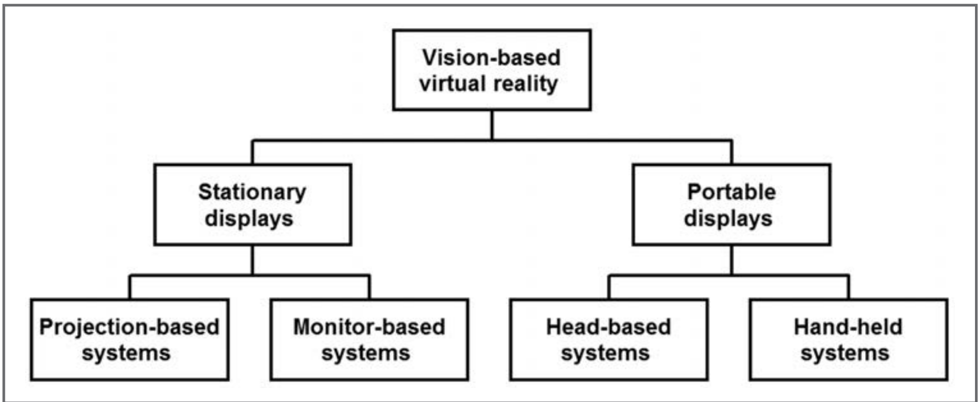

Figure 2. Diagram of different categories of visual-based virtual reality systems.

tation, about interaction with pedagogical goals, similarity to current teaching methods, ways to support technology for the future etc. Finally, the group of students is the factor that answer the questions of their role in innovation process, demands on information technologies skills, knowledge of similar systems and/or tools, benefits and advantages regarding previous teaching forms, comfortable usage etc.

Even if there are challenges to use the latest technologies, the above mentioned factors should be carefully considered. A special attention should be also paid on experience one may obtain while studying functionality, options and properties of the technologies before they will be used as learning tool.

3D Visualisation

Modern teaching methods are based on different innovative technologies. 3D visualisation technology is one of them. It can significantly improve current teaching methods by resolving common educational problems connected to the explanation and understanding of specific topics. Basically, the teaching is supported by 3D virtual environments that offer more illustrative presentations. The main consumers of 3D technologies are mostly higher education institutions that bring them to the applications through the research and development.

We may find a lot of technologies referred as 3D. Most of them use transformation of 3D content into the 2D pictures so they cannot be considered as real 3D. One of the truly 3D technologies is presented by stereoscopic 3D visualization that really shows all dimensions of the objects. The process of stereopsis was described by Charles Wheatstone in 1838. He formulated that this is the process by which humans perceive three dimensions from two highly similar, overlaid images. Wheatstone developed his stereoscope and used it to view static images. Since that time, the 3D technology overcame long way and now we can watch 3D movies, play 3D games etc. Stereoscopic

Figure 3. Anaglyph, polarized and shutter glasses for stereoscopic visualisation.

vision has been very important in human development. Using stereoscopic vision we can identify position of surrounding objects in relation to our bodies. The importance of depth dimensions is evident especially in cases when the objects are moving toward and/or away from us. We can also see a little bit around solid objects without moving our heads and we can even perceive and measure space with such binocular vision. Many occupations strongly depend on stereo vision including surgeons, dentists, but also architects, drivers and many others.

3D stereoscopic vision refers to how human eyes and brain create the impression of a third dimension. Human eyes are approximately 50 mm to 75 mm apart and each eye sees a bit different part of the scene. It means that the image on one side (eye) is similar but slightly offset to the image on other side. Therefore, for true perception of objects' depth, it is necessary to visualize not only one 2D image, but at least two separated images – one for each eye. The source image has to be recorded by multiple cameras or the scene must be generated from multiple views/positions. In addition, the presentation devices have to deliver the proper image to the proper eye while watching 3D scene. In this case, two slightly different images enter the human brain, which is able to determine all spatial dimensions: width, height and depth. The ability of depth perception includes perspective, overlay, shadowing, aerial perspective, relative motion, relative size, etc.

Modern 3D technologies try to replicate the same principles of how the human brain works with two different perspectives of the scene. All are designed to offer different perspectives of the same image into our individual eyes. However, while it is quite easy for our brain to figure out the disparity between the two images, it is a hard job to do the same with camera. Main task to be solved is to get individual images to individual eyes without the loss of information and space effect. The systems used to "create" 3D virtual environment refer to hardware and software that enable users to be immersed in. Such systems basically offer stereoscopic view, cover maximum proportion of user's field of view and allow controlling of the viewpoint in real time. Figure 2 shows simplified diagram of different categories of visual-based virtual reality systems.

Depending on the number of students and considering the teaching purpose we may expect the stationary systems will be preferred in lecture rooms. Playing education movies and/or animations using projection usually on special silver-coated screens offers two main ways of how the 3D effect can be achieved: anaglyph or polarized glasses.

Anaglyph is one of the first and one of the easiest methods of 3D stereoscopic visualization. The users watch the scene wearing red-blue (red-cyan or red-green) glasses. Scene to be visualized is prepared as mixture of images for left and right eye, each in particular colour (red-blue). Using coloured glasses eyes get particular perspective and the brain process the 3D effect. The advantage of this approach is that the standard display units (monitors, projectors) can be used for projection.

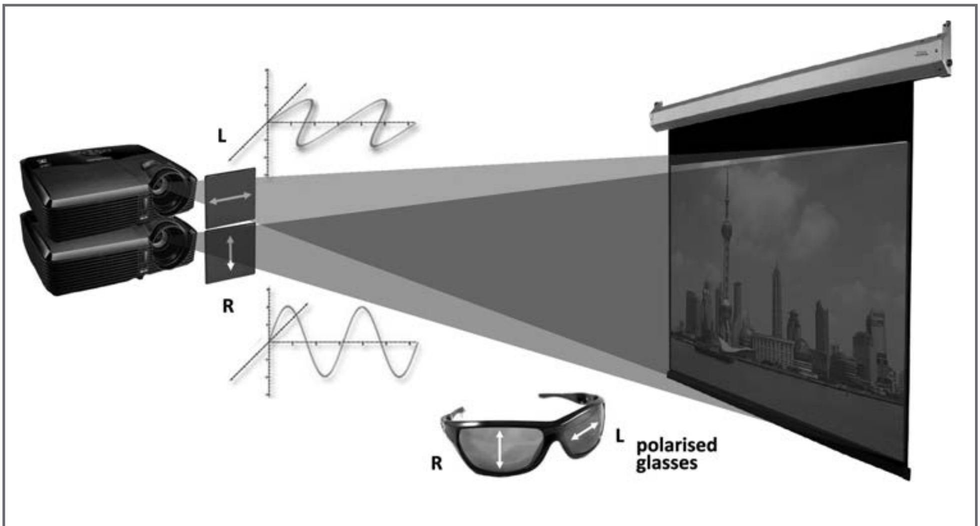

Figure 4. The principle of passive stereoscopic projection.

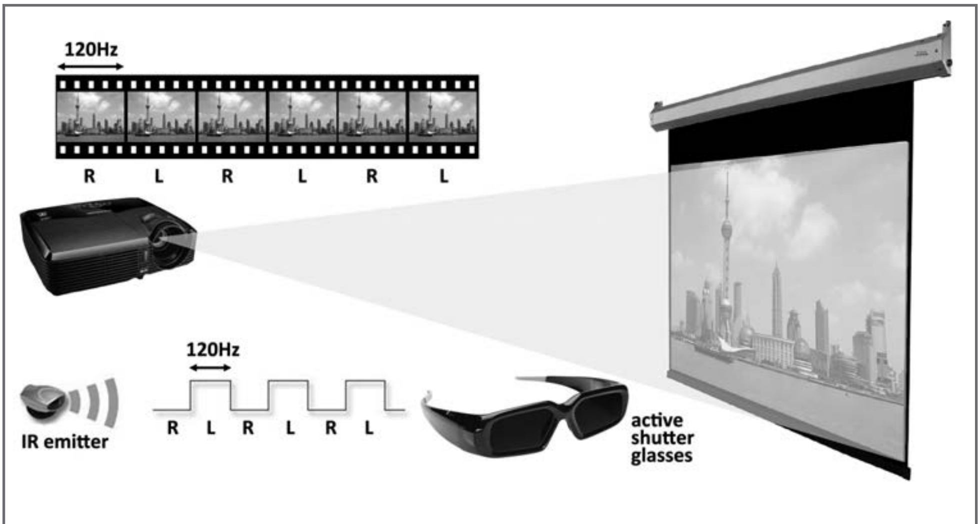

Figure 5. The principle of active stereoscopic projection.

Polarized glasses are much more common and are based on light polarization. Image for one eye is projected in horizontal direction while image for another eye is projected in vertical direction. Polarized glasses have corresponding polarization and allow horizontal polarization in one eye and vertical polarization in the other. Tilting the head may cause distort problems, but these can be solved using circular polarization (to make horizontal glasses displacement in tolerable range).

The stereoscopic view in monitor based systems (not limited to only small TV or PC monitors) can be achieved using passive or active visualization method. Passive systems have display unit equipped with a thin, lenticular screen "attached" over the standard display. A lenticular screen is made up of a series of magnifying strips that show a slightly different perspective of the screen

to each eye. In this sense, each eye can only see one half of the screen at any given time, because of interlaced images for the eyes. The quality of image may be reduced, but the method does not require expensive glasses.
Active stereoscopic visualization is based on fast switching between images intended for right and left eye respectively. Users wears special electronic glasses (shutter glasses) synchronized with projection devices. These are, e.g., special LCD monitors, TVs or projectors. Such glasses open and close shutter in front of a particular eye, and thus it allows only one eye to see the screen at the same time. As for the high persistence of human vision and high switching frequency, the flickering (switching changes) is seldom noticeable.
Recent developments in the area of 3D technologies improve the frame rates to minimize flickering effects and transform the underlying hardware from expensive huge devices on wide available hand-held devices such as laptops, camcorders etc. The developments are focused on products based on autostereoscopy and on products that do not require any glasses. In fact, 3D technologies have potential that may bring new dimensions to almost all activities of human life.

Starting strategies

Thanks to the information society and ubiquitous computer-based devices, the 3D technologies pave the way also in the education sphere. The teachers explore them and the students feel chance and benefits to improve their knowledge in the form of best practices. To understand the benefits and to decide whether to use such technologies in teaching activities, it is necessary to explore them, to work in team of interested colleagues and to recognise technical support at home institution.
Exploration should start by studying of documentation, features and capabilities of the technology. It is recommended to spend some time by playing with these technologies if possible, to visit product presentations or showrooms if any. One should compare utilization at other universities if exists and plan his/her own activities or simulate lessons, to imagine outputs and to have an idea of benefits he/she may reach.
Creating a team or searching for partners although at other departments will increase the chance of the technology acceptance. Collaboration is a good assumption of better ideas formulation, future usage and development, changes in curriculums, challenges for self-realization etc. Professional contacts can be found on internet or at the specialized conferences.
Technical support at home institution may bring resources to support technological activities, and usually well operational background. The comments of IT staff will help to recognize limitations and possibilities of existing infrastructure, specification may be adopted for particular lecture room or the activity may be presented on the web etc.
Even if the 3D technologies facilitate best practice learning there are still unexplored areas of usability. Nevertheless, there is no need to wait for the future

to understand if and how these technologies can be implemented. Today's students use modern technologies, they found the benefits and strong results, so it is up to teachers to build steps towards the future.

Conclusion

Teachers do not need to be teenagers to understand or use modern 3D technologies. Many of them are frequently used by middle-aged adults. Therefore, the teachers should forget the prejudices and they should start to engage 3D technologies as something more than entertainment. These technologies have already proved their impact on the way we think, learn, and interact. They also demonstrated the tremendous potential they have in teaching and learning.

Acknowledgement

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UTILIZATION OF 3D ANIMATIONS IN EDUCATION OF MEDICINE

08

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Abstract
The imagination is one of the most important factors affecting the ability to study medicine, especially human anatomy. Many new and modern books and atlases of anatomy already brought beautiful and lovely coloured illustrations, but they are still presented as plane. This may cause misinterpretations of some structures and/or misunderstanding of space depth. Nowadays, thanks to the virtual reality technologies, it is possible to offer new dimension in presentation of individual human body parts and systems. We use a 3D virtual projection system to enrich lessons of anatomy that are organized in lecture room for large groups of students. 3D animations are presented using large screen projection. To utilize such animations out of the 3D projection system as well as out of the lecture room, we searched for the best and easiest way to present them in both off-line and on-line forms.

Keywords
3D technology, 3D animation, human anatomy, education

Introduction

Well-organized teaching methods are affected by several important factors. These usually include well prepared teaching content, interaction with students and effective evaluation tools as well. Main aims to improve teaching in human anatomy are oriented on improvement of students' abilities to understand body composition, topography of anatomical structures as well as functions and interactions of individual body systems.

To do this, we use the 3D virtual projection system at the Faculty of medicine in Kosice. 3D projection system, based on principles of virtual reality and whose main aim is to support traditional forms of education in the area of human anatomy, is installed in the lecture room with the capacity of 200 students. Wearing specialized glasses, the students feel an existence of 3D space and they are allowed to study human body systems in more detailed and illustrative forms. Even if the students’ response is highly positive, the teaching using 3D virtual projection is limited by the time schedule of the lecture room as the system itself is not portable.

Figure 1. Auditorium of lecture room with large screen 3D virtual projection.

Due to this, the teachers of anatomy asked us to create such versions of education materials that will be useable and playable also outside of the lecture room and its projection system. To meet these teachers' needs, we started to prepare so called 2D versions of 3D education animations. In the same way as the traditional teaching movies, also these animated outputs can be equipped by additional audio and text comments and/or by teachers' explanations if necessary to improve the quality of content.

Individual animated movies are prepared according to the syllabus of Anatomy guaranteed by Department of Anatomy. Database of such transformed materials is available for students in the classroom equipped with 10 personal computers. Thereafter, we suppose to create also an off-line portable version in the form of CD or DVD and after completion of all necessary modules, the animations will be offered and available in on-line form via faculty portal too. Using this approach, we expect to reach our primary goal that is to offer students the best possibilities for detailed study of human body, its organs and their topographical relations. However, these education materials will be repetitively useable during different education activities realized at the faculty.

Large screen 3D virtual projection

3D virtual projection system composed of special large projection screen, pair of projectors, cluster of three computers and sound system was installed in the lecture room with the aim to make education more effective and more illustrative. Other components of the system like teacher's workstation and 3D camera are used in other office. All these devices were continuously tested

Table 1. Functionalities of 3D virtual projection system.

Function	Description
3D movies projection	presentation of real 3D movies recorded by 3D cameras (surgery interventions, medical treatment procedures, rehabilitation techniques, etc.)
3D animated movies projection	presentation of 3D computer animations (usually materials prepared from 3D model of human body)
2D movies projection	presentation of scenes recorded using only one single non 3D camera
projection of 3D content in real time	presentation of 3D model in case when no dynamic material was prepared before the lecture (teacher works with the system and with the 3D content during lecture)
live events 3D projection	presentation of real scenes directly from 3D camera (3D videoconference)

and improved if possible according to the skills we have reached while preparing our first education materials.

3D camera system is used to record real 3D content (e.g., surgery interventions). Teacher's workstation allows us to process real captured contend as well as digital animations and to prepare required teaching content. The large screen projection shows final stereoscopic education movies and/or animations during lectures to the audience.

To create a 3D animated education material we use human body model bought together with the 3D system from Slovakia Supercomputers, s.r.o. The model is divided into the several parts, e.g., muscles, bones, nervous system, vascular system, etc. Required parts of the human body are loaded into the SuperEngine (software to create scenes and to synchronize individual parts of the system) according to the aims of prepared presentation. Users can use the functionalities of the engine to make selected parts highlighted, transparent or invisible. Using space mouse, one can organize movements, change viewing angles and prepare all the necessary effects in the scene. All created scenes can be equipped with texts and audio records and saved as dynamic 3D output for large screen projection.

The system allows us to prepare and present real movies, animated scenes, but also combination of both 2D and 3D content. Everything without the need to change polarized glasses the users wear while watching education

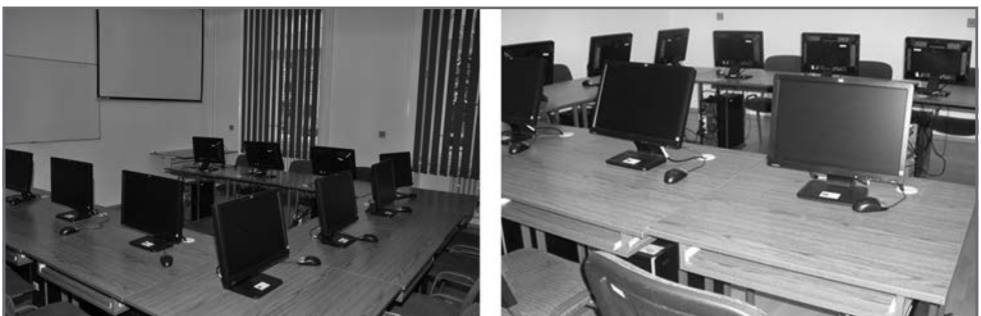


Figure 2. Computer classroom at the Department of Anatomy.

materials during lectures. Functionalities of the system are briefly summarized in *Table 1*.

3D and 2D teaching

The most preferable way to use the system functionalities during anatomy lectures is presentation of prearranged materials. It's because the teachers do not want to spend any time by managing the scene in real time. However, the main reasons are that they worry to use it as something new and difficult and also there is a need to be skilled in using of the space mouse.

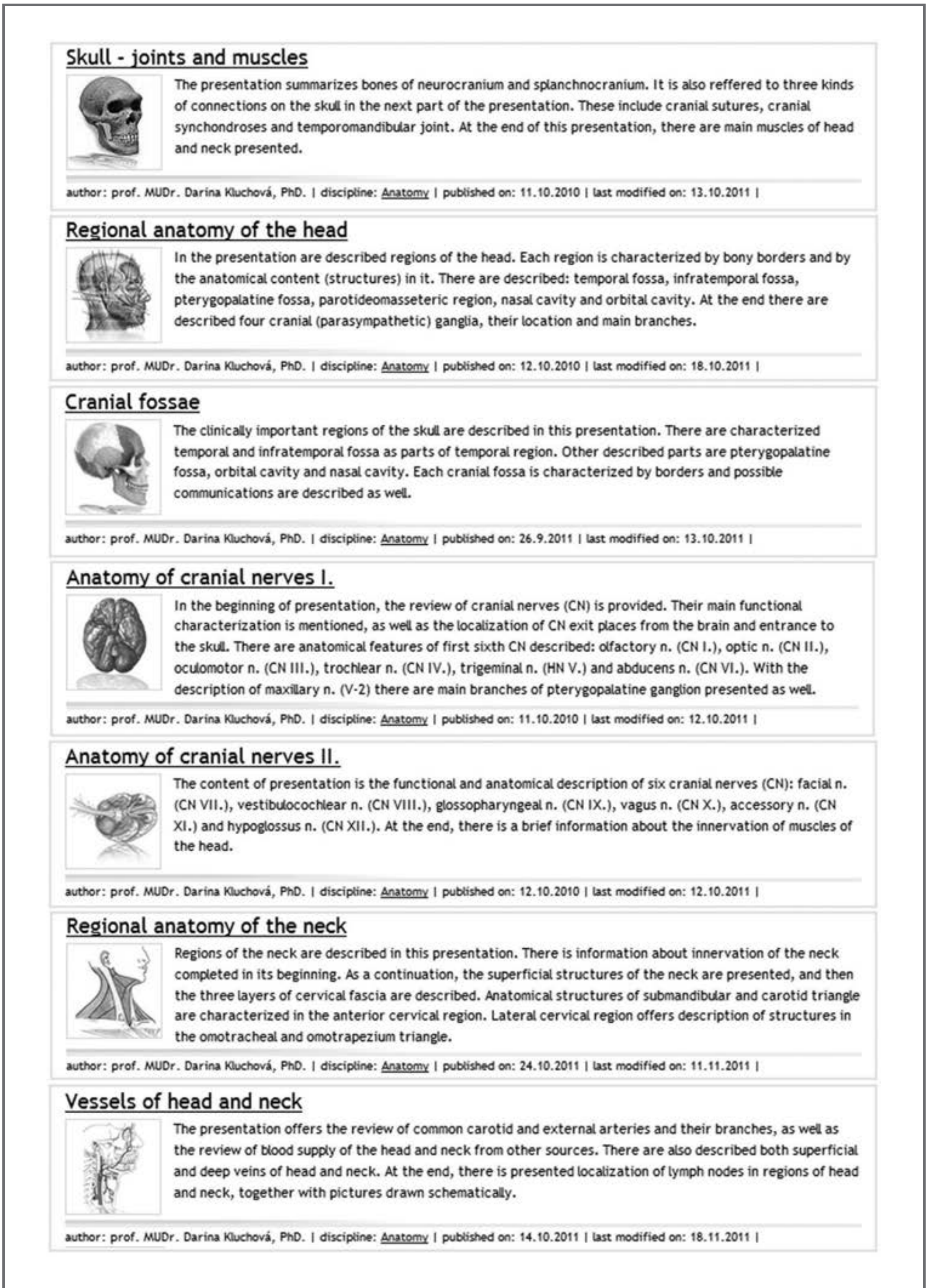
The limitation of 3D system usage is caused also by the time schedule, as the lecture room is often occupied by other teachers to teach students in other subjects. Therefore, we decided to transform already created 3D animations into the non-stereoscopic form, i.e., to the form suitable for use without the large screen projection system and generally playable by common software players installed on common personal computers.

A relatively small disadvantage (subjective opinion) of this approach is that the 3D information is missing and that the visualisation is reduced and is not as best as in 3D virtual space. Nevertheless, the students are allowed to see the content several times and discus it with their teachers in smaller groups. It is also used as good tool for preparation on practical lessons and exercises. Everything is organized in newly created computer classroom of Department of Anatomy that is localized close to the anatomy labs and dissecting rooms of this department.

The content and the design of existing 3D source were upgraded before its transformation into the form of common (not stereoscopic) 2D movies. In some cases, we were forced to do completely new scenes as we discovered some mistakes while using previous versions. Sometimes, there was also the need to add and/or remove some parts of the model from the scene. Everything was done with the aim to create as best education and illustrative output as it can be. Also the requirements of teachers with respect to the content of lecture are considered and therefore the final result is discussed and reorganized several times. During this time consuming work we found several mistakes and deficiencies in the original human body model as well. Thanks to the professionals and teachers of anatomy we were able to define precise requests to repair them directly at the side of produces.

Topics and syllabus

Because of MEFANET and its publication portal, the students have access to the presentations of individual subjects taught at the faculty. They can read the slides on-line, wherever they are. Doing so, they can easily memorize all explained topics. What the teachers were worried about is that the attendance during lectures will be poor, but the time convinced us that it was groundless apprehension as the current attendance is better now and the students attend the lectures more prepared and also with the questions that can be discussed.



Skull - joints and muscles

The presentation summarizes bones of neurocranium and splanchnocranium. It is also reffered to three kinds of connections on the skull in the next part of the presentation. These include cranial sutures, cranial synchondroses and temporomandibular joint. At the end of this presentation, there are main muscles of head and neck presented.

author: prof. MUDr. Darina Kluchová, PhD. | discipline: Anatomy | published on: 11.10.2010 | last modified on: 13.10.2011 |

Regional anatomy of the head

In the presentation are described regions of the head. Each region is characterized by bony borders and by the anatomical content (structures) in it. There are described: temporal fossa, infratemporal fossa, pterygopalatine fossa, parotideomasseteric region, nasal cavity and orbital cavity. At the end there are described four cranial (parasympathetic) ganglia, their location and main branches.

author: prof. MUDr. Darina Kluchová, PhD. | discipline: Anatomy | published on: 12.10.2010 | last modified on: 18.10.2011 |

Cranial fossae

The clinically important regions of the skull are described in this presentation. There are characterized temporal and infratemporal fossa as parts of temporal region. Other described parts are pterygopalatine fossa, orbital cavity and nasal cavity. Each cranial fossa is characterized by borders and possible communications are described as well.

author: prof. MUDr. Darina Kluchová, PhD. | discipline: Anatomy | published on: 26.9.2011 | last modified on: 13.10.2011 |

Anatomy of cranial nerves I.

In the beginning of presentation, the review of cranial nerves (CN) is provided. Their main functional characterization is mentioned, as well as the localization of CN exit places from the brain and entrance to the skull. There are anatomical features of first sixth CN described: olfactory n. (CN I.), optic n. (CN II.), oculomotor n. (CN III.), trochlear n. (CN IV.), trigeminal n. (HN V.) and abducens n. (CN VI.). With the description of maxillary n. (V-2) there are main branches of pterygopalatine ganglion presented as well.

author: prof. MUDr. Darina Kluchová, PhD. | discipline: Anatomy | published on: 11.10.2010 | last modified on: 12.10.2011 |

Anatomy of cranial nerves II.

The content of presentation is the functional and anatomical description of six cranial nerves (CN): facial n. (CN VII.), vestibulocochlear n. (CN VIII.), glossopharyngeal n. (CN IX.), vagus n. (CN X.), accessory n. (CN XI.) and hypoglossus n. (CN XII.). At the end, there is a brief information about the innervation of muscles of the head.

author: prof. MUDr. Darina Kluchová, PhD. | discipline: Anatomy | published on: 12.10.2010 | last modified on: 12.10.2011 |

Regional anatomy of the neck

Regions of the neck are described in this presentation. There is information about innervation of the neck completed in its beginning. As a continuation, the superficial structures of the neck are presented, and then the three layers of cervical fascia are described. Anatomical structures of submandibular and carotid triangle are characterized in the anterior cervical region. Lateral cervical region offers description of structures in the omotracheal and omotrapezium triangle.

author: prof. MUDr. Darina Kluchová, PhD. | discipline: Anatomy | published on: 24.10.2011 | last modified on: 11.11.2011 |

Vessels of head and neck

The presentation offers the review of common carotid and external arteries and their branches, as well as the review of blood supply of the head and neck from other sources. There are also described both superficial and deep veins of head and neck. At the end, there is presented localization of lymph nodes in regions of head and neck, together with pictures drawn schematically.

author: prof. MUDr. Darina Kluchová, PhD. | discipline: Anatomy | published on: 14.10.2011 | last modified on: 18.11.2011 |

Figure 3. List of selected topics published at the faculty's portal.

The process of transformation of existing 3D materials and creation of new ones is now organized in accordance with the syllabus of Anatomy. Currently, we are working on the systems of the head and neck. There are several topics we want to process during this academic year. These topics include skull – joints and muscles (bones of neurocranium and splanchnocranium, cranial sutures, cranial synchondroses and temporomandibular joint, main muscles

Figure 4. Teaching with physical models was supported using virtual models.

of head and neck), regional anatomy of the head (regions of the head, bony borders, anatomical structures, temporal fossa, infratemporal fossa, pterygopalatine fossa, parotideomasseteric region, nasal cavity and orbital cavity, cranial (parasympathetic) ganglia, location), cranial fossae (description of clinically important regions of the skull, characteristics of temporal and infratemporal fossa as parts of temporal region, pterygopalatine fossa, orbital and nasal cavity), anatomy of cranial nerves (review of cranial nerves, main functional characteristics, localization of CN exit places from the brain and entrance to the skull, anatomical features of olfactory n., optic n., oculomotor n., trochlear n., trigeminal n., abducens n., maxillary n., main branches of pterygopalatine ganglion, functional and anatomical description facial n., vestibulocochlear n., glossopharyngeal n., vagus n., accessory n., hypoglossus n., innervation of muscles of the head), regional anatomy of the neck (review of superficial and deep structures of the neck, description of borders of the neck, innervation of the neck, layers of cervical fascia, anatomical structures of submandibular and carotid triangle, describtion of structures in the omotracheal and omotrapezium triangle), vessels of head and neck (review of common carotid and external arteries and their branches, review of blood supply of the head and neck from other sources, description of superficial and deep veins of head and neck, localization of lymph nodes in regions of head and neck).

Once the animations are created, the teachers can complete their study materials and share them for their students. These education materials will be accessed as combination of presentations (PPT, PPTX), lecture notes (DOC, DOCX, PDF) and animation (AVI – offline, FLV – online).

Conclusion

Utilization of 3D virtual projection in the education activities, even if it is not organized in periodic terms of all lectures, brought benefits for both the students and the teachers. According to our expectations, these methods increased interest of students in the presence forms of study as well as the quality of lecture content. Direct students' response is also reflected by the teachers as they prepare more precise and more qualitative education pres-

entations. On the other hand, the students are directed to draw attention on important anatomical structures.
The teachers demonstrate that the lectures were significantly improved thanks to implementation of 3D virtual models and animations prepared according to the topics to be explained. Visual perception equipped with the comments of teachers brought great didactic benefits, especially in the sense of visualization of organ sections and understanding the space relationships. Separation of themes into the structuralized and smaller standalone monothematic education units brought also possibilities to improve practical self-study as well as the knowledge assessment using short quizzes and/or tests. Except of computers, the classroom is equipped by multimedia presentation technique and videoconferencing tools. These may be used to discuss the topics with the colleagues wherever they are. As the teachers said, the camera system for audiovisual real-time transmission between dissector room and the classroom significantly improved the teaching of anatomy and brought new dimensions into the pedagogical processes.

Acknowledgement

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09 EDUCATION IN DENTAL MEDICINE SUPPORTED BY AUDIO VISUAL TOOLS

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Abstract
This paper deals with the possibilities of audio visual tools utilisation in education of dental medicine students. The audio and video recordings as well as photos used in teachers' presentations play meaningful role in the sense of explanation and understanding of clinically oriented problems. They have an irreplaceable place in today's educational methods, but they should be considered just as education aids and not as standalone methods that solve all teaching problems. The usage of audio visual tools requires careful selection of relevant cases and their preparation to fulfil interpretation of specific topics.

Keywords
education, dental medicine, audio visual tools, visualization, video communication

Introduction

Recent development of modern educational tools is based mainly on information and communication technologies. This development affects also education processes in the area of dental medicine. To make education in this branch more effective, illustrative as well as progressive, we realized a project in which audio visual tools are used as essential components of teaching and learning. The audio and visual techniques were integrated together with the network infrastructure to bring more detailed and precise explanations of clinical cases to the pre and post-gradual students.

The main reason to use the suitable audio visual aids is to increase impact and the effectiveness of education. Such tools, when used properly, may significantly increase the interest of the audience. Using attractive forms of presentation and combination of static and dynamic educational content will result in higher concentration of the students that can be maintained for longer time. The ability to understand and to remember information is also better when presented to more than one sense (sight, hearing, touch). Furthermore, audio visual tools may have an immediate impact on students' emotions in contrast to the pure text or words. For example, the record of patient status, or the record of surgery interventions will increase interest more effectively.

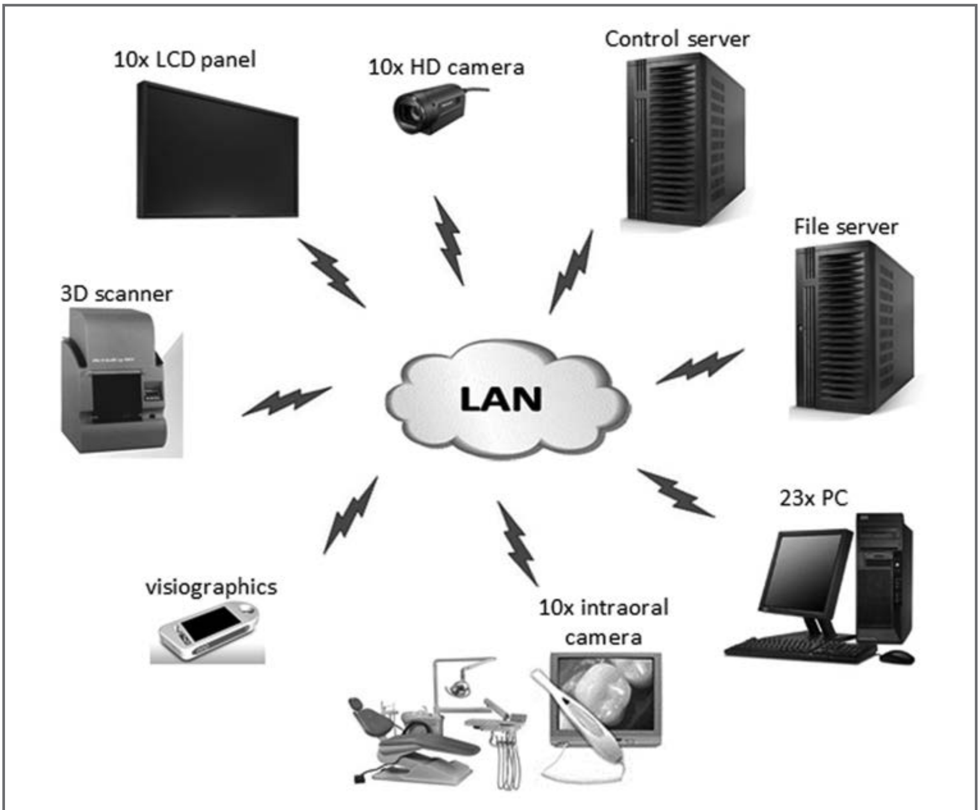

Figure 1. Main visualization components installed at the Department of Stomatology and Maxillofacial Surgery with the aim to improve the quality of education processes.

Department and the labs

Innovation of education in dental medicine was realized at the Department of Stomatology and Maxillofacial Surgery. Visualization tools were installed in the rooms deployed across three floors of the department. Basically, this audio visual equipment includes technologies as are shown on *Figure 1*.

All these technologies, installed in the labs of the department allow us to communicate and to see the patients, interventions and/or models, usually in real time. Individual processes can be easily recorded, processed and archived to be useable not only in present, but also in distance learning. The usage of such multimedia tools helps teachers to explain practical problems of dental medicine in more efficient way.

To realize a conceptual design of departments' multifunction laboratory we solved both clinical and technical problems. The clinical side of the project was solved by installation of new dental chairs, purchasing of dental materials and by obtaining of the instrumentation and equipment that is necessary for maxillofacial surgery. However, the technical part of the project required more things to be done, even if we consider basic network infrastructure or absence of information and communication technologies at the department. All these problems were continuously solved with respect to the limitations of existing old building architecture.

Figure 2. One of two departments' phantom classrooms (left) and the dental training system PREPassistant (right).

Figure 3. Ten intraoral cameras with LCD computerized units were installed on dental chairs within the clinic.

The process of visualization was divided into the several phases, where the network infrastructure was created as first. There, the primal LAN was extended to the 72 connection places with the aim to maximize options of individual workplaces interconnection. The communication between network devices is now operated by three fully manageable 1Gb switches. The bone of the network was interconnected through optical fibres directly to the university infrastructure that ensures both the quality and the stability of network connections. This is a really important fact, especially in the case when there is a need to transmit any real and/or archived events out of the department.

Preclinical education

To improve preparation of students for practical clinical work with the patients at the dental chairs we have modernized technical equipment of the phantom classrooms.

There was a specialized digital dental training system – 3D scanner (KaVo PREPAssistant) with ten additional students' workstations installed in two phantom classrooms. Such so called active vision system is based on reverse engineering approach. It means the system extracts the three-dimensional (3D) geometric information from the models of teeth (wax models, ceramic crowns, 3-unit bridges) the students work on and transfer this information into computer-aided design software to get the precise information about the quality of students' models. The preparations are measured within 2 minutes with an accuracy of 20 micrometres using PREPassistant Scan software installed

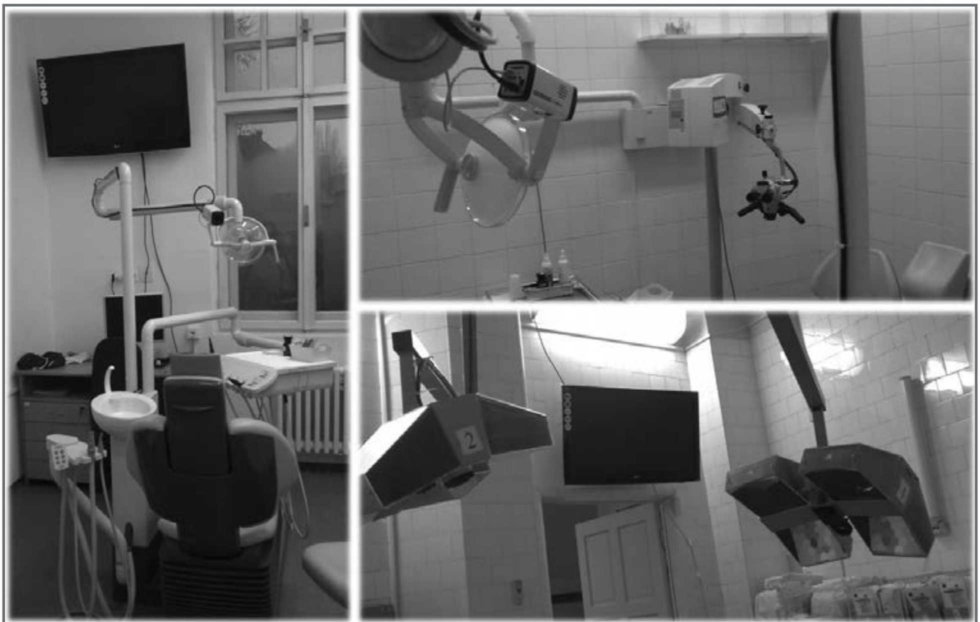

Figure 4. HD audio visual tools were installed to support education of maxillofacial surgery.

on the system power unit. Recognizing deficiencies from an ideal preparation – model (specified by the teacher), the students are able to improve the accuracy of their 3D teeth models (or dental prostheses made of plastic, ceramic or wax) and verify if their skills are going to be better in time. They do this using PREPassistant Evaluate software installed on the students' computers. With this type of interactive self-learning system, the students obtain objective feedback on an enlarged 2D and 3D scale.

The system may be used also to improve the quality of construction units intended to help patient treatment. The 3D vision system offers much more functionalities like edge detection, boundary tracing, 3D modelling, etc. All these functions may be used via software installed on computers connected to this digital training system.

Combined education materials are also projected to the students using visualizer that captures documents and/or 3D objects and displays them on flat screen, projector or interactive whiteboard. The advantage is that it allows displaying of very small objects and that the images can be recorded and used to improve presentation of currently explained themes.

Clinical education

Education in clinical environment (contact with the real patients) was supported either by the intraoral cameras, RTG and viosiographis system as well as by HD video techniques.

Ten intraoral cameras with standalone LCD displays were installed directly on the dental chairs to visualize small elements and small details of treated parts or teeth in oral cavity. Naturally, these dental chair units with integrated PCs are interconnected to allow teachers and their students see the pictures

Figure 5. Two different maxillofacial interventions. Such long-lasting procedures may be offered to students via detailed education documentation.

of patients' details from any chair. Data from these intraoral cameras can be saved on separate file storage server and after that viewed by authorized users whenever needed.

The storage system works also as a central unit of these intraoral cameras' network. In combination of interconnected RTG and viosiographic unit the clinicians have access to all necessary records, pictures and documentation almost immediately after it was generated. Except of others, the advantage of the system is that the patients can be treated by clinicians who have all relevant information about the current health status in patients' oral cavity.

To support visualization in maxillofacial surgery a system of full HD video cameras and related projection equipment with large screen displays was installed at the department. These audio visual devices are used to interconnect surgery halls, ordinations and consulting rooms.

Ten HD video cameras together with 10 large screen LCD displays installed across the clinic were networked in this phase of project realization. The HD cameras transmit the content to the server that provides its redistribution to the co-workers' workplaces. The content can be captured and archived for later processing and application in pre and post-gradual education. Using this HD technology, the clinicians as the teachers can easily record, store and access any common clinical cases, but also any clinically serious interventions they performed.

The individual records are also used to build a database of maxillofacial surgery interventions. After the intervention is planned and prepared for realization, the technical process starts with the aim to capture all the relevant scenes. Thereafter, the recordings are processed and completed by specialized clinical documentation.

In general, there are two different approaches we use to develop audio visual education works. First approach is aimed to prepare a movie with comments of clinicians, surgeons and/or other clinical professionals. The output is in off-line form, e.g., CD or DVD playable in any PC or DVD player or it is transformed into the on-line form for web publishing. The second approach extends possibilities of digital presentation techniques and adds the educational texts and other related scientific content to the output multimedia materials. In this case, the interactive material contains text, audio and video to offer students maximum information about relevant topics of the dental medicine curriculum.

The advantage of both approaches is that the students and the teachers have access to educational material that describes treatment procedures performed by professionals and are based on real clinical cases. Thanks to the multimedia support used in pedagogical processes the students can also see the long-time procedures as well as rare pathologies.

Discussion

Many education projects are based on combination of audio, visual and haptic perception. In that sense, the audio and video recordings as well as photos are essential tools to increase visualization of education. Combination of such tools with well-prepared discussion of teacher and his/her students makes the process more attractive.

Production of final video records requires both the professional experiences and the financial resources. The way of their distribution to the students should be also carefully considered. However, the reward for this hard job is offered in the form of attractive educational aids. Visualization in education brings many other advantages. It is useful to stimulate and maintain interest of the students, it saves teachers' time as the explanations are more illustrative and understandable than pure words, it ensures clear clarification of the topics, and it can strengthen emotions and memorizing abilities too.

Conclusion

Main aims of our activities were oriented on new innovative approaches in education of dental medicine students that increase both the quality and the efficiency of realized clinical teaching processes. The implementation and the usage of modern audio-visual technologies brought possibilities to study individual clinical cases in more detailed ways.

The recorded video outputs equipped with explanations of professionals, e.g., in the form of texts and/or audio comments inserted into the final movies, can be easily used also for self-education and/or for distance education. Special attention is paid to treatment procedures of rare cases and special randomly performed surgery interventions that may be viewed in real time via videoconferences or that may be used as a source of multimedia documentation.

The multimedia tools helped teachers to explain practical problems in more illustrative way. On the other hand, the students are better prepared for their future work as they are better prepared on situations they can meet in real clinical praxis. All multimedia education outputs are archived and accessed to the students during lectures and/or practical exercises.

Acknowledgement

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ADVANCED CLINICAL CASE PLAYER FOR DATA-DRIVEN EDUCATION BASED ON REAL SEVERE SEPSIS CASES

10

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Abstract

The EPOSS/SEPSIS-Q project has been running in the Czech Republic since 2011. The key activity of this project includes a research database in which data about patients with severe sepsis and septic shock are inserted retrospectively. An advanced infrastructure has been developed enabling data utilization from everyday clinical practice for innovation of clinical teaching. The implementation of the first two pilot tutorial cases fulfilled the attractive idea of data-driven education.

Keywords

clinical education, e-learning, clinical cases, severe sepsis, intensive care medicine

Introduction

Severe sepsis and septic shock are still associated with high morbidity and mortality rates. Severe Sepsis Bundles have been designed recently by the international Surviving Sepsis Program (www.survivingsepsis.org) with the expectation of considerable reduction in mortality due to severe sepsis and septic shock. Since 2011 the EPOSS project (data-based Evaluation and Prediction of outcome in Severe Sepsis) has been running in the Czech Republic. The key activity of this project includes a multicentric research database in which data about all consecutive patients, who met criteria for severe sepsis within 24 hours of admission to ICU, are inserted retrospectively. The EPOSS project aims to advanced analytical reports on the typology of patients as well as on potential risk factors that can be used to optimize the management of severe sepsis patients.

In parallel to the EPOSS research database (http://eposs.registry.cz), an educational portal SEPSIS-Q (http://www.sepsis-q.cz) has been launched, which focuses on information and educational cultivation of this specific field of intensive care medicine. One of the main added values of the SEPSIS-Q portal is a clinical case collection drawn up in a tutorial manner. Source data for the tutorial cases are taken from the EPOSS research database. Thus, EPOSS

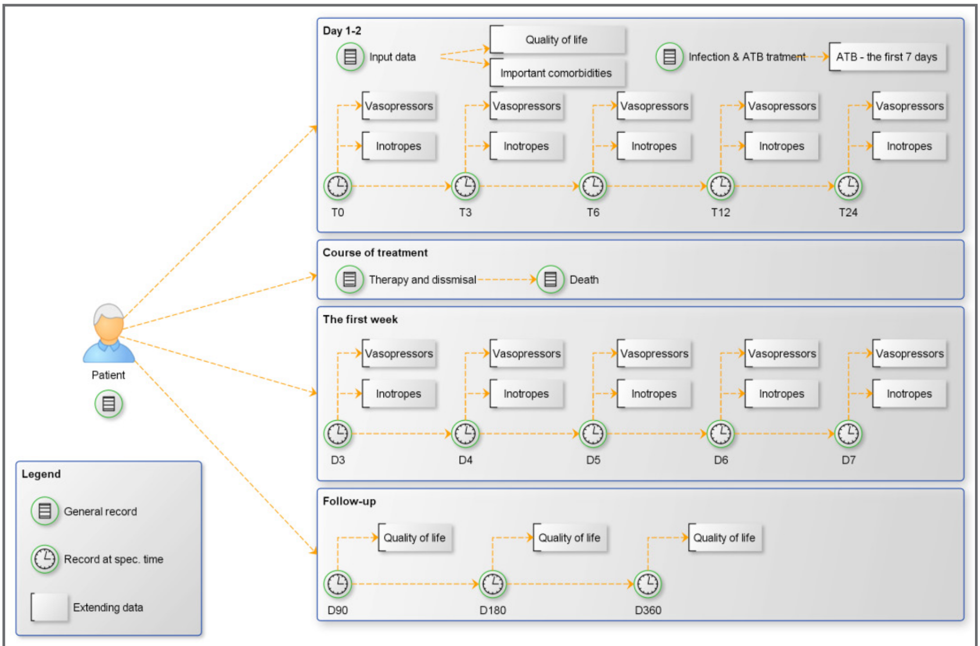

Figure 1. The structure of the EPOSS research database.

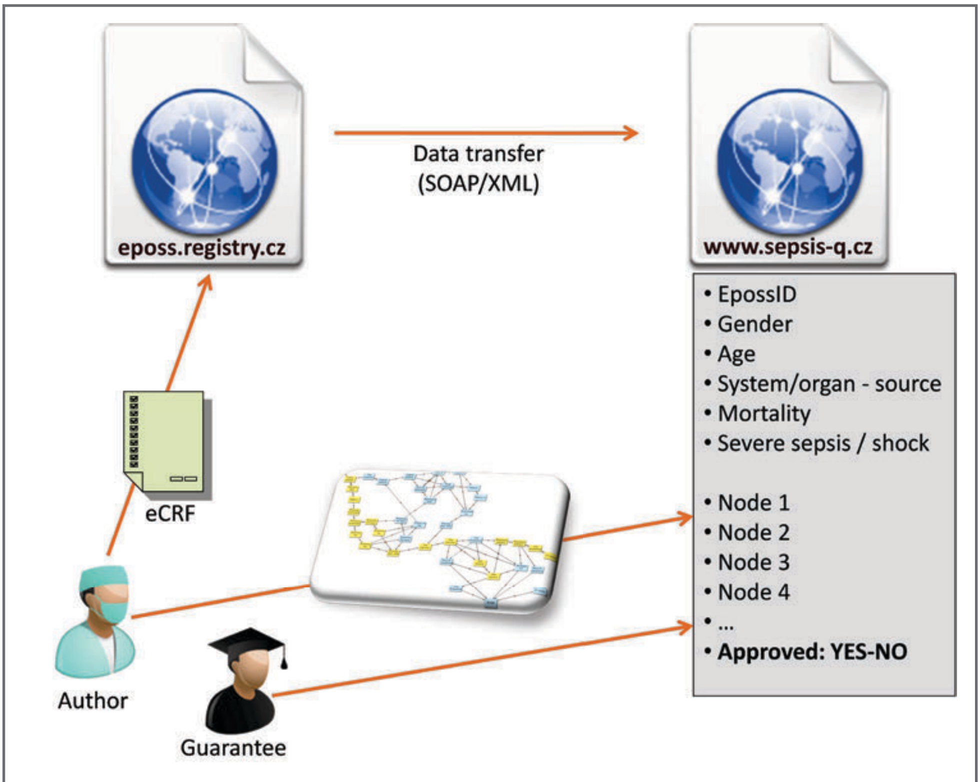

Figure 2. Illustrative diagram of the editorial process in publishing clinical cases on the SEPSIS-Q educational portal.

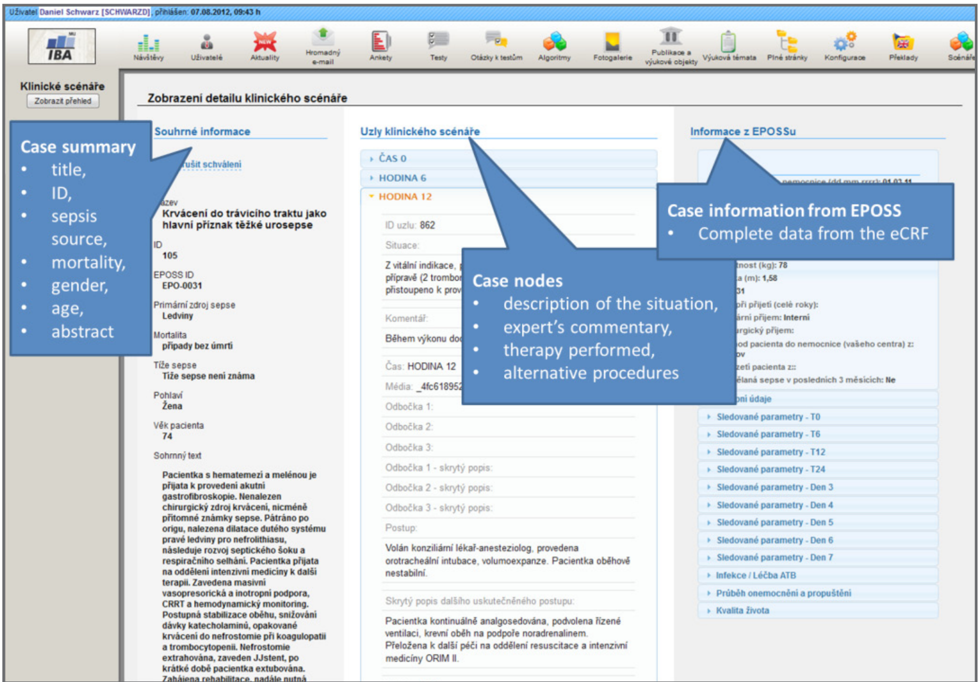

Figure 3. A screenshot from the backoffice application of the SEPSIS-Q educational portal. The upper bar: list of available modules. The main frame: the module for clinical cases.

and SEPSIS-Q tools fulfill the attractive idea about data-driven medical education, which was presented by Dušek et al. in [1] as one of the main pillars for medical education in the MEFANET (MEdical FAculties NETwork) [2–4].
Our concept of the clinical cases for medical education was developed based on the Interactive Algorithms for Acute Medicine [5–6], which compose the main part of the digital content on the AKUTNE.CZ educational portal. The very important benefit of our case-based teaching lies in the information synthesis. It is not just a text chapter or an image material that is utilized by students in their learning process, but also the scenario, in which each student is drawn and within which he/she takes advantage of his/her knowledge. The real clinical cases may become the basis for Problem-Based Learning (PBL) sessions. PBL is one of methods used often in well-developed countries for training physicians and healthcare professionals to develop their clinical reasoning skills and competencies, often referred as abilities to think critically. This is not a revolutionary innovation – detailed information on PBL can be drawn from [7, 11]. Alternatively, clinical reasoning training can also be approached using the case-based learning (CBL) method. However, the CBL method does not include useful pedagogical features to ensure that students are not disconnected from real situations to a virtual computer world. This includes the following PBL principles: 1) classes are held in small groups of students, 2) sessions are not teacher-centered, but moderated by a tutor according to the principle of "too much teaching kills the learning", 3) students hustle learning

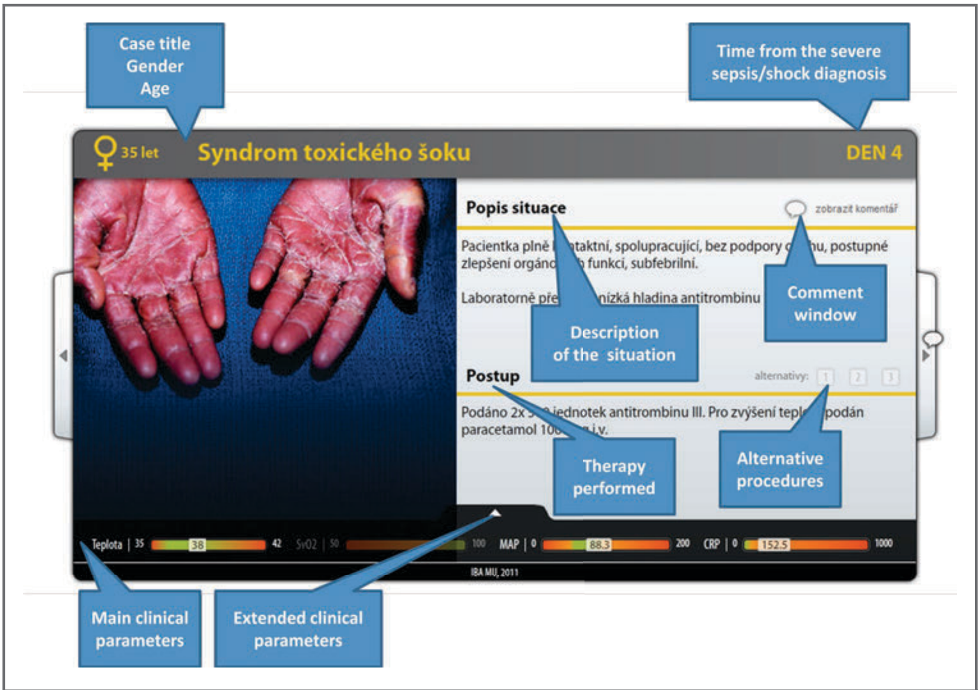

Figure 4. Scheme of the clinical case player available on the SEPSIS-Q educational portal.

materials themselves and lecture to each other, 4) PBL sessions are complemented with properly and coherently selected theoretical lectures.

Methods and tools: what is behind the SEPSIS-Q cases

EPOSS research database

The data acquisition system is operated in the academic environment of the Institute of Biostatistics and Analyses at Masaryk University in Brno. The system is constantly accessible over the internet, the EPOSS portal URL is: http://eposs.registry.cz. Parametric data are stored from a set of on-line forms that include input data (meeting the criteria of severe sepsis, birth date, gender, clinical workplace), clinical parameters in 10 time stages during the first seven days of hospitalization, as well as information on anti-infective therapy on the course of the disease and finally the information on dismissal, *see Fig. 1*. Further, there are data inputs for follow-ups in the 90th, 180th and 360th days from diagnosis, as well as a form to describe the causes and date of patient's death. Retrospective medical records are the only source of data for the EPOSS research database. No direct person identifiers are allowed to store in there.

SEPSIS-Q educational portal

The main content sections of the portal are: A) clinical cases, B) current events about sepsis, C) monitoring of scientific journals, D) calendar, E) best practices (guidelines), F) useful links. The glue between both the tools

www.sepsis-q.cz and eposs.registry.cz are the clinical cases. For hundreds of consecutive patients in the EPOSS research database, suitable cases are selected for education. Those are selected by experienced teachers from the participating clinical sites and subsequently upgraded to didactically appropriate level. This process includes also anonymisation of individual cases.
Editorial procedures for each individual case are illustrated in *Fig. 2*. It is clear from the diagram that all finished cases have to be additionally approved by a guarantee designated by the Board of the EPOSS/SEPSIS-Q project.
The SEPSIS-Q educational portal is equipped with a backoffice application (PHP/MySQL), which enables convenient and comprehensive web content management. For the purposes of clinical cases management a separate module has been developed – its screenshot is shown in *Fig. 3*. The module is operated by the authors of clinical cases as well as by the guarantees.

Player: how the clinical cases are presented

After a clinical case was completed and approved, it becomes immediately available on-line through the clinical case section of the SEPSIS-Q educational portal. The cases are sorted here by mortality, gender, severity of sepsis and with organ/systems that are the primary source of sepsis. Each case is presented by its title, abstract and information about the author. Selecting a case from the collection activates a player, which takes the form of a flash object executed in Adobe flash player environment. Clear presentation of one of the nodes in the case of toxic shock syndrome in a young woman is shown in *Fig. 4*.

Results

After one and a half years of collecting nearly 490 parametric records about severe sepsis and septic shock patients into the EPOSS research database, the first two pilot tutorial cases were created, both with seven nodes and both accompanied by pictures and video sequences. Summaries of these two cases follow.

Bleeding in the digestive tract as a major symptom of severe urosepsis
Patient with haematemesis and melaena admitted to perform an acute gastrofibroscopic examination. A surgical source of bleeding found, signs of sepsis were presented. When searching for origo, a dilatation of the right kidney hollow system found. Followed by a development of septic shock and respiratory failure. The patient was sent to ICU for further treatment. Massive inotropic and vasopressor support, CRRT and haemodynamic monitoring. Progressive stabilization of circulation, decreasing the dose of catecholamines, repeated bleeding into the nephrostomy – coagulopathy and thrombocytopenia. Nephrostomy extracted, JJstent introduced, then, after a short time, patient was extubated. Rehabilitation initiated and intermittent hemodialysis

continued. Patient translated to internal medicine department's ICU on the 14th day and sent to the local hospital on the 18th day.

Toxic shock syndrome

Young woman admitted unconscious to the clinic of infectious diseases, a history taken from her husband: vomiting, diarrhea and fever lasting one day. Laboratory and clinical examination confirmed the diagnosis of septic shock. A much used vaginal tampon removed from the patient. Empirical antibiotic therapy started, circulation supported by vasopressors, patient transported to ICU. Followed by stabilization of circulation, correction of the internal environment and septic coagulopathy, normalization of the fluid balance, rehabilitation. Development of the erythema on the legs and chest followed by hands, wrists and feet. Increased sensitivity and burning in tongue. On the 5th day, patient translated back to the clinic of infectious diseases. On the 15th day, patient's dismissal to home care, no problems, no swelling, no erythema.

Conclusions

The EPOSS/SEPSIS-Q research project aimed on monitoring of medical care in patients with severe sepsis and septic shock allowed development of an advanced infrastructure enabling data utilization from everyday clinical practice for innovation of clinical teaching. The implementation of the first two pilot tutorial cases fulfilled the attractive idea of data-driven education.

The web-based tools eposs.registry.cz and www.sepsis.cz belong to the top of the field of Medical education informatics – thanks to the applied technology and methodology. The learning objects created with the two tools can be used both for face-to-face teaching, as well as for CBL/PBL sessions. The EPOSS/SEPSIS-Q project not only delivers the first comprehensive information on how severe sepsis and septic shock is treated in the Czech Republic, but may also advance the education of future clinicians who will be able to influence the outcome of the medical care.

Acknowledgements

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11 EVALUATION OF A NEW E-LEARNING METHOD OF TEACHING PRACTICAL HISTOLOGY USING VIRTUAL MICROSCOPY

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Abstract

In order to use virtual histology slides successfully in practical sessions, a suitable database system has to be developed that enables students to orientate themselves in the learning contents of the practical quickly, and also that allows opening attached supplementary text- or picture-based documents easily. This database system should have a student-friendly graphical user interface, as well as it should allow teachers a simple access to the database for adding, organizing and editing of teaching documents. At our Department of Histology and Embryology in Olomouc, we have developed our own system of application of virtual slides in the e-learning format of practical sessions. Using the official university-recommended questioner and also our own specific set of evaluation questions, we have allowed students to evaluate this new method of practical sessions. Students evaluated positively the use of PC for observation of virtual slides, as they allowed them to study and also to discuss various details of cells and tissues clearly at various magnifications. Teachers benefited from a uniform quality of presented slides and also from a straightforward and personal communication with students in the class when personal guidance and explanation was needed at student's monitors.

Keywords

histology, e-learning, virtual slides, practical

Introduction

Virtual microscopy has already been established as a new tool for delivery of histology slides for teaching and diagnostic purposes. Several slide-scanning systems have been developed and manufactured by well known brands of optical companies like Leitz [1], Nikon [2], Zeiss [3], Hamamatsu [4], Olympus [5], and others. During the last five years, several universities introduced a new method of virtual microscopy in teaching [6, 7, 8, 9, 10, 11], research, and diagnostic activities at morphology departments. Virtual slides provide many benefits over the observation of classical glass slides. They ensure a long-term and

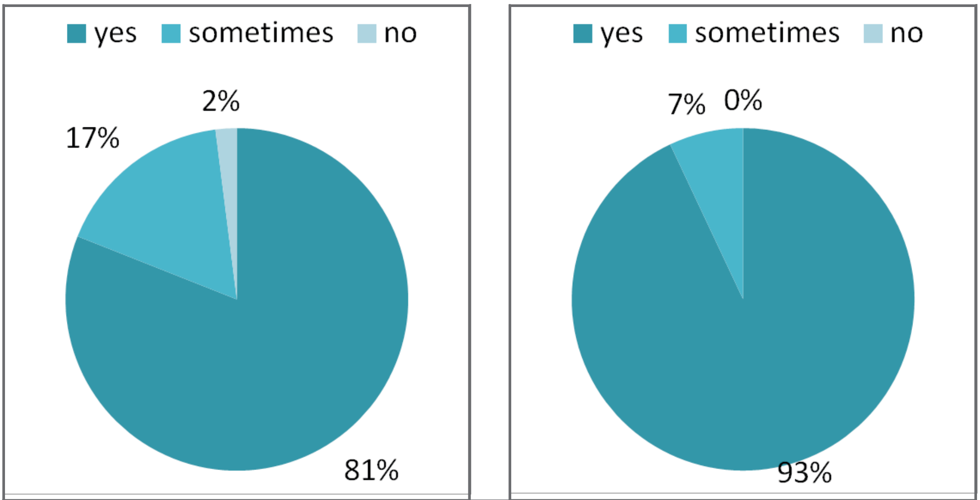

Figure 1. Virtual microscopy helps students with their orientation and understanding histology slides. A – General medicine students, B – Dentistry students.

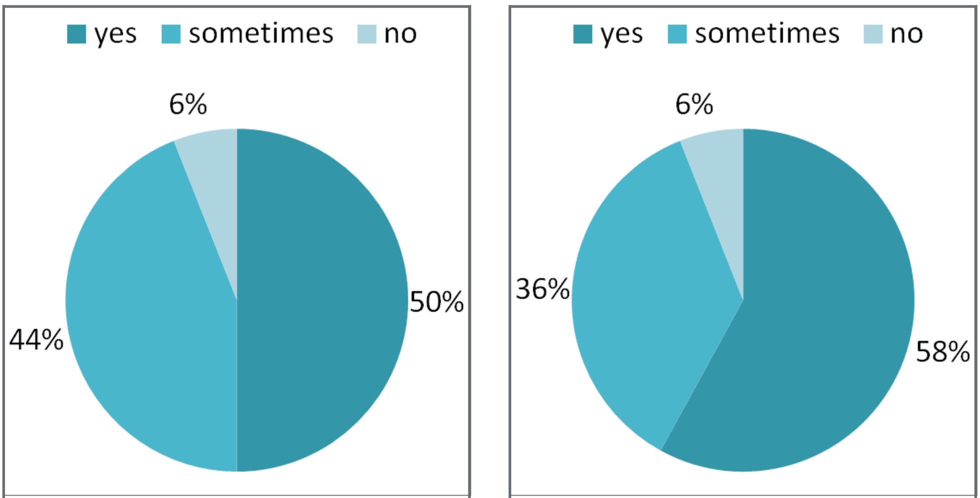

Figure 2. During practical sessions with virtual slides students use the attached supporting documents. A – General medicine students, B – Dentistry students.

safe archiving of important slides without losing their original staining quality. They can be studied with simple computers locally or computers connected to departmental websites. Several professionals can observe and discuss virtual slides simultaneously during teleconsultations or conferencing over internet. Since the resolution and magnification of digital slides is well defined and calibrated, the slides can be used for quantitative analysis of sizes, distance, and areas of structures observed. Screen shots of important parts of virtual slides can be saved and directly used in professional reports and presentations.

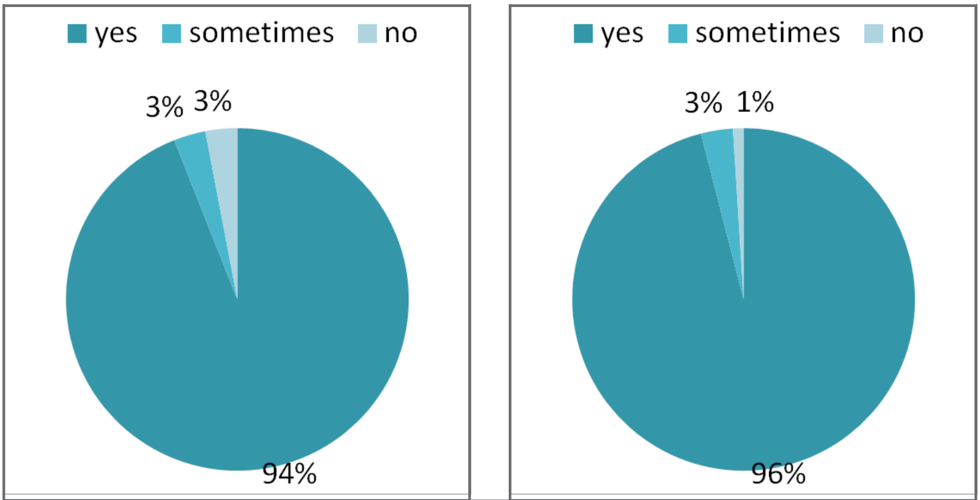

Figure 3. Students download the attached supporting documents to their external media for self-study. A – General medicine students, B – Dentistry students.

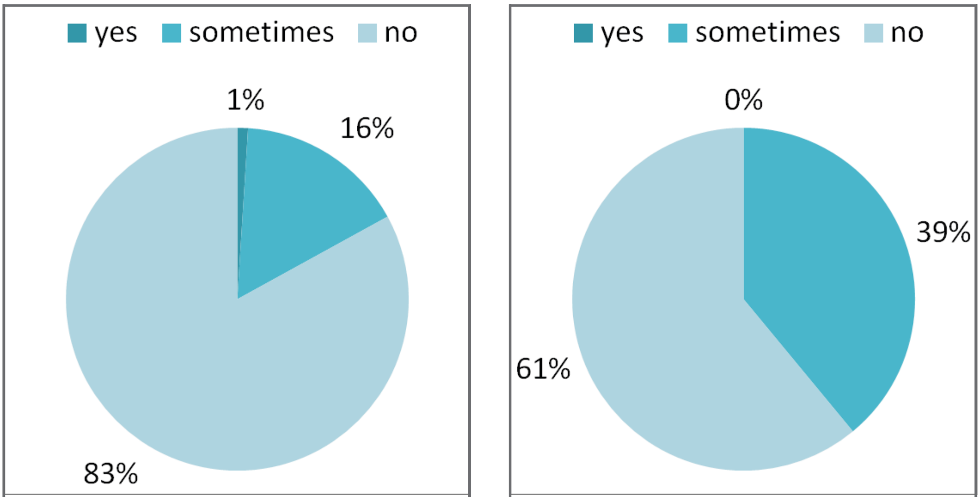

Figure 4. Students use light microscopes together with observation of virtual slides. A – General medicine students, B – Dentistry students.

Methods of application of virtual slides in histology practical teaching

Virtual slides can be delivered to histology students in different ways depending upon budgetary and equipment possibilities of teaching departments.

1. Observation of virtual slides in PC-equipped and intranet-networked classroom

This solution requires a set of computers connected to an intranet network with a server running a database of virtual slides and logging rights for several clients to access the contents. Databases of virtual slides are commer-

cially available. Olympus NET IMAGE SERVER SQL [12] database accepts virtually unlimited number of virtual slides and provides simple graphical user interface to organize and search virtual slides according to given criteria. For student's observations, the contents of this database can be accessed directly from Olyvia viewer installed on PC connected to the server. In order to organize and update this database and to insert annotations to virtual slides a special application software OLYMPUS dotSlide (or dotSlide desktop) is required with administration rights. A graphical user interface of this database is simple and requires some knowledge of management of SQL databases.
Another example of well designed database of virtual slides is the Leica Slidepath Digital Slidebox [13]. The Digital Slidebox allows academic tutors to build extensive libraries of slides for review by students using web. Virtual slides, pre-annotated cases, MCQ tests, course notes, and multimedia content can all be integrated into the digital Slidebox, creating a flexible digital slide resource accessible from the classroom or the dormitory. This database has well designed graphical user interface and provides many teacher-friendly features like visibility control that allows the administrator to sequentially release content to learners. Administrator can also define custom access to virtual slides for individual learners or class groups. Student's performance can be tracked using dynamic statistics and heat-mapping technology [14] showing the regions and magnification that were observed. A group examination results can be exported into spreadsheets for analysis. Separate access permissions can be given to students, teachers, and IT administrators.
These examples of ready-made and commercially available databases are available at certain costs that may exceed budgetary possibilities of some teaching departments. In our Department of Histology and Embryology in Olomouc, we have developed a histology practical teaching system in a classroom of 30 student's PCs (clients) and one teacher's PC as a server [15]. This system is locally networked with limited connection to the faculty intranet. The teacher's PC runs our own database of histology practical designed in MS Excel format that contains virtual slides organized into sessions that systematically follow syllabus of General and Special Histology. In each session, the virtual slides are complemented with supporting documents and other explanatory visuals. According to our two year long testing experience, the system runs flawlessly and it is easy to be used by students, teachers, and database administrators.

2. Observation of virtual slides on a dedicated website

In their full resolution, virtual slides cannot be displayed in an ordinary website as their files have very large sizes that would make their distant observation difficult. This is why manufactures of virtual slide scanning systems provide a possibility to compress digital data of virtual slides and export them for web application. The quality and some annotation features are reduced in these web-exported virtual slides but they can be viewed easily even over

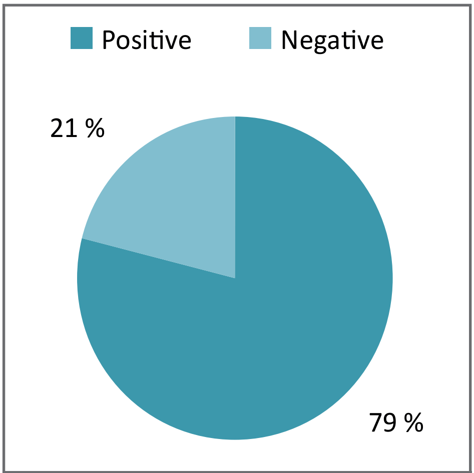

Figure 5. Identification of glass histology slides by students trained with virtual microscopy education system.

a long distance internet connections. This application of virtual slides is useful for distant learning histology courses or self-learning and revision activities.

Structure of our database and supporting documents

The database of histology practical, which is under development at our department [14], is based on the format of MS Excel document. It is available in two identical language versions, Czech and English. After logging into a welcome desktop screen, students are hyperlinked into the content page of the histology practical database. Each topic of practical session (24 themes in total) systematically deals with General Histology and Microscopic Anatomy of various body systems including notes on development of various organs. Each practical session contains a set of virtual slides with slide properties, keywords, file size information, and overview pictures of virtual slides.

Figure 6. Medical students prefer virtual microscopy over classical microscopes, although both methods of observation are available at their benches.

Additional supporting documents in PDF and PPSX format are also available for each of the histology topic. These documents are as follows:
A guide to the practical session includes description and labeled micrographic visualization of all virtual slides available in the session. This information is supplemented with didactic tools like control questions, schematic pictures with legends, and references to external bibliographic and internet resources or quizzes. Teacher's presentation for pre-lab session contains micrographs and schematic drawings of slides that are introduced to students at the beginning of the practical session with teacher's explanation and diagnostic notes.
A document, presentation of electron micrographs, briefs students with basic information about ultrastructure features of specific types of cells in the body system. It contains selected and labeled electron micrographs with explanatory legends. A folder of movies, animations and embryology notes guides students through the difficult visualization of 3D shapes of developing organs (ossification process, tooth eruption, muscle contraction, etc.), containing movies and animations available from our previous FRVŠ projects or from internet resources.
During their own study of virtual slides, students can copy to clipboard selected areas of virtual slides viewed in the Olyvia, (OLYMPUS) viewer [16], and paste them directly into their own self-prepared PPTX presentation for later revisions.
As an optional student's activity in the session, classical binocular light microscopes are available for each student in the class to revise and compare the virtual and optical microscopy images of histology structures.

Pros and cons of practical sessions with virtual slides

Students of histology practical classes readily accepted the use of computers for observation of virtual slides. They represent a computer-trained generation of future medical professionals that is able to utilize fully the capability of modern PCs and can learn new software applications easily. They benefited from a high quality scans of histology slides available equally to all students in the class. The user-friendly interface of Olyvia viewer makes the orientation in the virtual slides at various magnifications easy and enables students to quickly follow teacher's demonstration of the same slide on the central projection screen. This is a highly beneficial feature of this system when used in large practical labs of 50 and more students participating simultaneously. Practical histology with virtual slides makes also the departmental organization of the teaching process easier, since students can revise their practical experience home in their own time and pace, independently of office hours of professors and teaching assistants. It also makes an important environment for future distant learning courses.
Teachers benefited from a uniform quality of presented slides and also from a straightforward and easy personal communication with students in the class when personal guidance and explanation was needed at student's monitors.

PC-based classes of practical histology also provide an easy environment for computerized testing of student's practical knowledge of structures displayed on their monitors during formative and summative examination quizzes or tests.

From the point of view of a traditional histology teacher, the drawback of this method could be seen in limited manual use of light microscopes during practical sessions with virtual slides. This can be contradicted with the fact that the experience in operating light microscopes is trained mainly in biology and microbiology practicals. Our students also have the possibility to use light microscopes during or at the end of their regular histology sessions.

Student's evaluation of a practical with virtual slides

Using the official university-recommended questionary and also our own specific set of evaluation questions, we have asked students to evaluate this new method of practical sessions. Majority of students in General Medicine and also in Dentistry specializations evaluated positively the use of virtual slides, as they allowed them to study and also to discuss various details of cells and tissues clearly at various magnifications (*Figure 1*). About half of students of both specializations claim that they benefit from using the attached supporting documents during practical sessions (*Figure 2*) and almost all students download these supporting documents to their external media for later self-studies (*Figure 3*). The classical light microscopes and glass slides, that were available next to computers, were used by histology students occasionally, according to their reply in this questionary (*Figure 4*).

In order to assess student's ability to operate classical light microscopes and to perform well in identification of histology tissues and organs, we have tested their practical skills on a group of students attending two semesters of histology practical solely with virtual slides.

After completing their practical and theory examinations, and without their prior knowledge, these students have been given standard glass slides for identification. As seen in *Figure 5*, most of these students operated the light microscope correctly and identified the slide of a given organ successfully. About 21 % of students that failed this classical identification failed also in the final theory examination. This proves that the use of virtual slides in histology practical course does not affect student's practical abilities to use light microscopes for their own observations, if necessary.

Virtual slides versus classical light microscopy

From the point of view of traditional histology teaching style, the histology labs are supposed to be equipped with self-illuminated light microscopes and sets of glass slides, ideally available to each student in the session. These basic observation tools are usually complemented with a photo slide projector, overhead projector, or a light microscope with a photo camera connected to a data projector and, not to forget, the traditional blackboard and color chalks. With the advent of virtual microscopy, the format of histology practical labs is changing towards the use of virtual slides viewed by individual students on their PCs. In the earlier-equipped histology practical labs the availability of both classical light microscopes and virtual slides is maintained up to date to give students a possibility to observe histology slides in both ways. According to survey of Drake et al. 2009 [17] regarding the laboratory experience, of the 45 respondents, 13 reported that their laboratory used microscopes, 20 reported that their laboratory used virtual microscopy only, and 12 reported that their laboratory used a combination of microscopes and virtual microscopy. The authors conclude that microscopic anatomy lends itself to approaches that are more independent study friendly. This is especially true with the continued increased usage of virtual microscopy systems that students can access anywhere by computer.

Conclusion

Virtual microscopy is a new vital teaching tool, an educational enhancement and improvement in how microscopic material is presented to students. The e-learning format of histology practical based on virtual slides proves to be a modern and didactically efficient method of teaching histology to medical students. It standardizes the set of histology slides and gives all students in a large teaching group equal opportunity to see the same high quality slides in practical sessions. It also gives students a new experience with the observation of histology structures on PC monitors, and enables them to take selected screen prints of virtual slides for their own study/research observations as if they would be using a complete research microscope with a digital camera. Students evaluate positively their use of virtual slides and accompanying supporting documents in histology practical sessions. Teachers benefit from a uniform quality of presented slides and also from a straightforward and easy didactic communication with students in the class.

Dedication

This paper has been dedicated to the memory of our colleague MUDr. Eva Pospíšilová, CSc., a brilliant and enthusiastic Assistant Professor at Department of Histology and Embryology in Olomouc. She has been actively engaged in preparation and application of this project, and she also presented the substantial part of this paper at MEFANET 2011 conference in Brno. She passed away suddenly on January 2012.

Acknowledgement

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INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

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TESTING PRACTICAL SKILLS OF HISTOLOGY STUDENTS IN THE PC-EQUIPPED HISTOLOGY PRACTICAL LAB

12

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Abstract

We use new and effective methods of examination and testing of student's practical skills. We started with the use of projection of simple slide presentations in MS PowerPoint format on a central screen in the class. These presentations have been setup to advance automatically with one minute timing in order to allow students to write their answers into a prepared answer forms. After the practical laboratory has been equipped with PCs for each student's seat, this method was improved with delivery of testing presentations on student's monitors simultaneously in three different versions. As a further step in developing PC-based testing of identification of histology slides we have used a special software Articulate Quizmaker '09. Because this software shuffles the quiz content randomly onto monitors of examined students, only one version of histology test was necessary to prepare for one practical class. Quizmaker '09 offers the possibility to use a mix of various formats of questions like – MCQ, MRQ, Hot Spot, and Drag & Drop. The test can be exported into different application formats for web or LMS. The major benefits of this system are the straightforward and quick use of question packages, immediate and objective evaluation and reporting of results, limitation of lateral student's communication and crosstalk, and a good prevention of leaking questions outside of the examination room. This PC-based method of practical skill testing was well accepted by students and teachers alike.

Keywords

histology, practical skill, PC testing, examination

Introduction

The important component of the teaching process are in-course and final assessments of student's theoretical and practical knowledge and skills. These assessments provide teachers with a feedback on the quality of their tutoring activities, as they also help students with self-assessment of their understanding of the subject. With the advent of modern didactic methods in histology

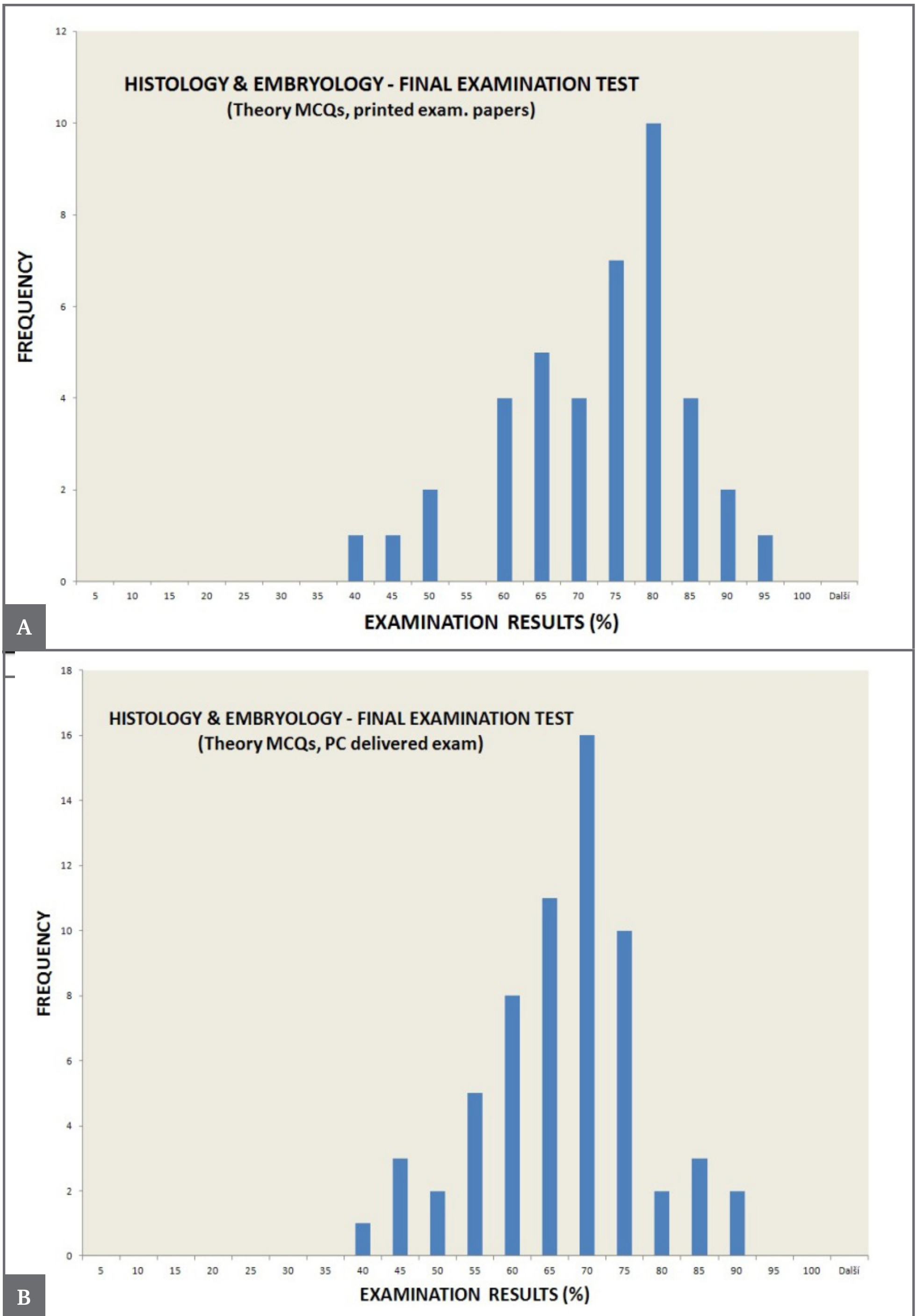

Figure 1. Comparison of the examination results of two different groups of medical students given MCQ questions on printed question sheets (A) and MCQ questions displayed on PC monitors only - electronic examination (B).

teaching, we have started to use new and more effective methods of examination and testing of student's practical skills.

Quizzes and tests in MS PowerPoint format

We started using simple slide presentations in MS PowerPoint format on a central screen in the class. Most of these questions were picture-based aiming at the identification of various structures in tissues and organs. A small portion of questions dealt with simple theory questions that could be answered in one line of a written text. Compared to the individual examination of students next to their microscopes, this method of collective testing method proved to be advantageous for students as well as for teachers. These PPTX presentations have been setup to advance further automatically. All students were given the same quality slides to be identified in one minute per question time. Students had to write their answers into prepared forms that listed all questions and provided blank spaces for answers.

This method had several drawbacks like a necessity of maximal dimming of room lights that interfered with the student's need to write their answers, and a possibility of cross talk of students in crowded benches. Students sitting in the rear benches had been disadvantaged by their difficulty to resolve some details of projected images correctly. After the practical laboratory has been equipped with PCs for each student's seat [1], this method was improved with the delivery of testing presentations on student's monitors simultaneously in three different versions for each of the three rows of student's benches in the class. This arrangement reduced the possibility of lateral communication during testing.

Tests prepared with a special quiz-making software

As a further step in developing our PC-based testing of practical identification of histology slides, we have tested several applications especially developed to create examination quizzes and tests, like Quiz Press [2], Multiple Choice Quiz Maker [3], Students MCQ Manager [4], Wandershare Quiz Creator [5] just to list a few of them.

Finally we decided to purchase a license of a special software ARTICULATE Quizmaker '09 [6] which has proved to be simple and easy to use by teachers having no programming skills. The user interface of this software is similar to the standard environment of MS Office applications. Since this software has a selective option to shuffle sequences of questions and also to shuffle all distracters in the quiz content randomly on monitors of examined students, only one version of histology test was enough to prepare for one practical class. A time limit for display of each question and a total time allowed for a complete test were settable during test creation.

Quizmaker '09 offers the possibility to use a mix various formats of questions like – MCQ (one correct answer), MRQ (one or more of correct answers), and Drag & Drop format (dragging and aligning several correct options to the same number of statements). For identification of structures in displayed micrographs a Hot-Spot format of question (clicking with a mouse on a structure in question) proved to be very useful in histology testing. This software provides a possibility to arrange a set of questions into groups according to topics they represent. The images inserted into questions can be labeled with various graphical symbols like arrows, rectangles, alphabetic, and numeric symbols and their on screen appearance can be set up easily with the provided timeline for each slide. The color format for each slide can be selected from several slide templates. If necessary, each slide can be synchronized with an acoustic effects and commentaries, which can be used in authoring of formative quizzes.

Prior to exporting tests for PC application the teacher can decide about information that will be visible to student during examination time. These are: the test title, countdown display of the total examination time, point value of each question, and a current student's score as achieved during testing. On completing the test, the software automatically summarizes and displays value of correct answers in percentages and shows a minimum passing limit for that exam. When completely authored, the test can be exported into different application formats for web (for use on a website or a PC-equipped lab), for CD or DVD distribution, for LMS managed classrooms, and it can be also exported into a simple MS Word document for archival documentation.

We use quizzes and tests authored with this software for examination of large groups of students (up to 30 students simultaneously) in our PC-equipped practical lab where students log into an exam mode of the PCs [1]. At this examination mode the USB ports, DVD rewriter drives and e-mail access are deactivated so that students can not copy and save any of the examination questions.

Evaluation of PC-based testing of student's practical knowledge of histology

Major benefits of this system are the straightforward and quick use of question packages, immediate and objective evaluation of student's performance in percentage points, and immediate reporting of test results, limitation of lateral student's communication and crosstalk, and a good prevention of leaking questions outside of the examination room. This format of examination tests is easy to apply in large PC-equipped labs with large groups of students, it also saves the time of examiners as well as economizes stationary and consumables.

As we have been interested in student's evaluation of this new method of testing their knowledge, we have designed an anonymous evaluation questionary. The question about student's preference of examination in MCQ format over the classical oral examination was replied positively in 81 % of responding students of General Medicine specialization and 94 % of responding students of Dentistry specialization. Regular in-course testing of student's theory knowledge and practical identification skills has been considered helpful and motivating to improve their study activities in 86 % of responding students of General Medicine specialization and 79 % of responding students of Dentistry specialization.

We have also compared student's performance in classical paper printed examinations (*Figure 1A*) with electronically delivered examinations on PC monitors (*Figure 1B*). Both groups of students were given identical tests of 100 MCQ questions with identical time of 90 min allowed for completion of these tests. The distribution histograms show a normal Bell-curve distribution of examination results in both groups of students, with median values of 70 % in printed examination group and 65 % in PC delivered examination group. This preliminary evaluation of student's test results shows that computerized in-course examination of theory and practical knowledge has no negative effect on student's performance in this subject. It has been well accepted by students of our histology classes and teachers alike.

Summary of features of electronic testing in MCQ format with text- and picture-based stems

Applications:

- Formative in-course quizzes and tests
- Summative end-semester credit tests
- Self-learning/self-assessment student's activities on the department website.

Benefiting features:

- Quick, time-controlled form of examination with a possibility to set up pacing for each question.
- Immediate evaluation and display of test results readily accessible to students and teachers.
- Objective evaluation of student's performance reported in percentage units.
- LMS compatibility.
- Quick and simple preparation of tests in user-friendly, MS-Office like environment.
- Possibility to insert pictures into the stem of questions in full colors and various formats, editable and zoomable.
- Simple application of tests in PC-equipped and networked lab.
- Safe application to large examination groups ensuring reduction of lateral communication of students and copying of questions.
- Economy of stationery and toner materials.

Conclusion

PC-based testing of students knowledge may be used not only as regular in-course assessments in practical sessions, but also as in-group summative examination tool at the end of the teaching semester, and with some modifications, it can be a helpful tool to create formative quizzes for student's self testing on the Department of Histology and Embryology website.

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INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

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VARIABILITY OF SUPERPOSITION OF ACTION POTENTIALS, THEORETICAL MODEL

13

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Abstract

Linearity of values of rectified and integrated EMG signals with frequency of incidence of action potentials in muscle fibers and the effect of moving average window width on the range of values of integrated signals was tested on theoretical model. Our simulations of 4 overlapping single units multipotential signal demonstrated that integrated EMG signals are only approximately linearly proportional to the frequency of action potentials in the superposition – multipotential. The width of moving average window influences the range (dispersion) of integrated values (their accuracy). Quality of EMG recordings, the frequency (the number) of action potentials as well as the width of moving average window increase the accuracy of the determination of integrated EMG signal.

Keywords

action potential, superposition, linearity, moving average window, accuracy

Introduction

Nerves conduct signals in form of action potentials. Action potential is a basic manifestation of excitatory tissues activity. It represents an essential element of encoding and transmission of informations in neural system and it also represents the first stage of muscle contraction triggering. It is generally assumed (in the field of nerve modeling as well) that the nerve compound activity (multipotential) is a linear superposition of single fiber action potentials [1]. Elektromyogram (EMG) usually represents a complex electrical biosignal, the results of superposition of action potential trains recorded from muscle fibers located near the electrode and generated by active motor units. The motor unit consists of the motor neuron and the muscle fibres innervated by its axonal branches. The number of muscle fibres in the motor unit ranges widely across human (and animal) muscles. The muscle fibres of each motor unit are intermingled with fibres of other motor units so fibres belonging to several different motor units are close to each other [2]. The assumption of linearity of summation of their activation is crucial for evaluation of intensity of the whole muscle activity, for decomposition of multiunit EMG, for computer simulations and mathematical models [1]. In this paper, we attempted to study linearity of superpositions of action potentials from few motor units recorded at the electrode using computer theoretical model. We hypothetized that linearity of superposition of action potentials as well as its variability depends on frequency of action potentials and on the width of integrated windows.

Methods

The model consisted of five waveforms. Four of these waveforms simulated single unit EMG signals and the fifth waveform represented algebraic summation of the four single units. A three phase shape of action potential (single units) was chosen. It corresponded to the in vivo recordings [3] and lasted 5 ms (the 1st and the 3rd waveform) and 7 ms (the 2nd and the 4th waveform) [3]. All waveforms were shifted in time from the first one. The second started 4 ms, the third 1 ms and the fourth waveform 5 ms after the first one. The frequency of their incidence was 5–75 Hz (the 1st and the 3rd one) and 9–135 Hz (the 2nd and the 4th one) [4]. The integrated waveform represented rectified (absolute values) and averaged signal. We employed 3 windows widths – 1 s, 200 ms and 40 ms. Moving average window (MA) was shifted by 0.01 ms each step. Theoretical model was built and simulations were performed in PC environment MATLAB.

Results

First, we verified the linearity of superposition of action potentials. We tested the linearity of action potential integration for each of four single unit waveforms as well as the linearity of moving average values of their superposition.

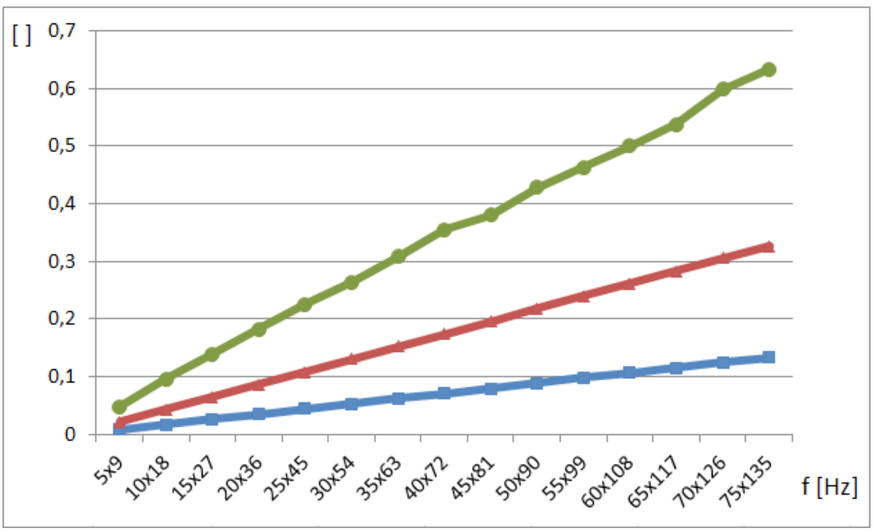

Figure 1. Relation of integrated EMG signal values and the frequency of action potentials. Blue (square) line – values of waveforms (the 1st and the 3rd single unit train) with 5 ms duration of action potentials, red (triangle) line – values of waveforms (the 2nd and the 4th single unit train) with 7 ms duration of action potentials, green (circle) line – superposed waveform.

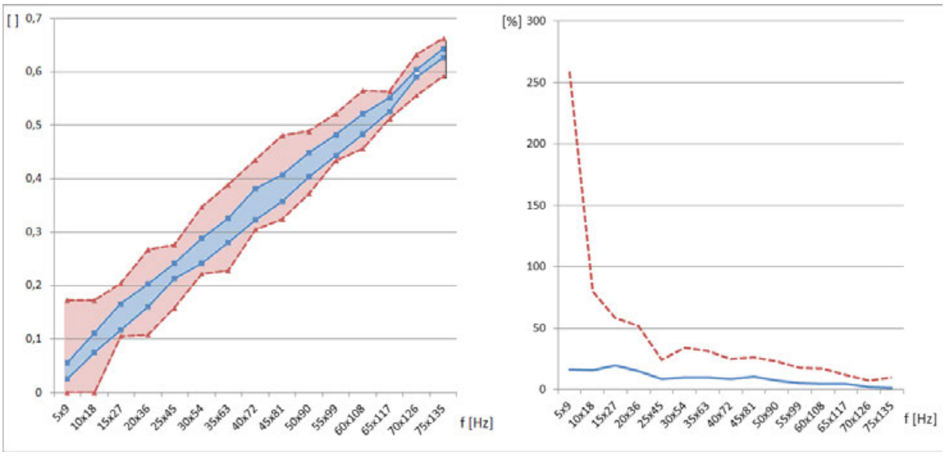

Figure 2. Inaccuracy of moving average values (deviations) related to different moving average window width and frequency of action potentials. a) The width of interval with 200 ms window (blue) was 3.2 fold narrower than using the with of 40 ms window (red). b) With the increasing frequency of incidence of action potentials the deviation was decreasing in both cases, 200 ms window - blue unbroken line, 40 ms window – red broken line.

We increased successively the frequency of action potentials and we acquired the rectified and moving average values of all five waveforms. The width of moving average window was 1 s. Using this window width the integrated values of four single unit waveforms increased linearly with the frequency of action potential incidence. Moving average values (integrated signal) of superposed waveform increased approximately linearly with the frequency of the occurence of action potentials, however, with some variability (errors) due to overlaping of positive and negative components of individual action potentials (*Figure 1*).

Second, we tested an impact of the width of moving average window on the interval wherein values of integrated waveform can fall. We used moving average window widths 200 ms and 40 ms. Superposed waveform was rectified and integrated. Then, we found minimal and maximal values in the entire range of integration. These values (the differences maximum minus minimum) were determined for all frequencies and for both moving average window widths. This way 2 sets of intervals were obtained (*Figure 2a*). The variability of differences (maximum minus minimum) with 200 ms moving average window was 3.2 fold less than that with 40 ms moving average window. Subsequently we attempted to express the inaccuracy of integration performed using 200 ms and 40 ms windows at superposed waveform. Reference (the accurate) value was obtained with integration of the signal using the window width of 1 s (all action potentials were taken). The values obtained with 200 ms and 40 ms, which differed the most from the reference value were calculated and these deviations were expressed in percentage. We determined the deviations for all 15 pairs of frequencies. The deviation at 40 ms window and the lowest frequency of incidence of action potentials was 259 %, while using 200 ms window the deviation was only 17 %. The deviations decreased with higher frequency of action potentials in the waveforms in both cases (200 ms and 40 ms moving average window), and at the highest frequency it was 1.55 % for 200 ms window and 10.2 % for 40 ms window (*Figure 2b*).

Discussion and conclusions

Our simulations demonstrated that moving average values of four raw single unit waveforms increased linearly with the frequency of action potentials. Similar linearity, however, with some variation (inaccuracy) was found also for integrated multipotential EMG signal (superposition of individual single units). The width of moving average window significantly influences the range (dispersion) of integrated values. Approximately three fold higher variability was found for the moving average window width of 40 ms compared to that for 200 ms window. Our results are consistent with experiences obtained during experiments and analyses of data on animals (reference; our own data). Quality of EMG recordings depends on both the frequency of action potentials (possibly the number of action potentials recorded) and the width of moving average window. The accuracy of the determination of integrated EMG signal increases with the number of action potentials taken and with the width of moving average window. These two factors have to be taken into serious consideration in addition to the duration and variability of analysed signals (short bursts with steep start and finish [5]) during EMG and potentially electroneurogram analyses.

Acknowledgement

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