E-Learning Applications for Basic and Advanced Education in Medicine and Dentistry

Herbert K. Matthies
Head
Peter L. Reichertz Institute for Medical Informatics
Hannover Medical School
Hannover, Germany

Abstract

The era we are living in is often referred to as "the age of communication", the young generation is often called the "google generation". Both world-wide telecommunication networks (using satellites, cables, wireless) and the new information and communication technologies (ICT) have had an enormous influence and a revolutionary impact to change the way we do business, live and learn. New educational concepts, technologies and course contents will be required with consideration of topics, e.g. teaching/learning strategies, e-learning environments, development and production of learning modules, web-based learning resources/tools, virtual learning labs/classrooms in conventional universities, public private partnerships (PPP) between universities and publishing companies, collaborative learning in small groups, policies, ethics and worldwide standards.

1 New Ways of Education: E-Learning Applications in Medicine and Dentistry

New technologies open up new possibilities for new forms and ways of learning. Especially considering the education of physicians, web-technologies promise to advance teaching and training. E-learning modules are available independent of location and time and promote self-determined learning. They also facilitate a better understanding of anatomy and pathology. The development of such multimedia course units demands cooperative working teams of interdisciplinarily working authors, who are able to master several areas of medical knowledge as well as the presentation of these using different multimedia facilities in a web-based teaching and training network. These new multimedia and information technologies offer manifold educational and training opportunities, e.g. net-based e-learning both in classrooms and individually at home with access to libraries, also mobile learning.

The theory and practice of education are undergoing dramatic changes. Lifelong learning and adaptation of medical practice to new knowledge and new techniques will be even more important. The focus will move on from conventional teacher based lectures to blended learning courses, a combination of classroom course units with internet-based multimedia courseware.

1.1 E-Learning Modules for the Medical Education at Hannover Medical School

Apart from the Bologna process recommendation, studies of human medicine at the Hannover Medical School were restructured in 2002 according the to new government regulations as specified in the German National Guidelines for Medical Education. In order to generate new impulses, faculties were allowed to install a Model Curriculum. Since the academic year 2005/06, the Hannover Medical School offers a new model course for students in medicine, called HannibaL (Hannover integrated adaptive practice-related learning concept) (Paulmann et al. 2008). In this new curriculum, the preclinical and the clinical stage of the course are intertwined. Consequently, the patient-related education was significantly intensified.

In 2002, the Learning Lab Lower Saxony (L3S) was established in Hannover (Germany) to provide scientists from several participating universities with a common platform for researching innovative learning technologies. The L3S is partner of the Wallenberg Global Learning Network. The ELAN project granted by the government of Lower Saxony, which is being coordinated by the L3S, uses modern multimedia and information technology for presenting knowledge. In the context of this project, an interdisciplinary, multilingual center for e-learning in medicine and

dentistry is being realized at the Hannover Medical School. As part of this effort, both a learning management system ILIAS (ILIAS 2003) and a content management system SCHOOLBOOK (Kupka et al. 2004a) have been established, which contain learning modules for a variety of medical fields.

1.2 The Content Management System SCHOOLBOOK

The Schoolbook is a web-based content management system that enables authors to present their specialised knowledge in the World Wide Web without the need to be familiar with internet technologies (Kupka et al. 2004, 2006; Zajaczek et al. 2003). It was developed as an Open Source Project at the Institute of Medical Informatics at the Hannover Medical School. The entire system is realised on a Linux system using an Apache web server, the programming language PHP and the database MySQL. These components realise a LAMP environment (LAMP: Linux, Apache, MySQL and PHP). Through a web browser, the PHP application allows reading content from the database and enables authors to insert their content. Different Schoolbooks can easily be implemented and every Schoolbook has its own database and design. Structure and content are stored in the database, but the layout is defined by the PHP application. All Schoolbooks have a consistent layout.

In the Hannover Medical School, the Schoolbook software is used to collect medical topics for education. The system provides access to several sources of medical knowledge and is used as an e-learning platform for different departments. Presentation of real cases plays an important role in medical education. A practice-oriented education in medicine should use genuine patient cases to foster diagnostic abilities. A multi-disciplinary, case orientated training pathway is the key to providing successful medical training and continuing education. In this way, the case based multimedia system Schoolbook promotes learning based on practical experience.

The following figures show example screenshots of Schoolbooks implemented for several medical fields (internal medicine, trauma surgery, neuroradiology, neuropathology, dentistry).

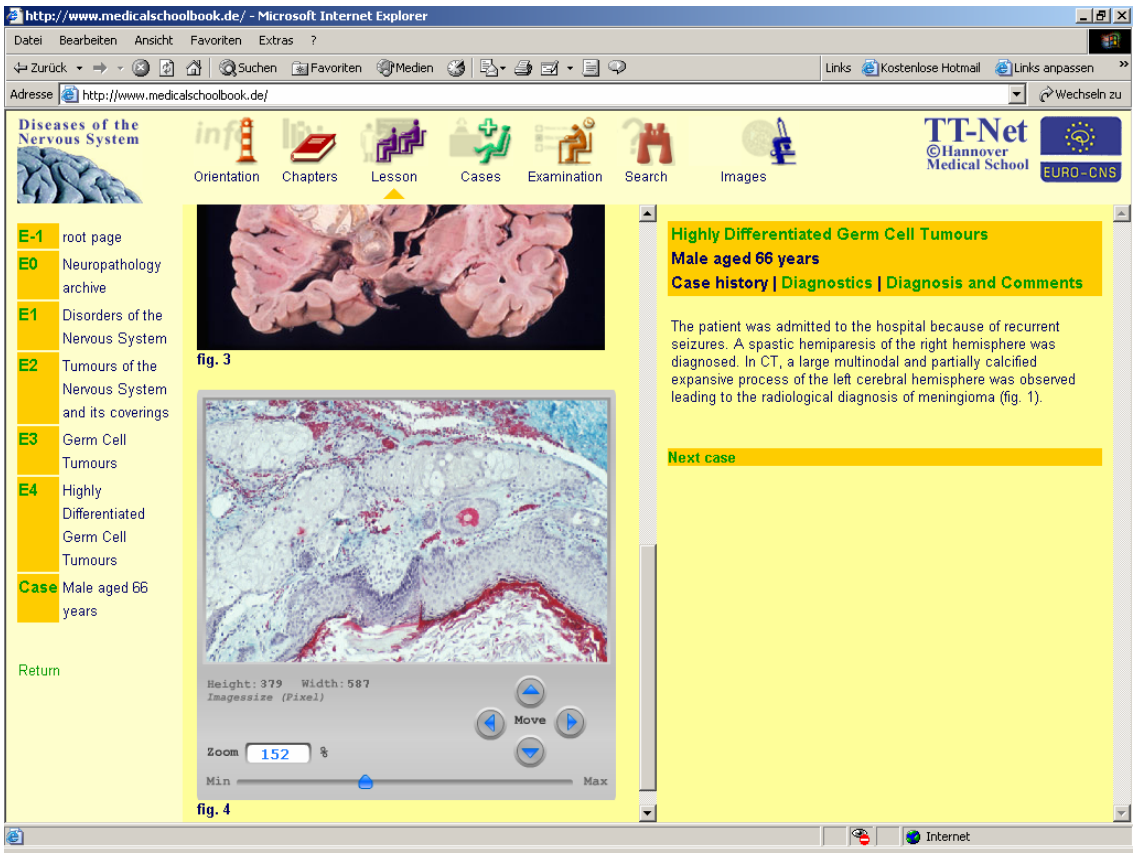


Fig. 1: Schoolbook for Neuropathology

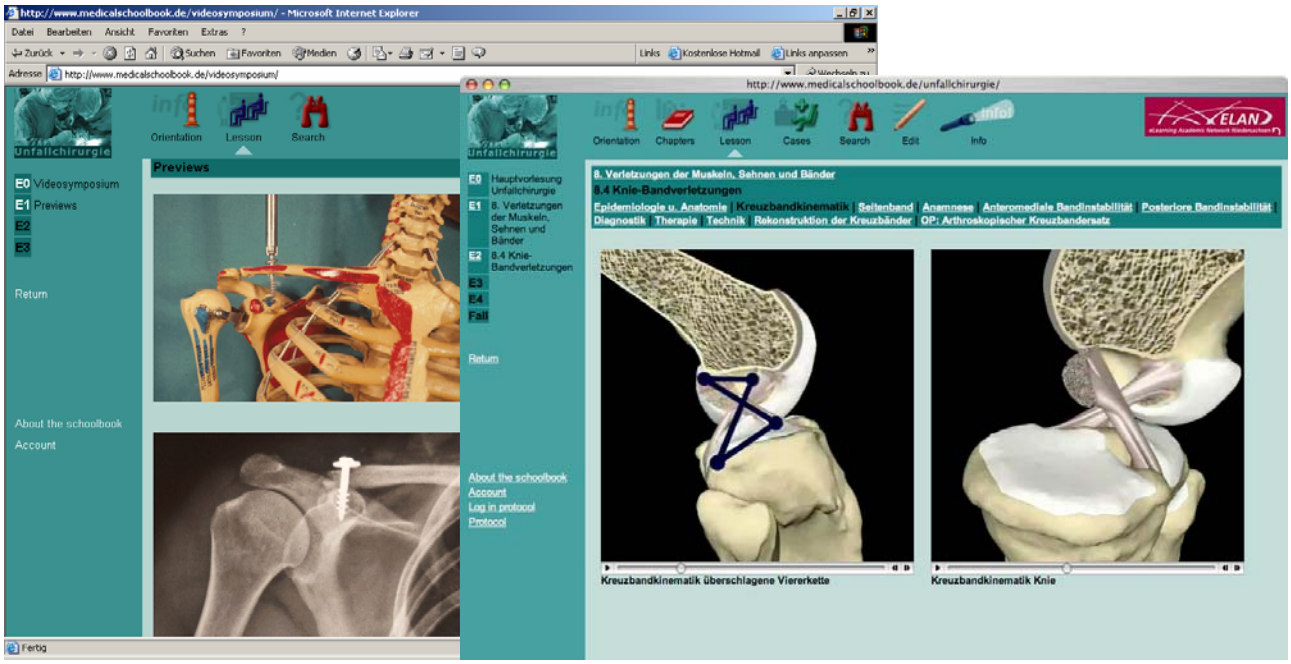


Fig. 2: Schoolbook for Trauma Surgery

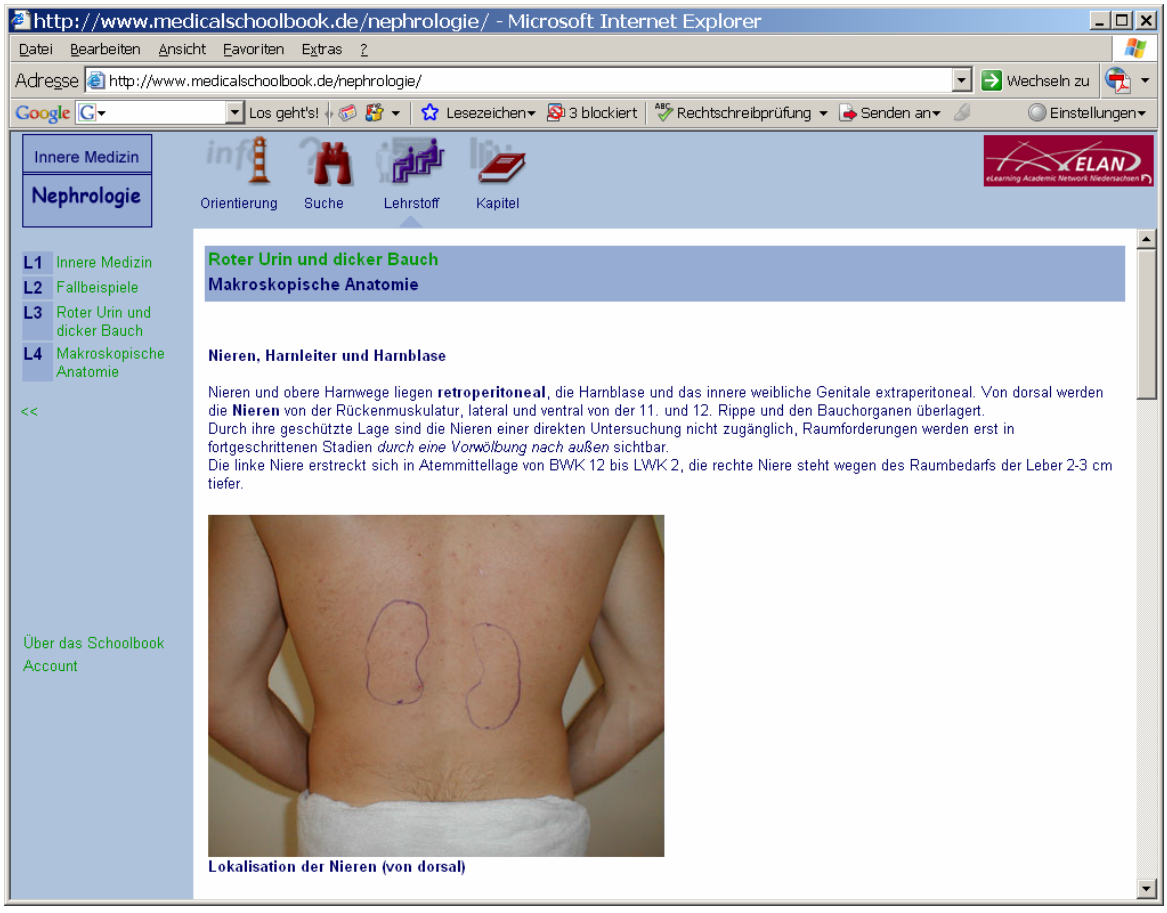


Fig. 3: Schoolbook for Internal Medicine

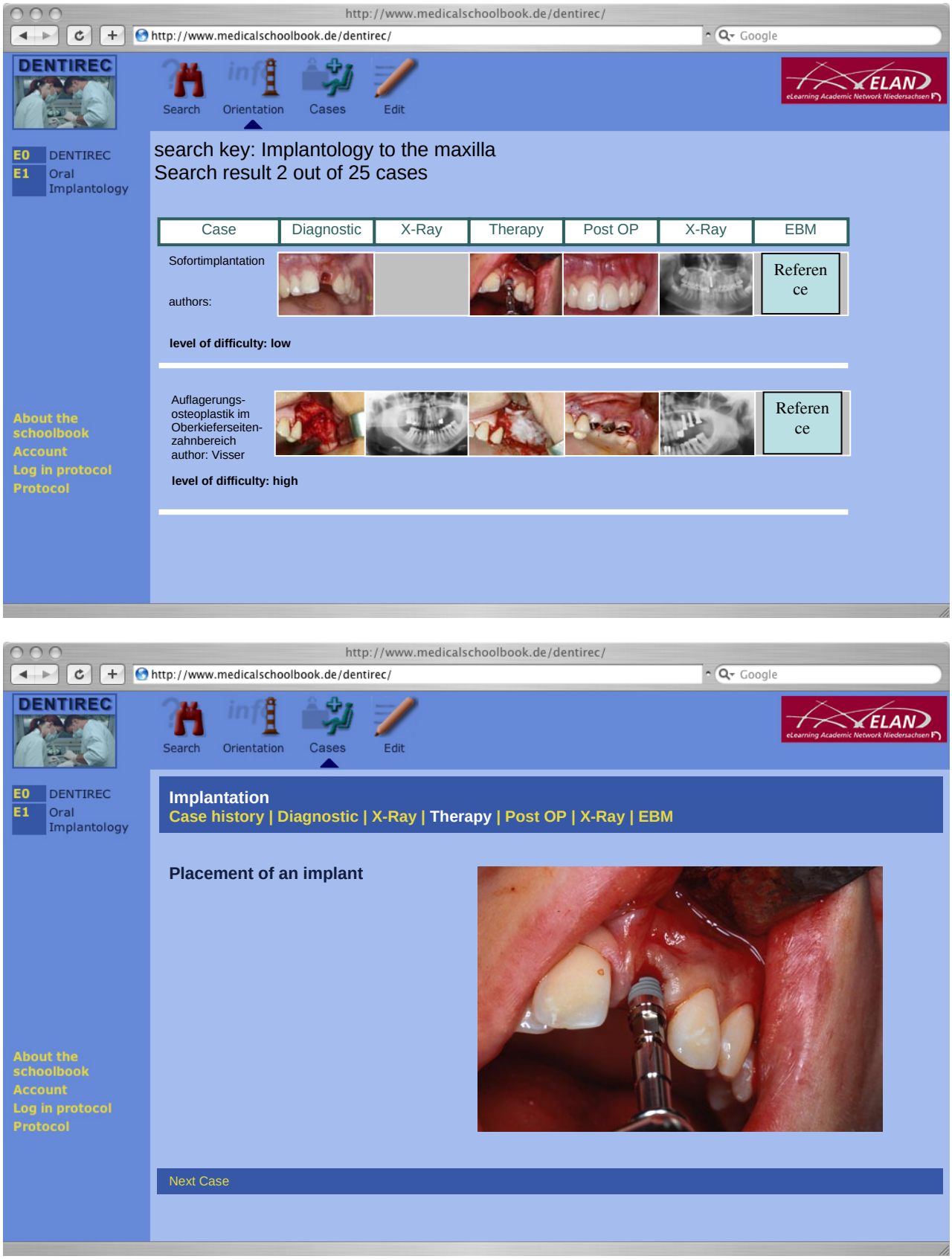


Fig. 4: Schoolbook for Implantology

1.3 The Learning Management System ILIAS

Both the Schoolbooks and the course modules of the learning management system ILIAS are basic components of the teaching and training network at the Hannover Medical School. Based on specific user requirements, both ILIAS and the various Schoolbooks can be used in an integrated environment. ILIAS is used for setting up and supplying consolidated course units. For building learning units containing complex medical contents, medical personnel are actively involved in setting up a medical knowledge base. Furthermore, ILIAS offers the possibility of creating multiple-choice questions. On the base of those course units, students are able to acquire knowledge and to examine their knowledge. Up to now, course units for general medicine, biochemistry, cellular-chemistry, biometrics, orthodontics, ophthalmology, and additional curricular relevant course units such as medical informatics are available in ILIAS. All these course units supplement the regular lectures and provide an opportunity to the students to concentrate on a subject, irrespective of time and place. The following figures show example screenshots of realized course units of ILIAS.

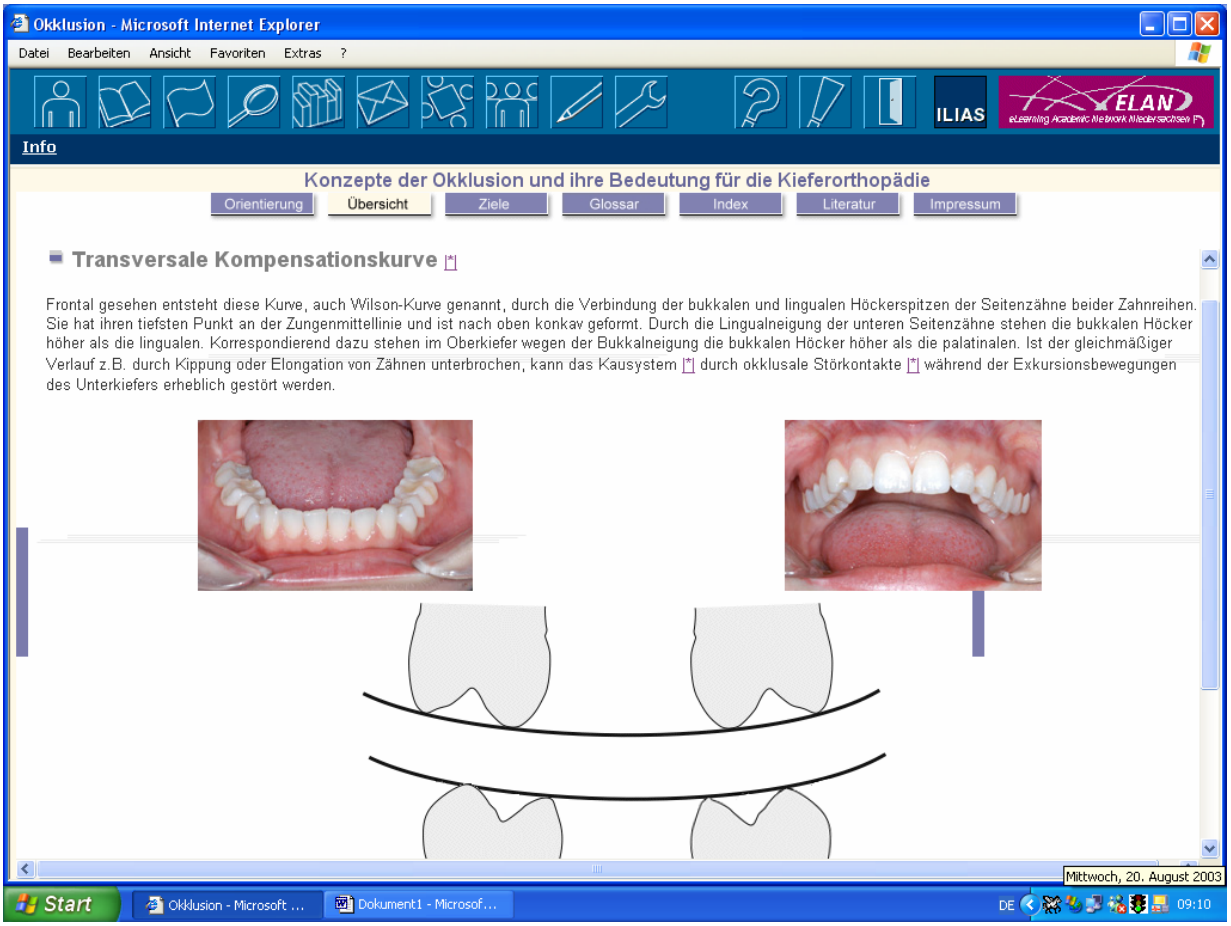
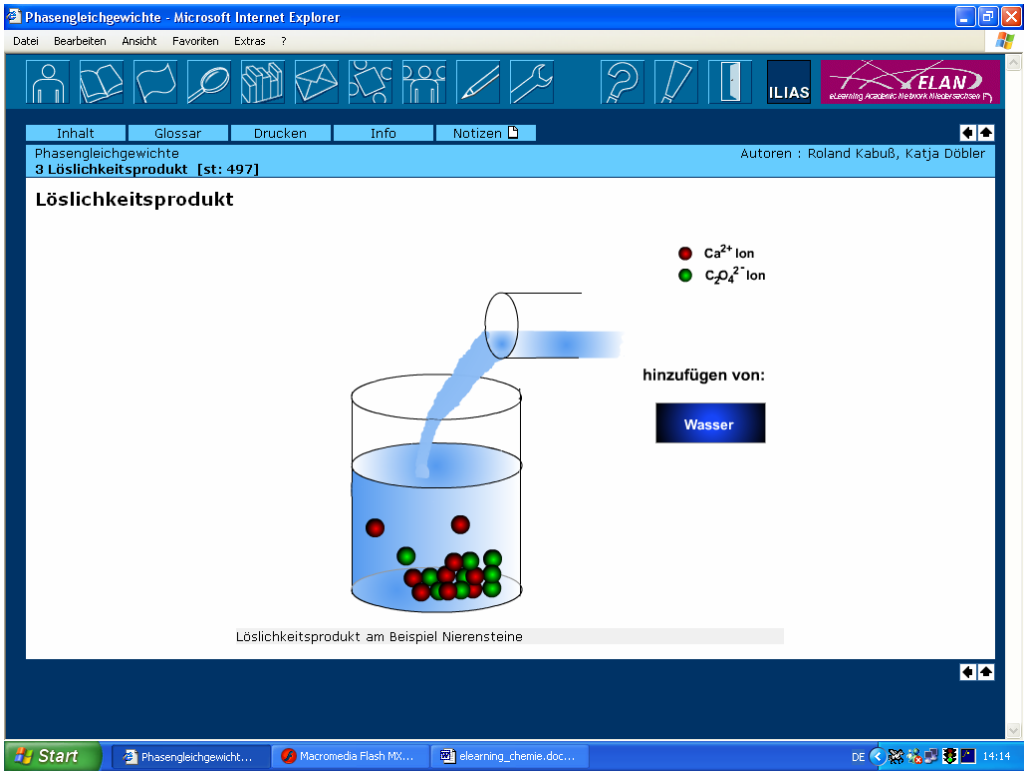


Fig. 5: ILIAS learning module for Orthodontics



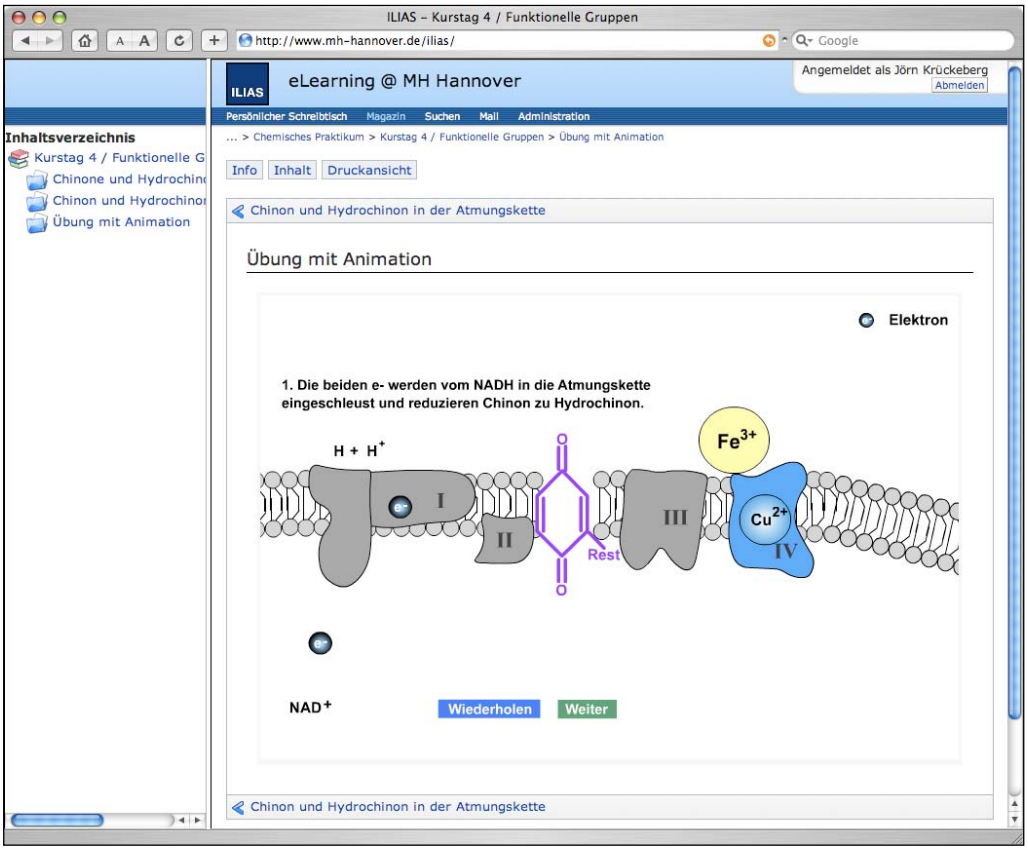


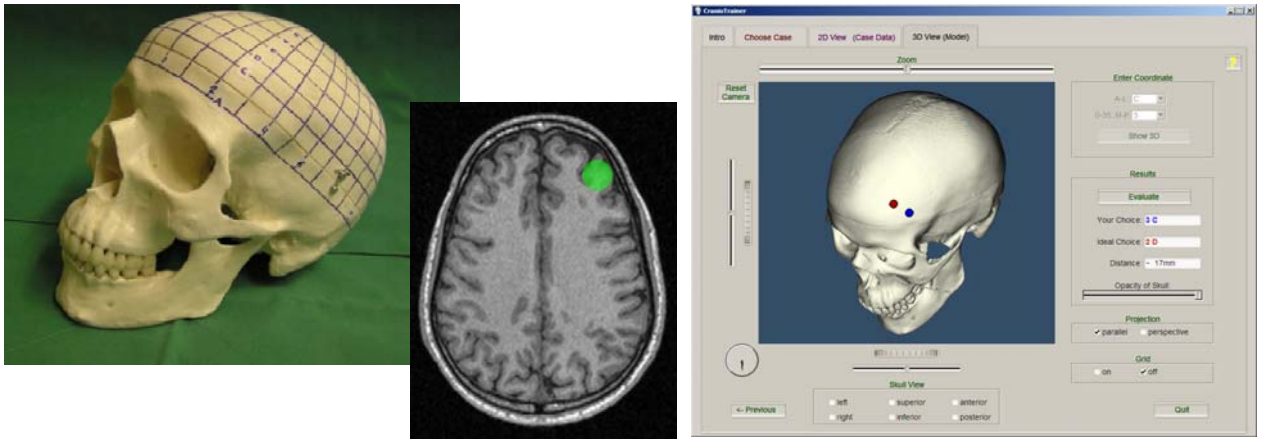
Fig. 6: ILIAS learning modules for Chemistry

1.4 CranioTrain – a New Concept for Training Craniotomy Localizations

In education and advanced training of physicians imaging data are best suited to mediate the knowledge ever since the area of the new media. For example, CranioTrain is a novel software based approach for training how to determine the correct craniotomy localization (von Jan et al. 2007).

Determining the correct placement of craniotomies for neurosurgical procedures performed for certain pathologies such as tumors, vascular pathologies or hemorrhage has great influence on the outcome, since complications may arise by choosing an inappropriate localization. Intra-operative manipulation of deeper structures may be considerably harder with an adverse angle for accessing the pathology, whereas pathologies near the brain's surface may require an enlargement of the craniotomy which is later detrimental to healing and stability. For the inexperienced resident, determining its correct placement is a difficult process due to the skull's complex anatomy as well as the different angulations of the provided image data such as CT and MRI. In clinical routine, one generally uses distances from certain anatomical structures to localize the ideal place for the craniotomy, which is aggravated by having to do this on the surface of the convex skull. This method also requires considerable practice to be able to confidently find the correct localization.

To simplify the learning process, a software tool was developed which is to be used in conjunction with a specially prepared anatomical skull phantom. In the software, virtual pathologies are overlaid into the available CT and MRI image data. The learner must then determine the correct craniotomy position on the skull phantom. For this purpose, a grid was engraved on the phantom (Fig. 7a) and the labels of the grid's intersection points can then be used as a reference for entering the chosen position into the software. Finally, the program shows the chosen as well as the ideal center point of the craniotomy in a 3D view (Fig. 7b) and also provides the distance of both points on the skull's surface. It is also possible make the skull transparent to give the user the possibility to view the position of the pathology within the 3D model.



(a) (b)

Fig. 7: CranioTrain: (a) An anatomical skull model with reference grid is used for determining the craniotomy position based on the 2D views of the image dataset (MRI) with virtual pathology. (b) 3D surface model of the skull with the chosen and ideal craniotomy positions.

2 Conclusion

The consistent use of innovative multimedia technologies in clinical everyday life as well as in research facilitates fast integration of the latest research results in teaching, since digital media can efficiently be processed for use in valuable teaching modules for medical training and continuing education. The learning of medical skills is based on audio-visual information and therefore can be demonstrated, explained and trained interactively using computer-assisted multimedia applications.

The evaluation outcomes (Krueckeberg et al. 2005) show a high motivation of the students using the learning management system ILIAS as an additional offer to prepare for written exams. Likewise, a great level of satisfaction with the course units can be found in the statements of the students. The introduction of medical students at the Hannover Medical School to e-learning applications was achieved with positive evaluation results, and the prospect of future usage of e-learning was also supported by the students.

The integration of web-based multimedia learning modules in addition to and in combination with classroom courses is important. Strategic blended learning (a mix of presence and e-learning) creates an opportunity for institutions, universities and companies to utilize the "power" of ICT for real social and educational change bringing benefits for all its users. Web-based training not only replaces the traditional classroom, but also the roles of the teachers, the learners, and all interactions among them. The user statements point out that students have recognized a basic benefit in the course units.

The increasing technical capabilities as well as the wide distribution of mobiles devices challenge educational institutions to develop appropriate concepts and applications of mobile learning (Marx et al. 2007). The range of learning content of different kinds is growing. Many publishers offer multimedia-based courses, including video clips, electronic textbooks, multimedia reference books, etc. for mobile training on mobile devices, most of them including an update service.

References

Ammann A., Matthies H. (2007). Knowledge Management and Clinical Workflow. In: C. Montgomerie, J. Seale (Eds.), *Proc. of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2007* (p. 3421-3426). Chesapeake, VA: AACE.

Krueckeberg J., Meyer G., Matthies H.K. (2005). Evaluation of Web Based Course Units in Medical Education. *Proc. of the HCI International 2005*. Mahwah, London: LEA Publishers (CD-ROM).

Kupka T., Behrends M., Zajaczek J.E.W., Matthies H.K. (2006). Establishing the Content Management System Schoolbook in Medical Education. *Proc. of the IASTED International Conference on Web-Based Education.* (p. 232-242). Anaheim, Calgary, Zürich: ACTA Press.

Kupka T., Behrends M., Zajaczek J.E.W., Matthies H.K. (2004a). SCHOOLBOOK – Open Source Project Site: http://www.medicalschoolbook.de/project/

Kupka T., Zajaczek J.E.W., Behrends M., Walter G.F., Matthies H.K. (2004). Schoolbook - An Authoring Tool and Content Management System. *Proc. of the IASTED International Conference on Web-Based Education 2004*. (p. 169-171). Anaheim, Calgary, Zürich: ACTA Press.

ILIAS – Open Source Project Site: http://www.ilias.uni-koen.de/ios/index-e.html

Littlejohn A., Regler C. (2007). *Preparing for blended e-learning.* London, NY: Routledge.

Marx C., Gwinner, W., Krueckeberg J., von Jan U., Engelke B., Matthies H.K. (2007). Mobile Learning Applications for Education in Medicine and Dentistry. *Advanced Technology for Learning*, vol. 4 (2), (p. 92-98).

Paulmann V., Fischer V., Haller H. (2008). Hannibal: the new model curriculum in Human Medicine at Hannover Medical School. *Proc. of Association for Medical Education in Europe (AMEE) Conference*. (p. 275). Prague.

Pellegrini T., Blumauer A. (2006). *Semantic Web.* Berlin, Heidelberg: Springer Publishing.

Schatz, S. (2006). Improving Performance Support Systems Through Information Retrieval Evaluation. *JI. of Interactive Learning Research*, 17 (4), (p. 407-423).

von Jan U., Ammann A., Matthies H.K. (2008). *Generating and Presenting Dynamic Knowledge in Medicine and Dentistry*. In: C.J. Bonk, M.M. Lee, T.H. Reynolds (Eds.), Proceedings of the E-Learn 2008, World Conference on E-Learning in Corporate, Government, Healthcare & Higher Education, p. 209-214. Chesapeake, VA: AACE.

von Jan U., Rodt T., Koeppen G., Galanski M., Krauss J., Matthies H.K. (2007). "CranioTrain" - a new concept for training craniotomy localizations. *Int. J of Computer Assisted Radiology and Surgery, 2 (Suppl. 1)* (p. S501).

Zajaczek J.E.W., Götz F., Kupka T., Behrends M., Haubitz B., Donnerstag F., Rodt T., Walter G.F., Matthies H.K., Becker H. (2006). eLearning in education and advanced training in neuroradiology: introduction of a web-based teaching and learning application. *Neuroradiology*, 48(9), (p. 640–646).

Zajaczek J.E.W., Kupka T., Behrends M., Köster I., Götz F., Becker H., Matthies H.K.. (2003). Net-based Multimedia Education in Medicine exemplified by Neuroradiology. In Lemke, H.U. et al. (Eds.): Computer Assisted Radiology and Surgery CARS 2003, Excerpta Medica ICS vol. 1256, (p. 1330), Amsterdam: Elsevier Science B.V.

Ziegler M., van Deelen I., Tschentscher D. (2007). *Grid Media.* Frankfurt: Time Labs.