Advanced system for optimization of medical curriculum

PHD THESIS PROPOSAL

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Declaration

Hereby I declare, that this paper is my original authorial work, which I have worked out by my own. All resources, references and literature used during preparation of this work are properly cited and listed in complete reference to the due source.

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1 Introduction

Medical students face specific challenges compared with students studying other areas at universities. The reason is that their future job does not allow any gaps in the knowledge obtained during studies and that any error in their medical practice may have fatal consequences. The need for guaranteed and high-quality education involving predefined curricula covering a corresponding scope of input knowledge and skills required in subsequent practice has been gaining momentum. Medical universities compile their curricula so as to ensure that they cover all steps essential for the students to obtain employment later on. The students must fulfil all duties such as successful completion of compulsory and optional courses and the final state exam only to prepare for attestation to obtain professional qualification for employment as a physician.

A correctly compiled and balanced curriculum across medical fields is an essential prerequisite for medical doctor education. A suitable combination of theoretically focused courses and a clinical teaching base is certainly the key to a successful draft curriculum. Medical faculties mostly offer education in 6-year “General Medicine” Master’s medical programmes from which students graduate as MUDr. (MD – medical doctor). As in other fields and faculties, also in medicine it is evident that the overview of lesson structure and content is not ideal and it often happens that the overlap of theoretical subjects with clinical ones is too large or, on the contrary, insufficient. As modern IT has seen a rapid development, the Internet can now be utilised for developing a technology which would not only eliminate the poor transparency of curricula but also help improve teaching as such.

The list, annotations and curricula of compulsory subjects, compulsory-optional courses and optional seminars are available to students and teachers – typically in local teaching management systems. But the differing level of detail and description style lacking any kind of standardisation or parametrisation hampers transparency and comprehensibility, particularly when searching for information on the entire course of studies. As a result, it is very difficult to look at the whole field, specialisation or studies from a broader perspective and enjoy the possibility of searching easily across the curriculum and finding one’s way through it to see what is actually being taught and how. What would such a view mean for the student? It would provide clear information about what knowledge shall be obtained over the six years, what topics will be on the agenda, what fields will be covered repeatedly and what subjects are connected with the studies. For teachers parametric description would mean the easy way how to clearly describe their lessons and how to browse curriculum data of all available courses at medical faculty according to the pre-defined parameters. For the faculty management this overview would represent a practical view of teaching. It would provide clear and comprehensible data about who teaches what and in what scope, if an overlap is desirable, what is taught in clinical and theoretical fields and if the overall teaching pattern is correct or restructuring is necessary.
1.1 Thesis goals

The goal of the research is focused on two topics:

(i) To propose an extended methodology which works on existing and published results, and which will help optimize curriculum structure in medical fields of study.

(ii) To develop a web-oriented platform based on described methodology for complex curriculum content management and visualization, which provides effective tools for user-friendly creation, transparent browsing and review and easy optimization of the curriculum in medical education. An integral part of the designed platform will also be online reporting tools for analysis and further visualization of educational data.

(iii) To analyze data which will be collected during pilot optimization process of medical curriculum.

1.2 Thesis structure

The thesis proposal is organized into four sections.

• The first section includes an introduction, thesis goals and structure.

• The section 2, the state of the art, consists of an introduction to the research area, a definition of an outcome-based approach, a description of current solutions for reviewing the curriculum and an overview of a system for support of optimization.

• In section 3, the aims of the thesis proposal are described, the chosen innovative method model is outlined, an innovative platform based on origin methodology is presented and the dissertation timetable is prepared.

• The fourth section presents the results achieved during the research.

• Section 5 includes the author’s publications.


**Appendix B** contains the statement of the coordinating council chief of the OPTIMED project, where Prof. J. Štěrba, Ph.D. has been described the purpose of developing the methodology and platform.
2 State of the Art

The introduction of new learning technologies, the exponential growth of Internet usage and the advent of the World Wide Web have the potential to change the face of higher education (1). The Bergen ministerial conference of the Bologna Process in May 2005 discussed reforms of degree structures, credit transfer, quality assurance and curricular development, which are transforming the European Higher Education Area. The European tertiary education systems are undergoing radical restructuring in line with objectives defined by the Bologna Process. Design and structure of new curricula constitute significant processes of change and require cooperation and coordination (2). Implementing new curricula which adhere to European and national qualification targets requires cooperation and coordination efforts among teaching staff and policymakers to offer coherent study programs (3). There appears to be an interesting opportunity for application of new technologies which provides an interface for collaborative curriculum content management including graphical representation of available data.

Learning outcomes are arguably best viewed as a fundamental building block of the Bologna educational reforms and bring more transparency to higher education systems. They have a reputation as rather mundane and prosaic tools, yet it is this basic underpinning function that makes them so significant. It is important that there should be no confusion about their role, nature and significance, or the educational foundations of the Bologna process will be undermined. Learning outcomes have applications at three distinct levels: (i) the local level of the individual higher education institution (for course units/modules, programmes of study and qualifications); (ii) the national level (for qualifications frameworks and quality assurance regimes); and (iii) internationally (for wider recognition and transparency purposes). Learning outcomes and “outcomes-based approaches” have a strong impact on curriculum design, teaching, learning and assessment, as well as quality assurance (2).

The use of learning outcomes implies a fundamental paradigm shift in curriculum design for many European institutions offering higher education. The adoption of learning outcomes means a shift of emphasis from content (what staff teach) to outcome (what a learner is expected to know, understand and/or be able to do), or expressed in other words, a clear shift from a teacher-centred to a learner-centred perspective. These issues are closely related to teaching and learning methods as well as student workload. Definition of learning outcomes (instead of teaching inputs) promotes the idea of the teacher as a facilitator of learning and recognizes that a great part of learning takes place outside the classroom. It promotes the idea of learners who are actively involved in planning and management of their own learning activities and who assume more responsibility for it (4). S. Adam defined in (5) that a learning outcome is a written statement of what the successful student/learner is expected to be able to do at the end of the module/course unit, or qualification. The key aspect that each of the definitions has in common is the desire for more precision and consideration as to what exactly a learner acquires in terms of knowledge and/or skills when he or she successfully completes a period of learning.
Modern information and telecommunications technologies offer an opportunity to revolutionize the way we provide education (6). The potential of ICT to represent information in a variety of ways is from a practical, theoretical and empirical point of view important for medical education. The same information can be presented with various combination of text, graphics, pictures, video, animations and audio (7). In traditional education, learners, learning materials (both specific course materials and general information resources) and instructors are temporally and physically connected. In distributed learning, ICTs connect learners, instructors and materials. When using ICTs for education, the temptation is often to focus more on the technology and less on the learners and instructors, often to the detriment of the educational quality (8). The combination of appropriate computer technologies and methodical approach can fundamentally improve whole educational process.

2.1 Overview of outcome-based approaches

In recent years, innovation of the curriculum has gained increasing attention especially in the tertiary sphere. The need for a more fundamental paradigm shift in education has been accented. There appears to be a space for replacing the current model of the educational process (9). An appropriate curriculum structure is required, so universities and other stakeholders have invested a great deal of time and funding into a detailed curriculum review process and subsequent optimization. Curriculum planning and development is very much on today’s agenda for undergraduate, postgraduate and continuing education. The whole curriculum is more than just a syllabus or a statement of content. It is about what should happen in a teaching programme – about the intentions of the teachers and about the way they make these happen. This extended vision of a curriculum is illustrated in Fig. 1 (10).

![Curriculum Diagram](image)

**Fig. 1 – A wider view of a curriculum (10).**

The new paradigm has introduced outcome-based education, a performance-based approach at the cutting edge of curriculum development, which offers a powerful and appealing way of reforming and managing medical education. The emphasis is on the product – what sort of
doctor will be produced – rather than on the educational process. In outcome-based education the educational/learning outcomes are clearly and unambiguously specified. These determine the curriculum content and its organization, the teaching methods and strategies, the courses offered, the assessment process, the educational environment and the curriculum timetable. Among the major advantages in adopting an outcome-based model for medical education are relevance, controversy, acceptability, provision of a framework, clarity, accountability, self-directed learning, guidance in assessment, participation in curriculum planning and a tool for curriculum evaluation (11).

The concept of learning outcomes has been widely used in education research (12). The thesis proposal focuses on a specific educational area covering medical fields of study, so close attention has been paid to experiences in medical study programmes, where there are also demands for defining new aims of innovation, such as: (i) the application in medical education of innovative thinking and approaches to the new learning technologies including e-learning and virtual reality; (ii) the application of new approaches to curriculum planning and advanced instructional design incorporating approaches such as curriculum mapping, outcome-based education, the use of electronic study guides, peer-to-peer learning, dynamic learning and a bank of “reusable learning objects”; (iii) the provision of a unique international perspective on medical education which takes into account the trend towards globalization and offers benefits to society, to medical schools and to students; (iv) the development of a flexible curriculum which meets the needs of different students and has the potential to increase access to medicine (1).

The integration of learning outcomes into the medical curriculum can be presented in a number of ways depending on the objectives and goals of individual study programmes. For example, Brown University described their learning outcomes as a list of nine abilities, such as effective communication, basic clinical sciences, diagnosis, management, prevention, etc. (13). The English National Board of Nursing, Midwifery and Health (14) has identified ten key characteristics as the basis for the learning outcomes required for the Higher Award. The Association of American Medical Colleges in the USA has developed a set of goals for medical education. These attributes were memorably stated in four groups: the physician must be altruistic, knowledgeable, skillful, and dutiful (15).

The University of New South Wales has applied the outcome-based approach and has introduced a new curriculum in which the capabilities of graduates are central to its design. In developing its curriculum, the idea of “capabilities” was adopted from the Capability in Higher Education movement in the United Kingdom. Twelve capabilities include not only knowledge and skills but also the capacity to continue to learn from experience, to act in unfamiliar and changing contexts, to be clear on professional purpose and to successfully function with others in the workforce (16).
Outcome-based education is being implemented in many institutions despite controversy and debate about whether learning outcomes can be clearly defined. The curriculum represents a multifaceted concept at a variety of levels and the chosen form always depends on individual institution requirements. Obviously a lot of academic institutions across the world have been using the concept of outcome-based curricula in different ways and in various forms. The goal is still the same, to improve the current educational process.

### 2.2 Web-based systems for curriculum management

The recommended curriculum could be identified through content analysis of curriculum documents and interviews with individuals responsible for teaching (17). The question is, how can one make the whole process easier and more effective? The quantity of electronic educational content in today’s information society is steadily increasing through the use of Internet technologies. So, academic institutions require new innovative web-based tools for user-friendly creation and effective organization of outcome-based curriculum data. The true power of visualization tools is that they provide a broad view of the whole curriculum. Apart from the aforementioned functionalities, the key and obviously necessary task rests in appropriate data visualization for easier understanding and further analysis. The term visualization represents a set of technical means and methods allowing a clear graphical presentation of data. The data stand in hidden relationships whose identification is the main task of visual analysis, which can be made with the integration of computer-based interactive tools and techniques based on cognitive, perceptual design principles (18).
There has been limited discussion of original information technologies to support outcome-based ideas. There are only a few available and published solutions, which have been developed for making educational outcome-based data accessible to the target group – students and teachers. In (19) A. Huang has presented an integrated outcome assessment application, for instance the design of a database to accumulate learner performance output by means of an outcome assessment application and store it as learner profiles. These profiles could then serve as valuable input to produce customized learning content or to conduct overall performance evaluation. Y. Mong et al. (12) have described the web-based application LOTS (Learning Outcome Tracking System), which provides overall management of learning outcomes and access to both student and teachers. In brief, LOTS consists of six components, namely group, metric, learning outcome, incident, correlation and analysis.

Fig. 3 – Relationship among the components for a single group instance in LOTS (12).

The first four provide management functions of those entities while the last two allow users, mainly teachers to perform correlation between and analysis for entities. Fig. 3 illustrates the relationship among the components for a single group instance. Group includes student and group administration, where users can manage students and groups in the database. A group can be a course, degree program, or a subset of students. A great benefit is the integration of LOTS with an existing LMS (learning management system) environment. LOTS includes also several types of basic analysis with graphical output presentations (typically bar charts) for users to exploit the advantages of outcome-based education.

The “generic” electronic portfolio called ePortfolio (20) is an application, which is being used to support the evidencing of learning outcomes and to facilitate personal development planning. In modular courses portfolios may provide a focus on programme-level as well as module-specific learning outcomes. The whole process may help students become better at relating what they have learned to the requirements of teachers. The ePortfolio has been developed using robust platform-independent open source tools (including the Apache web
server, the ZOPE publishing environment and MySQL databases). At the design phase some of the potential “value-added” features, which an IT approach can bring compared to paper-based portfolios, were considered, i.e. being highly customisable, with multiple structures and views, easier cross-referencing, being searchable, integration with virtual learning environments, etc. A number of generic tools have been developed for support of personal development planning, i.e. a reflective learning diary, outcomes/skills log, CV, records of meetings with tutors, SWOT and an Action Planning tool. The ePortfolio framework also allows sharing of specific content with supervisors, peers and others, with the facility for viewers to add formative comments.

Fig. 4 – Overview of the “Generic” ePortfolio (20).

Dynamic Learning Maps (DLM) have provided a novel way to navigate and engage with the curriculum and support learning. Curriculum drivers included a long-standing need for maps to aid understanding of complex curricula in Medicine, and for promoting “cross-modular” learning in modular programmes. DLM has been designed to be flexible and extensible and can be used for a range of different pedagogic/educational purposes. This web-based tool utilizes existing technologies and standards to provide access to information from curriculum databases, ePortfolios and other established sources. This approach provides a unique resource for learners, teachers and curriculum managers alike by providing a detailed and convenient way of accessing the formal and informal curriculum. DLM is an interactive tool, which can be aligned with an institution’s Teaching and Learning Strategy, while at the same time it supports a wide range of requirements for specific programmes. There are two main views: “tree view” (hierarchical text) and “MindMap”. For example, the maps can display and make linkages between granular curriculum information and overarching transferable skills frameworks and/or programme-level outcomes. This novel concept has been well received by
learners, teachers and curriculum staff and has had considerable impact both at Newcastle University and within the broader JISC CETIS community (the Centre for Educational Technology and Interoperability Standards). DLMs took a rapid development/action research style approach, with an emphasis on formative evaluation involving substantial input from students, teachers and other stakeholders. Open-source software was used for DLM development, in particular the Python-based rapid development framework Django, MySQL databases, jQuery and other Javascript libraries and the Freemind Flash browser (21), (22).

S. Kabicher et al have presented a sophisticated approach, the use of visual modelling within an interactive online environment (ActiveCC Web) for collaborative design, implementation and visualization of curriculum structure and content. ActiveCC, an abbreviation for Active Curriculum for Computer Science, is an e-learning project at the Faculty of Computer Science, University of Vienna. The project aims to provide an insight into the structure and implementation of the new computer science curriculum to support teaching staff in coordinating their course contents and to support instructors at the faculty in obtaining an overview of the curriculum structure. It was technically based on the Cooperative Environment Web Services platform, a web service-oriented architecture for cooperation and learning, which offers a wiki module including the functionality of directly writing graph visualization code into the wiki. Using the graph visualization tool, the temporal arrangement of modules and dependency links among modules are visually modelled to show the modules’ location and role within the curriculum. This approach offers an easily accessible and intuitively editable virtual space to facilitate working together on curriculum content, provides a transparent view of the curriculum’s structure and an insight into module and course implementations, content and pedagogical methods (3), (23).

One of the options for describing content related to the curriculum is special taxonomy. T. G. Willett et al. have published a paper introducing TIME (Topics for Indexing Medical Education), a hierarchical taxonomy of topics relevant to medical education. The content and structure of topics within TIME was developed in consultation with medical educators and
librarians at several Canadian medical schools. As a web application, TIME can contain three
types of items that are distinct but related to each other in a hierarchical way. It can contain
Outcomes, which we operationally define as culminating demonstrations of learning at the
end of medical training; Topics, which describe the content (subjects) of medical education;
and Objectives, which we define as the more specific expectations associated with courses or
learning opportunities.

TIME is primarily intended to be a generic index for medical education. It is meant to be
applicable to curriculum maps, as metadata for tagging reusable learning objects, as
a classification for assessment objects, as a means of linking Objectives to Outcomes for
a medical school, or potentially for any other indexing purpose in undergraduate medical
education. The application itself does not enable mapping or indexing. This simply web-
oriented tool allows the user to browse topics, create new outcomes and objectives, and link
these items to topics. The entire TIME content and structure can then be exported, via XML,
to external applications and used as an index for curriculum mapping (24), (25). Today,
unfortunately, the TIME application is not available and cannot be viewed via recommended
web address and follow-up development was probably terminated.

Fig. 6 – TIME includes Outcomes, Topics and Objectives (25).

2.3 Projects for support medical education

The MEFANET project (Medical FACulties NETwork) is probably one of the largest
educational networks across the world. The MEFANET aims to develop and strengthen the
cooperation among all medical faculties in Czech Republic and Slovakia. A community of
eleven medical faculties provides a large target audience, which covers numerous academic
staff – over 30,000 potential users. The project focuses on the progress in education of
medical and health care disciplines using modern information and communication
technologies by means of a common platform for sharing educational digital content. The
primary objective of the MEFANET portal platform is to ensure a horizontal accessibility of
electronic teaching tools for both teachers and students with full respect for the independence
of the individual faculty. The origin e-publishing platform provides many benefits in particular to the users at engaged medical faculties such as easy data sharing and capturing, ease of use and access, quality assessment of published contents. The network has been also covered unified medical and health care curriculum. The main purposes of the MEFANET activities are following:

- To help teachers with publishing their educational works;
- To help authors of multimedia teaching and learning tools to communicate with the users of these tools;
- To help people involved in the lifelong learning of physicians and health care professionals;
- To help students of medicine and health care disciplines with navigating through various tools for electronic support of their education (26), (27).

The primary effort of the OPTIMED project (Optimization of Medical Education) is a comprehensive innovation of the general medicine learning system at the Faculty of Medicine of Masaryk University and a strengthening of lessons focused on the solution, matching the future clinical or academic job of the graduate. The key elements of the project are:

- Horizontal innovation of all subjects taught by using the outcome-based approach and tools available within the platform to be developed (learning output browser, learning unit register, learning object repository, reporting tools).
- Vertical connection of teaching on this axis: input knowledge among medical students – theoretical and pre-clinical knowledge – clinical knowledge and skills – doctor-graduate abilities when entering practice.

OPTIMED strives to create an innovative dynamic platform to make orientation in the lessons easier for students and teachers alike and make the knowledge and skills of students in practice more efficient. The key parameter in the system is its dynamism, i.e. its ability to absorb new knowledge in medicine and incorporate it rationally into patient-oriented learning (28). The primary task is not any radical change in learning, but to map the current state at the Faculty of Medicine and allow better orientation and transparency across learning thanks to a suitable choice of ICT.

2.4 Summary

The idea of connection topics via the TIME web application is not the most suitable solution for complex and easy optimization of a curriculum, but it brings new inspiration for further development. Most importantly we need an all-in-one web-oriented service, which covers all phases of the optimization process. This means an interface for data creation and editing, a user-friendly tool for transparent browsing supporting fast and accurate searching and a technology for graphical visualization of curriculum relations. As stated above, there does not appear today to be any solution for how to parametrically describe, effectively manage and visualize clearly and in-depth the curriculum and all related educational metadata in only one system. This is the primary motivation for developing a new original technology for
optimization of a curriculum, which supports an outcome-based approach. A similar solution based on the aforementioned parametric description of curriculum including all appropriate metadata details (i.e. attributes of learning outcomes, units and objects) has not been widely seen. This approach will be primary used for a global curriculum audit within the OPTIMED project at Medical Faculty of Masaryk University and it should determine learning imperfections and potential overlaps across the chosen field of study. Building a powerful and robust system for management, visualization and analysis of the curriculum could extend the basic learning outcome concept. Another goal of the thesis is to provide a graphical representation of educational data for a simpler and easier way of information processing. In addition, this gives students a better idea of what they have learnt when graduating and for teachers of what topics they have to teach compared with colleagues.
3 Aims of the Thesis

In the Dissertation Thesis a brand new and original medical curriculum optimization methodology within tertiary education will be described by adopting an outcome-based approach and applying modern IT and communication technologies. The issue of curriculum innovation has been confronted in many medical and health care fields by different academic institutions, as the analysis of the current situation in the world indicates. The description, links and graphic representation of correlations between modules, topics and objectives of lessons are provided to users by the TIME web application (25). A flaw that can be identified in this system is that the application is intended for generating indices describing medical education, but for the actual visualisation of all predefined conditions the data needs to be exported to an external environment with the required functionality. Another environment with a similar degree of interaction – ActiveCC Web (23) allows a sophisticated description of the curriculum and offers interaction between modules. On top of that, it determines what modules the student must successfully accomplish before entering subsequent ones. A transparent diagrammatical structure is available only on the module level, but we cannot go deeper into a more detailed level which is however extremely useful for the target group. A detailed view will allow teachers to find any specific content overlap or flaws in the curriculum and so find their way through it better than they can now. ActiveCC Web brings an added value not only for students in the form of a comprehensible overview of graduation requirements (teaching outputs), but also correlation between real lessons where the topic is discussed and/or other related teaching areas.

Existing solutions that have been published are focused on the curriculum only from a certain perspective, offering the agenda together with selected functionalities and making an effort to provide them to students and teachers of the respective institution in a transparent format. However, there still does not exist a complex instrument that would cover all elements connected with global curriculum optimization, including a detailed parametric description down to the level of learning units, and that would be linked to learning objects. The aim of the Dissertation Thesis is to create a new parametric description of a medical curriculum based on learning outcomes, which provides effective organization and storage of appropriate educational data. The main idea immediately concerns many components of the curriculum model illustrated in Fig. 1, specifically content, educational strategy, learning outcomes and educational environment. This parametric approach was chosen because the need of transparent overview of curriculum has been accented. All attributes of the educational process could be easily visualized and analysed on the condition that they are neatly arranged (i.e. in a database structure). The main benefit of the Thesis is the proposal of a new concept resting upon the following functionalities – a concept which has not yet been implemented in similar solutions:

(i) Proposal of an original medical curriculum optimization methodology across clinical and theoretical fields based on an elaborate curriculum parametrisation by using the outcome-based paradigm.
(ii) Proposal of a database metadata arrangement describing the general medicine curriculum independent of subsequent implementation.

(iii) Development of a web-oriented platform based on the database model outlined above, allowing a real use of the methodology and optimization of a selected field of study. This system with a modular structure will provide the academic public an intuitive collaborative environment for easy creation and browsing of curriculum contents and efficient search and reporting tools for interactive graphic representation of links, connections and correlation between available data.

(iv) Integration of the MeSH thesaurus (29) for standardised work with key words. As a specific field taught in the Czech language shall be optimised, a dictionary was selected which is standardised in English and offers a Czech translation updated on an annual basis.

(v) Proposal of an elaborate access right system in accordance with a predefined methodology. The system differentiates between user roles depending on the level of engagement in the optimization process. A central verification mechanism will be integrated through the Shibboleth technology (30) to allow extension of access to the user level in the MEFANET education network (31), i.e. for students/teachers of one of the eleven Czech and Slovak faculties of medicine.

(vi) Integration of selected functions of the Czech morphology analyser Majka (32) for more efficient search and analytical processing.

(vii) System processing of metadata describing recommended printed and electronic materials for study with a direct connection to particular output from teaching and learning units. Given further development of the e-learning agenda at the Faculty of Medicine of Masaryk University, teachers are allowed to raise new demands and so define teaching materials which they currently lack.

(viii) Creation of a unique dictionary of essential terms for medical studies, generated from predefined attributes of the data sentence of diverse teaching outputs.

(ix) Link to local VLE (Virtual Learning Environment) through connection with the MEFANET educational portal and the Information System of Masaryk University (33).

The above-mentioned objectives of the thesis are directly connected with the OPTIMED project, the focus of which is innovation and overall modernisation of how theoretical and pre-clinical seminars are taught within the general doctor curriculum at the Faculty of Medicine of Masaryk University. The methodology and technological platform developed will be adopted in practice by senior teachers and professional guarantors within the content inspection of general medicine (Appendix B). The management of the Faculty of Medicine is
currently delegated to over 150 teachers who interact with the medical studies optimization and streamlining process in different roles and provide feedback to the innovative technology designed. The specific focus on medicine does not constrain the innovation from being used on a global basis. The model can be applied to any field of study at a university subject to minor adjustments. The solution presented contains certain specifics in the form of integration of the biomedical dictionary and direct links to existing virtual systems (Virtual Learning Environment) supporting the studies and aimed at medical education.

3.1 Key outcomes

The development of a new curriculum optimization technology and general methodology description are among the key attributes of the Dissertation Thesis. The outcome-based approach opens the possibility of redefining the curriculum structure and properties in the form of a parametric description. The learning outcome is a summary of requirements for graduates from the general medicine field, i.e. the list of knowledge and skills which the student should have upon completion of his/her studies, and signals the information essential for eventual work as a doctor. The organisation of these data and their correlation will be provided in the curriculum data model which can be implemented without any restrictions within any database technology.

The new methodology describes the different phases of the optimization process by using the platform to be developed. Its objective is to make all work of the user more efficient regarding the creation, editing and control mechanisms in the form of deep content inspection.

(i) Definition of the learning outcome (requirements on the graduate from the selected field) based on a predefined structure in an online environment. Each learning outcome is represented by a so-called data sentence which is based on predefined attributes.

(ii) Content and formal learning outcome inspection through a learning outcome browser module.

(iii) Definition of learning units (blocks with compact content with logical and/or time links) based on a structure designed for the online environment. Each learning unit is represented by parametric elements comprising predefined attributes.

(iv) Content and formal inspection of learning units through the learning unit register module.

(v) Graphic representation of the curriculum by using the modules of analytical processing and interactive visualisation reporting tools.

(vi) Horizontal discussion about the content of different learning sections in general medicine (surgical science, internal medicine, neuroscience, theoretical science) by using the above-mentioned modular tools.
(vii) Vertical discussion across general medicine learning, i.e. across the curriculum of clinically and theoretically focused lessons.

The architecture of the OPTIMED platform comprises two sections: FrontOffice and BackOffice. FrontOffice represents the interface to be used for presenting content to the end user. The content of this section will be freely available only to the target group of users, i.e. students and teachers at the Faculty of Medicine, with a possible extension to academic community members across the MEFANET education network (34) following the completion of vertical optimization. Also for this reason, a simple user authentication framework will be adopted. This framework is provided by the Czech academic identity federation eduID.cz (35). To be specific, this involves the activation of the Shibboleth (30) technology – one provides user authentication through a home institution. When entering protected content, the user is automatically redirected to his/her identity provider. The user will authenticate here with local login data and is subsequently returned to the original server. BackOffice is the second platform component to be used by administrators and editors and is intended as the interface for adding and editing static content.

Since the platform will serve users as a tool to oversee their curricula, attention will be focused also on efficient and fast search. In collaboration with the research aim of the Faculty of Informatics the functionality of the Majka morphology analyser (32), (36) is being further developed. The objective is to integrate the script that will process different input chains into root forms and store this information in a database along with a link to related metadata. If the user enters a search expression, then all words containing the root of the search expression will be displayed thanks to this functionality. As the current full-text search does not provide any reliable method of how to work with word forms for the Czech language, this processing method is an interesting and desirable solution. The root forms of words will also play an important role in implementation of analytical and visualisation tools.

Another feature is the adoption of the Czech version of the Medical Subject Headings (MeSH) thesaurus where the objective is to standardise key words related to the education content of learning units, the description of which is stored in the database. The actual key words are defined and structured in many forms and there is a growing need for their unification with respect to the international framework. The bio-medicine dictionary MeSH in the English language has been published since 1960 by the US National Library of Medicine. The Czech translation of this thesaurus is being prepared by the Czech National Medical Library which issues annual updates. The dictionary contains 26 142 entries with over 54 000 links (29). Following a contractual agreement with the Czech National Medical Library, MeSH will also be used for the purposes of the emerging curriculum optimization platform. The main requirement for standardised dictionary integration are regular updates of the Czech mutation, which MeSH fulfils as the only solution available. No other language mutations are foreseen at the moment, but a possible change should not bring too many complications in respect of the proposed structure.
Besides key words defined in an internationally recognised and standardised format, the learning unit description also features so-called essential terms for which no dictionary exists. The database of essential terms contained in the General Medicine field which the students meet during the six years and which graduates should be familiar with, will be fed by teachers and guarantors of studies. A unique dictionary of essential terms in medical studies will emerge and offer another view of the sophisticated and vast curriculum. To ensure at least a partial standardisation (quasi-standardisation), users will be assisted by autocompletion as they enter words. The autocompletion will display expressions corresponding with the text already typed – existing words or corresponding items already defined by past authors. After the final clean-up which cannot be fully automated, one of the outcomes and hence benefits is the still non-existent dictionary of essential expressions from the general medicine field of study.

Besides the data describing the curriculum, the platform will also contain direct links to virtual learning support systems offering the user further useful information about the studies and electronic studying materials. This involves firstly the connection with the Masaryk University Information System and the MEFANET educational portal of Czech and Slovak medical faculties. The development and engagement of the foundation in the form of a new repository of reusable learning objects – identified in literature as RLO (reusable learning objects) – depends on the number and format of newly created electronic learning supports. The solution will be ready for integration of the RLO repository including the application of selected metadata standard.

One of the biggest benefits of the thesis is the visualisation of data entered parametrically by experts – teachers and guarantors of studies. Independent modules will enable open views of the curriculum. The Learning Outcome Browser and Learning Unit Register modules will be based on the data grid component which will make data accessible to the user in a well-arranged form and offer the possibility of applying advanced search and filtering based on selected attributes. The reporting tools module will cover graphic representation of available data. The application of the data-mining method in combination with analytical processing will provide the basis for visualisation of valuable links across the curriculum and offer the user an original view of learning in the respective field in the form of interactive semantic networks and charts. An integral part of it will be investigation of details of different courses and learning units on the lower level based on terminology content.

To be able to implement the solution proposed, the education process first needs to be described parametrically and then it must be decided in what volume further processing is needed for the subsequent revision. The draft concept model is the basis for a possible implementation in practice. It describes in detail all interested entities and defines the relationships between them, so that all selected links can later be displayed in a transparent manner. The entire optimization process is split into several dependent phases allowing the efficient mapping of the curriculum of the respective field or specialisation of the studies. A characteristic tool is recommended for each phase to give the end user – the teacher – the possibility of intuitively creating/browsing certain content. All tools have been developed based on real requirements and are the practical manifestation of how the method can be
implemented when correct IT is applied. Unlike the platform being developed, the application of this method is fully independent of the ICT and of the focus (the selection of the field of study that will be optimized).

3.2 **Declared dissertation timetable**

Detailed study and research plan follows:

**Autumn 2012**
- State doctoral examination and thesis proposal defence.

**Spring 2013**
- Implementation of Shibboleth tool. Data mining and analysis of curriculum content.

**Autumn 2013**
- Integration of RLO repository including metadata description. Design of chosen visualization tools.

**Spring 2014**
- Integration of chosen visualization tools.
- Thesis defence.

Selected international conferences for publishing of achieved results:
- ICALT: International conference on Advanced Learning Technologies and Technology-enhanced Learning
- CSCW: Conference on Computer Supported Cooperative Work and Social Computing
- CSCL: International Conference on Computer-Supported Collaborative Learning
- AMEE Annual Conference
- MEFANET (MEdical FAculties NETwork) conference

Selected international interdisciplinary journals for publishing of achieved results:
- International Journal of Computer Support for Collaborative Learning
- Education and Information Technologies
- International Journal of Technology and Design Education
- Computers & Education
- Medical teacher
- MEFANET report
4 Achieved results

With respect to the specific focus of the studies, the results and publication outcomes achieved relate to the application of modern IT and communication technologies in education. Continuous attention is paid to the methodological development of the unique portal platform MEFANET (37) offering space for electronic publishing of medical education content for users at all Czech and Slovak faculties of medicine. The unique property differentiating this web-oriented tool from standard storage systems is an elaborate tool tailor-made for students and teachers at faculties of medicine. It covers a newly implemented, multi-dimensional quality assessment of published materials. This model provides a set of classification and control mechanisms applied to all education documents published on the portal with the aim of eliminating learning objects that are of poor quality, incomplete or unavailable. Contribution summarising the long-term development with the name MEFANET Educational Portal: A multi-dimensional quality assessment (27) was accepted in the journal Computer Methods and Programs in Biomedicine in June 2012. Thanks to the correct design of the MEFANET platform, published results can be used as the basic building block of the administrative interface of the OPTIMED portal. Picture 7 demonstrates the global view of the structure from which the BackOffice component will be used as the administrative section. All functionalities described in the chapter Aims of the Thesis will be linked with it in a modular manner.

![Fig. 7 – Global view of the MEFANET portal platform structure (27)](image)

The MEFANET portal platform is classified in the category of e-publishing systems that may be utilised for the presentation of different types of learning supports. However, the e-learning agenda covers a more dynamic environment providing teachers and tutors with a wide range of functionalities for comprehensive teaching with the support of ICT. This specifically involves learning management systems used frequently at universities as a suitable add-on in daily studies or as the primary source of information for remote studies. The quality of e-
learning is very difficult to measure, because LMS systems will often offer very different functions in different degrees. When looking at the local situation, the platform most widely used in the Czech and Slovak Republics is Moodle. The MEFANET educational network also provides a central Moodle system for the whole community of university teachers and students with efforts to share not only electronic publication objects, but also elaborate electronic courses. Effective Monitoring and Evaluation of Education – EMEE applied in LMS systems is another item in the e-learning support development plan. It would probably be a mistake to focus only on one specific platform in the general solution proposal regarding the monitoring of student behaviour in online learning environments. This is why the methodology was prepared on a general level and can therefore be adopted independently of the system. The abbreviation EMEE identifies the innovative education process evaluation method as to enable the monitoring of student activity during studies. The added value in this concept is the transparent statistics and analyses which give teachers well-founded feedback. Through effective mechanisms student behaviour can be mapped during different stages of studies – typically in semester cycles. The tutors can use the data from the logs in the LMS, analyse them and obtain an overview of the utilisation of electronic learning supports that are available and the overall utilisation of the e-learning agenda in time. A publication with the name EMME – Well-founded feedback in learning management systems (38) was printed in December 2011 in the AD ALTA journal. The Journal of Interdisciplinary Research registered with European National Electronic Libraries (ENEL) covers recent developments in this area. Thanks to the presentation of the solution proposal at expert conferences and workshops, collaboration with PragoData Consult s.r.o. (the official partner for the MOODLE e-learning system for the Czech Republic) could be successfully established. This company is currently involved in the development of the external pilot module EMEE for the Moodle LMS environment. All recent outcomes match the education optimization process at faculties of medicine. The relevance of the topic for this Dissertation Thesis lies in the coupling of the MEFANET portal platform as the source of guaranteed studying documents for the OPTIMED portal, representing a convenient browser for medical curricula. Reference to a central Moodle-MEFANET LMS can thus be made in future as long as it comprises enough quality e-courses. The aforementioned EMEE module should be helpful in this.

During the study author of the Thesis proposal was attended following conferences and workshops, where he had been presented existing achieved results.

Active attendance:

- Czech-Italian summer school structural bioinformatics and computational biology, Brno, Czech Republic, 2010.
- 7th Summer school of Applied Informatics, Bedřichov, Czech Republic, 2010.
- TeleMedicine congress, Brno, Czech Republic, 2011.
- 8th Summer school of Applied Informatics, Bedřichov, Czech Republic, 2011.
- MoodleMoot conference, Ostrava, Czech Republic, 2011.
• eLearning conference, Hradec Králové, Czech Republic, 2011.
• Creative Commons saloon, Praha, Czech Republic, 2011.
• International Masaryk conference, 2011.
• Conference of Professionalism in nursing, Olomouc, Czech Republic, 2012.

Passive attendance:

• NIS congress, Tatry, Slovakia, 2010.
• MoodleMoot conference, Brno, Czech Republic, 2010.
• AGILIA conference, Brno, Czech Republic, 2011.
• Inforum conference, Praha, Czech Republic, 2012.

Organization of following events:

• 4th international MEFANET conference, Brno, Czech Republic, 2010.
• Workshop: Tools of casuistic teaching for education in clinical medicine, Brno, Czech Republic, 2010.
• International Symposium on Environmental Software Systems, Brno, Czech Republic, 2011.
• 5th international MEFANET conference, Brno, Czech Republic, 2011.
• Symposium: Electronic support of education: best practice of MU’s Faculty of Medicine teachers, Brno, Czech Republic, 2011.
• Workshop: Modernization education of clinical reasoning, Brno, Czech Republic, 2012.

Foreign internship:

• One week internship – Stockholm university - Department of Computer and Systems Sciences – supervisor prof. Uno Fors.

Teaching activities:

• BMOF011 MS Office applications
• BKM OFFSET 011 MS Office applications

Non-university activities:

• since 2010: MEFANET coordinate committee member
• since 2012: MEFANET Report editorial board member (Managing editor of Medical Education Informatics)
5 Author's Publications


[18] SCHWARZ, Daniel and Ivo ŠNÁBL and Martin KOMENDA and Ladislav DUŠEK. Jednotná portálová platforma pro sdílení a nabídku elektronického vzdělávacího obsahu v síti lékařských fakult MEFANET verze 1.7. 2010.


[22] ADAM, Zdeněk and Martin KOMENDA and Michael DOUBEK and Marta KREJČÍ and Miroslav TOMÍŠKA and Daniel SCHWARZ and Jiří VORLÍČEK. Vysoké školy musí mít nejen kvalitní výuku, ale také účinnou kontrolu kvality znalostí a schopností studentů (produktů) vysoké školy. Vnitřní lékařství, Brno: Česká lékařská společnost J.E. Purkyně, 56, 6, from p. 624-8, 5 p. ISSN 0042-773X. 2010.


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33. Brandejs M, Hollanová I, Misáková M, Pazdziora J. In-house developed uis for traditional university: Recommendations and warnings. Proceedings of the 7th International Conference of


Appendix A - Selected publications


Medical faculties educational network: Multidimensional quality assessment

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ABSTRACT

Today, World Wide Web technology provides many opportunities in the disclosure of electronic learning and teaching content. The MEFANET project (MEDical FACulties NETwork) has initiated international, effective and open cooperation among all Czech and Slovak medical faculties in the medical education fields. This paper introduces the original MEFANET educational web portal platform. Its main aim is to present the unique collaborative environment, which combines the sharing of electronic educational resources with the use tools for their quality evaluation. It is in fact a complex e-publishing system, which consists of ten standalone portal instances and one central gateway. The fundamental principles of the developed system and used technologies are reported here, as well as procedures of a new multidimensional quality assessment.

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1. Introduction

There are a lot of experts who see the medical education field in different ways and with various attitudes. It is widely known that the progress of modern information technologies is also an important part of medical and health care education.

Things have progressed dramatically in the past decade. Information and telecommunications technology offers an opportunity to revolutionize the way we provide education [1]. Technological developments, in particular the rapid growth of the Internet and e-learning, are altering the nature of medical educational environment, and the possibilities offered are proving impossible to resist. Internet continuing education is gaining popularity, and most participants are satisfied with the experience and find it to be an effective learning format [2].

In medicine as in other fields, there has been a rapid expansion of e-learning. Almost every student in a medical school spends a part of their day or their week online searching using Google or some other search engine for information on a topic, communicating with a colleague or teacher, or studying a unit, module or course developed in their institution or elsewhere. E-learning has grown in popularity because of its convenience and flexibility and because of the increasing availability of computers and students’ familiarity with them. A legitimate aspiration of e-learning is to make existing approaches to teaching and learning more effective and efficient. If this is to
be achieved, e-learning implementation has to be monitored and managed by staff with the necessary education, technology and content expertise. There is no doubt, that if delivered appropriately, e-learning can be effective and can enrich the learning experience for the student while at the same time allowing the teacher to take on more productive and rewarding roles [3].

Learning is facilitated by a curriculum map, guided-learning resources, “ask-the-expert” opportunities, and collaborative or peer-to-peer learning. The educational philosophy is “just-for-you” learning (learning customized to the content, educational strategy, and distribution needs of the individual physician) and “just-in-time” learning (learning resources available to physicians when they are required). Implications of the new learning technologies are profound. E-learning provides a bridge between the cutting edge of education and training and outdated procedures embedded in institutions and professional organizations. There are important implications, too, for globalization in medical education, for interdisciplinary education, and for the continuous education from undergraduate to postgraduate and further to continuing education [4].

There have been many educational web portals designed in recent years. However, they usually, with a few exceptions, represent either storage of diverse study/teaching materials or huge data warehouses without tools for organizing and guaranteeing learning objects. Such digital libraries or large reusable learning objects [5] repositories like Jorum [6] and Wisconsin Online Resource Center [7] provide learning content for educators mostly for free without any registration or fees. On the other side, medical educational repositories appear that use various review processes and publish mainly peer-reviewed learning content, such as MedEdPortal [8], MERLOT [9], HEAL [10].

The need and importance for a well-designed collaborative environment as a source of information for students and academic staff has been recently growing. We explored how to most effectively use available technologies to advance the training of medical students, such that they can make the best possible use of published teaching materials via the Internet. The MEFANET project (MEDical FAculties NETwork) represents the cooperation between eight Czech and three Slovak medical faculties. It was decided to develop an original educational web portal platform for publishing and sharing teaching content among them. The objective of this paper is to describe our development experience and to present in detail a unique set of procedures for multidimensional quality assessment.

The development was driven by three major motivating factors, which in combination represent a demand for a novel approach to the effective on-line delivery of educational content. All of them are consequences of rapid ICT expansion, innovative teaching progress and the requirements of today’s students. The first factor follows the web accessibility rules, which are defined by an international community called The World Web Consortium (W3C). It’s an organization, where members, a full-time staff and the public work together to develop Web standards, technical specifications, guidelines and strategies [11]. The second motivation is to ensure high-level service quality of the platform for its users, including searching facilities, user support, communication elements, personalization and powerful administration background. The third motivating factor is the need for a quality assessment of published contents, in order to distinguish the MEFANET portal platform from usual anonymous web educational environments, which do not always provide updated and correct information. In our opinion, all the published information should be relevant, up-to-date and accurate for the needs of the audience.

2. Digital teaching contents

2.1. Progress of e-learning

The Internet is a very large scale hypertext information space where different types of users can search and find information in various domains. There is now access to a wealth of freely accessible online educational materials in the educational/instructional domain. Tutors can use these resources in their teaching, and students can use them to support their learning. A student is likely to first browse the web looking for relevant open access resources (tutorials, portals, example code, courses, assessments, experts, institutions, etc.). This scenario is true across all subject domains; the Internet has become an important tool within education [12]. Using the Internet is the norm for today’s university students and a lot of reasons exist justifying the use of this phenomenon as a source for learning. According to Geuke and Stausberg [13], the Internet promises many advantages: Access from all over the world with a low-cost technical infrastructure; independence from proprietary solutions in hardware and software by means of a common browser as front-end; independence from time restrictions because the material is available 24 h a day, 7 days a week without any technical necessity for downtime.

2.2. Quality of digital on-line content

Since one of the roles of educators is to assess and select learning resources based on curriculum goals and student needs, the development of standardized methods for educational content evaluation becomes vital. To the learner, it is important for reviews of the quality of the resource to be readily available. Unfortunately, systematic evaluation of computer-based education in all its various forms (including integrated learning systems, interactive multimedia, interactive learning environments, and microworlds) often lags behind development efforts [14].

Guaranteeing the correctness of the published content seems to be a long-term problem and is often related to system design, development and offered services. Various types of indicators, which should generally organize the quality of web portals and published information, were already described. Experts have been presented with many effective mechanisms to ensure and guarantee published content for many years.

Yang et al. [15] have published an instrument which measures user-perceived service quality of web portals. They proposed and validated a five-dimension service quality toolset involving: usability, usefulness of content, adequacy of information, accessibility, and interaction. These tools
provide a useful scale for researchers, who wish to measure the service quality of web portals.

Bottinet and Coutinho [16] have selected a set of indicators that, in their point of view, should be necessarily integrated on a portal dedicated to educational issues: ease of use, services, communication, content, performance and information. It is necessary to take these issues of quality into account in the construction and/or management of the educational portal, if one wants a successful portal with a larger traffic of site users and promoters.

Caro et al. [17] have presented a portal data quality model (PDQM), focused on the data consumer’s perspective. To produce the PDQM model, they defined a four-phase process: 1. Identification of web data quality attributes and definition of a Classification Matrix; 2. Classification of data quality attributes into the Matrix; 3. Validation; 4. PDQM.

During the first phase, they recompiled 41 web data quality attributes, which they believe should therefore be applicable to web portals. Caro et al. [18] also did an extensive web data quality revision, and identified relevant quality attributes. From this revision they captured several data quality attributes. The most considered are Accuracy, Completeness, Timeliness, Consistency, Consistency, Currentness, Interpretability, Relevance and Security.

Ellissavet and Economides [19] have described a very sophisticated evaluation framework for hypermedia courseware, which is concerned with social and practical acceptability. The term social acceptability is related to the social basis of an educational system (student-, teacher- or patient-centered). The practical acceptability is examined through the evaluation of the following four sectors: (a) content, (b) presentation and organization of the content, (c) technical support and update processes and finally, (d) the evaluation of learning.

2.3. MEFANET’s portal platform and central gateway

The MEFANET project aims to develop and strengthen the cooperation among medical faculties. It focuses on the progress in education of medical and health care disciplines using modern information and communication technologies by means of a common platform for sharing educational digital content. The primary objective of the MEFANET portal platform is to ensure a horizontal accessibility of electronic teaching tools for both teachers and students with full respect for the independence of the individual faculty [20–22].

A community of ten medical faculties provides a large target audience, which covers numerous academic staff – over 30,000 potential users. Logically, there appeared a need for a transparent and unified source of teaching contents. It was decided to design and implement a robust e-publishing platform, which provides the following benefits in particular to the users at engaged medical faculties:

- Easy data sharing and capturing;
- Ease of use and access;
- Common authentication framework;
- Quality assessment of published contents.

The main purposes of the MEFANET educational portal are:

- To help teachers with publishing their educational works;
- To help authors of multimedia teaching and learning tools to communicate with the users of these tools;
- To help people involved in the lifelong learning of physicians and health care professionals;
- To help students of medicine and health care disciplines with navigating through various tools for electronic support of their education.

The educational web portal of the Medical Faculty at Masaryk University has been accepted as the uniform groundwork for the solution of the common portal platform [23]. Every member of the network provides a standalone instance of the platform, which differs only in a local configuration, graphic template and various ISSN (International Standard Serial Number). All these independent web-based applications are covered by a central gateway [24]. This crucial part of the e-publishing system enables the effective gathering and monitoring all metadata about the contents published with the use of portal instances. A complete image of the available digital contents across the whole network is constructed in this way. Users can freely browse the objects sorted by medical discipline, author, faculty, or quality assessment criteria. The gateway, as well as each instance of the portal platform, includes a sophisticated tool for advanced searching in the entire MEFANET database and in external resources such as Google, Ariadne and Globe databases. Titles, keywords, other metadata and full-text indexes are searched and the results are given to the user in order of relevance.

3. E-publishing platform

3.1. System description

This subchapter describes the running environment and technologies used in the development process. The MEFANET portal platform runs on the most-used and widespread web servers – either an Apache server or a Microsoft Internet Information Server (IIS). The latest statistics show [25] that these two web server technologies host over 80% of the top 10,000 websites on the Internet (included Apache, IIS 5, IIS 6, IIS 7). We use Linux/Ubuntu and Windows Server operating systems for optimal performance. All technologies related to programming and system construction are PHP, XHTML, XML, CSS 2, JavaScript (JS), AJAX, MySQL.

We have also taken advantage of third party frameworks, such as jQuery (javascript library), Google Analytics (monitoring and analytics tool) and CKEditor (WYSIWYG text and HTML editor). The third party server application is used for the federative authentication process, which establishes user identity trust and authentication between universities. The Czech academic identity federation eduID.cz [26] fully provides means for inter-organizational identity management and access control into the MEFANET. The eduID.cz federation is based on one of the available tools for web single sign-on processes named Shibboleth [27]. All of the portal development has adhered to recommended rules and declared standards.
Each instance of the portal platform is composed of two major sections: FrontOffice and BackOffice. The FrontOffice interface is used to present the published contents to users. It is a non-secured and freely available on-line part of the educational portal. Each visitor can browse and search digital teaching materials here. But not every user has free access to all published educational content. There are defined restrictions in access rights, which are described in detail in the subchapter MEFANET user's identity. The BackOffice is the second, secured part of the system, which is used by editors and administrators. This section is divided into separate units called modules. Each module serves to manage a selected area of functionality (Guest book, Users, Contributions, Submitted contributions, Comments, Editing, File Manager, Links, Sections, Authors, Departments, Courses, Metadata, Full pages, Languages, Import), see Fig. 1.

Each system module is built on the most widespread software architecture for today's web applications called Model-View-Controller (MVC). This concept was described by Reenskaug [28] and it was first implemented by J. Althoff for the Smalltalk-80 class library. The MVC pattern was conceived as a general solution to the problem of users controlling a large and complex data set [28]. The main idea consists in separating an application into three parts, which represent core functionalities: model, view and controller. Fig. 2 shows all direct associations and notifications.

The model is responsible for managing the data, storing and retrieving entities used by an application, usually from a database, and contains the logic implemented by the application [29]. The view is responsible for displaying the data provided by the model in a specific format. It has a similar usage with the template modules present in some popular web applications, such as Wordpress [30] or Joomla [31]. Three types of view are implemented in the MEFANET portal platform – FrontOffice view, BackOffice view and Central Gateway view. The controller handles the model and view layers to work together and receives a request from the client, invoke the model to perform the requested operations and send the data to the view. The view then formats and presents the data to the user in a web application as an html output [32]. Models do not directly call views. Instead, each view registers itself with its model, and the model notifies all registered objects whenever it is updated. This lets a developer add or change views without altering the model. It also ensures that views are synchronous because each view reflects the same model state [33].

3.2 Fundamental elements of the MEFANET portal platform

Scalability and extensive customizations are important and desired properties of the MEFANET educational web portal. On the other hand, there are also several legitimate requests for particular common conventions which should be followed on the parts of local administrators. With this in mind, we established three fundamental elements in the MEFANET e-publishing platform, which are common and obligatory for all portal instances and the Central Gateway [34]:

1. Medical disciplines linker – to sort and categorize the published items. 2. Authentication framework – to provide an effective and easy authentication mechanism for user identification. 3. Multidimensional quality assessment – to ensure the publishing of quality data content.
3.2.1. Medical disciplines linker
This feature enables basic categorization of the educational contents and covers all learning areas among medical faculties. In the beginning, a single-level or multilevel list of medical specializations was 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 [35]. However, the medical disciplines mapping according to the Conspectus method showed to be inapplicable for MEFANET purposes. The medical disciplines linker is based on a varied list of medical fields adopted from significant medical publishing resources and can be modified only with agreement of the MEFANET Coordinating Council. As of February 2011, the list contains forty-eight medical fields, see Table 1.

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Sub-discipline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaesthesiology and Intensive Care Medicine</td>
<td>Anatomy</td>
</tr>
<tr>
<td>Biology</td>
<td>Biophysics</td>
</tr>
<tr>
<td>Cardiology, Angiology</td>
<td>Dentistry</td>
</tr>
<tr>
<td>Dermatology</td>
<td>Diabetology, Dietetics</td>
</tr>
<tr>
<td>Emergency Medicine</td>
<td>Endocrinology, Metabolism</td>
</tr>
<tr>
<td>Epidemiology, Preventive Medicine, Hygiene</td>
<td>Gastroenterology and Hepatology</td>
</tr>
<tr>
<td>General Practice Medicine</td>
<td>Genetics</td>
</tr>
<tr>
<td>Geriatrics</td>
<td>Hematology</td>
</tr>
<tr>
<td>Health Care and Nursing</td>
<td>Histology, Embryology</td>
</tr>
<tr>
<td>Immunology, Allergology</td>
<td>Infectology</td>
</tr>
<tr>
<td>Internal Medicine</td>
<td>Laboratory Diagnostics</td>
</tr>
<tr>
<td>Medical Ethics and Law</td>
<td>Medical Chemistry and Biochemistry</td>
</tr>
<tr>
<td>Medical Informatics</td>
<td>Microbiology</td>
</tr>
<tr>
<td>Nephrology</td>
<td>Neurology</td>
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<tr>
<td>Neurosurgery</td>
<td>Nuclear Medicine</td>
</tr>
<tr>
<td>Obstetrics, Gynecology</td>
<td>Occupational Medicine and Toxicology</td>
</tr>
<tr>
<td>Oncology, Radiation Therapy</td>
<td>Ophthalmology and Optometry</td>
</tr>
<tr>
<td>Other</td>
<td>Otorhinolaryngology</td>
</tr>
<tr>
<td>Pediatrics, Neonatology</td>
<td>Pathology and Forensic Medicine</td>
</tr>
<tr>
<td>Pharmacology</td>
<td>Physiology and</td>
</tr>
<tr>
<td>Psychiatry, Psychology, Sexology</td>
<td>Public Health Care, Social Medicine</td>
</tr>
<tr>
<td>Radiology and Imaging</td>
<td>Rehabilitation, Physiotherapy, Ergotherapy</td>
</tr>
</tbody>
</table>

3.2.2. Authentication framework
The objective of this part is to describe the MEFANET authentication framework implementation, which is provided by the eduID.cz federation. The primary goal consists in the application of web single sign-on (SSO), which ensures users access to multiple applications using just one password, which is generated and used by users within their home organization. Federated authentication and authorization services are key requirements in creating a secure and trusted technology infrastructure for the sharing and use of information by individuals at multiple locations [36]. The authentication represents a verification process that someone or something is, in fact, who or what it is declared to be (“I am who I say I am”). The authorization is used to find out if the person, once identified, is permitted to have the resource or to do the operation (“what I can see or do based on what my role is”).

The eduID.cz federation is based on technologies which supported a standard-compliant SAML implementation. The SAML, developed by the Organization for the Advancement of Structured Information Standards (OASIS), is an XML-based framework for communicating user authentication, entitlement, and attribute information. It is a flexible and extensible protocol designed to be used – and customized, if necessary – by other standards. It enables web SSO through the communication of an authentication assertion from the first site to the second, which, if confident of the origin of the assertion, can choose to log in the user as if they had authenticated directly. SAML is used by several other standards groups to provide a security and identity underpinning for their work, such as Liberty Alliance, XACML, WS-Security, WS-* [36] and Shibboleth, which is used in the MEFANET portal platform [37].

The Shibboleth is a standard-based and open-source architecture for supporting inter-institutional sharing of resources that are subject to access control. It is an attempt to solve the federated administration of authentication/authorization by allowing a user’s home institution to retain control of the authentication process while releasing enough information to the remote resource so it is able to make authorization decisions and preserve the user’s privacy to the maximum extent possible [27].

3.2.2.1. MEFANET user’s identity. Users’ identities are verified without need of previous registration and users are only required to enter their existing login and password to confirm affiliation to their institution. The MEFANET authentication mechanism is based on SAML concept, which permits secured transfer of authentication data between independent organizations that have an established trust relationship. As noted above, the SAML has been adopted for use with several other standard frameworks. Its specification defines the structure and content of both the assertions and the protocol messages used to transfer requested information. The following process explains the simplified workflow of SAML-based SSO service. There are three involved parts: User (access via web browser), Identity Provider (IdP – creates, maintains, and manages user identity), Service Provider (SP – controls access to services and resources). 1. The user attempts to access a resource on the MEFANET portal platform. 2. The web server determines that it has no credentials about the user (not even who the user is or what institutional affiliation it has). 3. The SP generates an SAML authentication request and sends a redirect response to the user’s browser. 4. The browser redirects the uniform resource locator and includes the encoded SAML authentication request that should be submitted to IdP SSO service. 5. The SSO service determines whether the user has an existing login security context at the IdP that meets authentication policy requirements. The IdP SSO generates an SAML assertion and returns the encoded response message placed in an HTML form to the browser. This message contains the authenticated user’s data provided by the IdP to the SP within the MEFANET network, which included controlled attributes (for example GivenName, Surname, Mail, Organization) and the local
attribute named http://www.mefanet.cz/mefaperson. This parameter was especially designed for MEFANET purposes and its value (“true” or “false”) differs in dependence on user’s medical faculty affiliation. 6. The browser, due either to a user action or execution of an “auto-submit” script, issues an HTTP POST request to send the form to the SP’s Assertion Consumer Service (ACS). The ACS obtains, processes and verifies the message from the HTML form. If the response is successfully verified, ACS redirects the user to the destination URL. 7. The user has sufficient authorization to access the resources on the MEFANET educational portal [26,27,37].

The access to the portal itself is not restricted anyhow. The educational content is comprised of contributions which are accessible for anyone who searches the portal. A particular contribution consists of a title, a short abstract, keywords, categorization, associated files and hypertext links. Every attachment (file or link) has its own access rights, which strictly define users who can access this material. Authors can choose from following user groups, in order to permit/deny access to their materials:

- non-registered anonymous user,
- registered anonymous user, who accepts the terms of use within his registration,
- user of the MEFANET network, i.e. student or teacher from any Czech or Slovak medical faculty university member,
- user of a local university, whose affiliation to that university has been verified at the portal via the local information system of that university,
- user of a local medical faculty, whose affiliation to that faculty has been verified at the portal via the local information system of the respective university or faculty,
- user to whom attachments are made available only with the author’s explicit consent.

The most widespread and preferred is “user of the MEFANET network”, so it means that all students and academic staff from the MEFANET network can freely access and view the offer of electronic study materials.

Every attachment has special parameters, which determine clinically sensitive material. These attachments consist of any materials, which could only be made after the patient gave his informed consent and will not be available to students of non-medical faculties. A ranking of “clinically sensitive” depends on the decision of the author of the respective contribution(s). Clinically sensitive materials can include various media, such as video records from multimedia atlases in which patients talk about their condition, or photos and videos from surgical procedures which reveal a patient’s identity.

3.2.3. Multidimensional quality assessment

After individual portal instances had been implemented, the central gateway was developed and consequently included into the MEFANET e-publishing platform. Since the start of the inter-university educational portal in March 2008, the number of published contribution has rapidly grown, see Fig. 5. We started to place major emphasis on quality instead of the quantity of learning content and the development of a new effective classification and review mechanism began.

Two different review approaches inspired the creation of procedures for multidimensional quality assessment:

1. An opponency action – in the case of a pedagogy work which meets basic criteria set by an academic board of a faculty, the work is reviewed and then published with a symbol of an editorial committee or another authority of that faculty.
2. Guarantee signatures – there are guarantees defined for each of the medical disciplines in the linker described in Table 1. They are allowed to express their opinions and objections for each contribution assigned to their disciplines. Their final decision can be one of the following meanings:
   a. Accept – the contribution will be signed by a positive icon with an alternate text identifying the guarantor;
   b. Reject – the contribution will be signed by a negative icon with an alternate text identifying the guarantor. The portal’s administrator should discard this contribution from the medical discipline.
   c. Undefined state – the contribution is not signed by any icon. Either it has not been read by the guarantor or there are some insignificant objectives which do not imply discarding the contribution.

We decided to combine the above described approaches with new ideas. The final set of procedures is called the 4-D quality assessment. The whole process stands on four independent principles, which enable easy classification as well as a complex on-line review workflow with the use of XML template forms in one of the BackOffice modules. The four dimensions consist of the following parts, see Fig. 3:

- review,
- typological classification,
- level of the target group,
- user self-study score.

3.2.3.1. Review. Each contribution published on a portal instance includes the teaching materials as well as additional metadata, including information about authors and their affiliations. Anonymous or social collaborative forms of publishing of educational resources are impossible. The first dimension represents the editorial review process, which ensures an easy and effective control mechanism for publishing educational content under the guarantee supervision. The guarantor is a selected expert from medical society who expresses the opinion to newly created contributions, establishes the review process and nominates reviewers. Each reviewer consequently fills in the form with binary and open questions in the BackOffice of the portal platform. Only the contributions with positive review conclusions and guarantor approval can be published on the central gateway.

3.2.3.2. Typological classification. Each contribution needs to classify to one or more of the following categories, which cover all possible media types of teaching content which might be published:

- Textbooks and manuals
- Educational websites and atlases
3.2.3.3. **Level of the target group.** The following list of user groups represents the scale of levels of user formal education.

- Undergraduate level – teaching materials advisable for bachelor and master degree.
- Graduate – study materials advisable for graduates and advanced graduates.
- Advanced Graduate – study materials advisable for deeply interested graduates.
- Complex – study materials that cover all the previous levels comprehensively.

Authors and reviewers select one or more options for each contribution and their preferences are logically unified and graphically reproduced in the 4-D quality assessment section of the contribution when displayed to users.

3.2.3.4. **Users’ self-study score.** The users anonymously express their opinions on the suitability of provided teaching materials for their self-study. They select a scalar value on a scale from 0 to 100 points and further add information about their education level: (a) student, (b) graduate, (c) postgraduate. The final score is computed as a weighted average of all votes:

\[
Sc = \frac{\sum_{i=1}^{n} (s_i \times w_i)}{\sum_{i=1}^{n} w_i}
\]

where \(Sc\) is final self-study score, \(s_i\) is individual user’s score (range from 0 to 100), \(w_i\) is individual weight of vote (calculated via Table 2) and \(n\) is total users’ votes amount.

### 3.3. Quality criteria model

The proposed criteria model was inspired by several studies published in the quality content assessment area, as well as in the research of educational portals, as referred to previously by Butcher [38], Bottentuit and Coutinho [16], Yang et al. [15], Caro [17,18], Ellisavet and Economides [19] and Karlsson [39]. We used our experiences and recommended the most important and significant properties. The final model is divided into three appropriate parts (see Fig. 4). There appears diversity in comparison with traditional commercial web portals, it is recommended to use described indicators primary for educational portals. The quality criteria model consist of website quality (design, development, performance, security and privacy), web content quality and web services quality indicators (see Table 3).

### 4. Discussion

All ten instances of the portal platform and central gateway are available on-line and open to everyone in Czech/Slovak and English versions. Published contributions have no access restriction, but related attachments always have strictly defined access rights, which define users who can view this study material. There are no specific browser requirements, visitors can use a standard web browser extended by common

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**Fig. 3 – The 4-D quality assessment mechanism.**

**Fig. 4 – Quality criteria of educational portal platform.**

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plug-ins. The latest release marked as version 1.8 contains the 4-D quality assessment implementation and many other upgrades. All members of the educational network can use its tools for quality evaluation of their published electronic teaching materials. Every updated version contains users' documentation including UML (Unified Modeling Language) standardized models. It is the set of diagrams of a system, which represents static and dynamic structure (for example entity-relations diagrams, use-case diagrams and activity diagrams). We can recommend an application of quality criteria during the development process, which are described in detail in Section 4.2. It is effective and useful from both the user’s and administration’s point of view.

The number of contributions published at the central gateway [24] has been growing since the launch of the central gateway (see Fig. 5). Apparently, the graph of published contributions implies three local rapid changes – June 2008, June 2010 and September 2010. These significant risings relate to the launching of new instances into the portal network. In April 2011, the central gateway contained 2035 contributions, which are categorized according to well-arranged medical fields.

The multidimensional quality assessment enables effective quantifying of digital content in the entire MEFANET network. It is an original and innovative approach, because other freely accessible medical repositories only exceptionally use various peer-reviewed mechanisms for quality guarantee of publishing resources (e.g. MedEdPortal, MERLOT, HEAL). Probably the largest educational content publication service MedEdPortal (provided by the Association of American Medical Colleges) clearly marked all learning materials with the appropriate review logo based on the evaluation approach (Peer Reviewed, Editorial Reviewed, Special Collection Reviewed) [8]. In essence, the primary objective is common for all mentioned systems: provide relevant, correct and useful educational data to medical learners and educators. However, the MEFANET solution promises a more complex functionality and wider range of tools for organizing the published contents as well as a possibility to present the contents completed by comments from tutors selected from expert medical societies. The graphic visualization of designed model gives users all appropriate information related to the learning material. We believe in success of the multidimensional assessment in the medical faculties network and hope it is the best suited classification and review mechanisms for all involved participants, which are directed by local editorial committees or other rules.

The preparation of educational content intended for medical disciplines differs from other fields. Authors have to consider higher claims and special rules related to the publishing of electronic medical learning materials. It is quite common to find clinically sensitive attachments including various media, such as videos from hypertext multimedia atlases in which patients talk about their condition, or videos from surgical procedures which reveal a patient’s identity. Ranking the attachment as clinically sensitive depends on the author’s decision and its content is then unavailable to students of non-medical faculties. The use of clinically significant materials form an integral and very important part of the matriculation oath of all medical students. In general, producers of medical-based learning content have to be very careful. All mistakes and incorrect statements contained in teaching materials have dramatic impact on the knowledge and skills of future physicians. All these published inaccuracies cause incorrect habits and can result in malpractice during the real human treatment. One of the MEFANET portal platform benefits for students and teachers is the complex classification and assessment mechanisms, which enable a gradual

<table>
<thead>
<tr>
<th>Level of the target group</th>
<th>Undergraduate</th>
<th>Graduate</th>
<th>Advanced graduate</th>
<th>Complex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Graduate</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 3 – Quality criteria of educational portal.

<table>
<thead>
<tr>
<th>Website quality</th>
<th>Web content quality</th>
<th>Web services quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen resolution</td>
<td>Varied formats</td>
<td>Multi-level navigation</td>
</tr>
<tr>
<td>Corresponding icons and symbols</td>
<td>Content quality assessment</td>
<td>Searching facilities</td>
</tr>
<tr>
<td>Simple and easy navigation</td>
<td>Transparent categorization</td>
<td>Communication</td>
</tr>
<tr>
<td>Readability of the information</td>
<td>Target audience</td>
<td>Printable version of content</td>
</tr>
<tr>
<td>Accessibility of the sites</td>
<td>No anonymous content</td>
<td>Technical support</td>
</tr>
<tr>
<td>Consistent representation</td>
<td>Updated information</td>
<td>Authors support</td>
</tr>
<tr>
<td>Site esthetics, color harmony</td>
<td>Currency of information</td>
<td>Administration background</td>
</tr>
<tr>
<td>Code and links validity</td>
<td>Amount of data</td>
<td>Support of online inquiries</td>
</tr>
<tr>
<td>Authorization</td>
<td>Content uniqueness</td>
<td></td>
</tr>
<tr>
<td>SEO</td>
<td>Object description</td>
<td></td>
</tr>
<tr>
<td>Optimization, standardization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Website feedback monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Page loading time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failure restriction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rights management</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
improvement in the quality of the content throughout the medical faculty network.

5. Conclusions

In this paper, the MEFANET portal platform and its advantages in the areas of biomedical and health care education with the use of modern information and communication technologies were presented. Students – about 16,500 potential users and academic staff – about 3900 potential users from all Czech and Slovak medical faculties can find their e-learning content via ten standalone faculties’ instances of the educational portal and central gateway, which makes it possible to collect all metadata from instances in the network and provides a complete image of available digital content. This web-oriented e-publishing platform offers a well-organized and guaranteed collection of many different types of study materials. The cardinal importance represents the implementation of the multidimensional quality assessment, which should solve long-term problem of unreviewed content publishing.

Many other interesting challenges now exist in the field of medical education, such as virtual patients (VPs) and mobile technology for learning. VPs technology covers computer simulation and virtual reality educational tools and offers several advanced methods for improving the standardized patients learning. There are enough primary content resources available through the MEFANET e-publishing platform, which could be used to create wide range of very complex VPs as well as other objects for training of clinical reasoning. Today a lot of web applications for VPs authoring are available and, from the MEFANET perspective, the key task rests in appropriate selection according to compatibility options. The MEFANET network is advantageous for VP technology deployment, because of the already existing infrastructure, including secure user authentication and powerful tools for monitoring the quality of published contributions. The same benefits can then be applied to the introduction of new interfaces for portable devices so that the innovative learning approaches called m-learning (mobile learning) could be made available to students and academics in the network.

Conflict of interest statement

The authors disclose any financial and personal relationships with other people or organizations that could inappropriately influence our work.

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EMEE – WELL-FOUNDED FEEDBACK IN LEARNING MANAGEMENT SYSTEMS

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Abstract: This paper gives an introduction to effective monitoring and evaluation of education. Well-founded feedback called EMEE (Effective Monitoring and Evaluation of Education) represents an interdisciplinary project combining an informatics approach with mathematical and pedagogical methods. The EMEE idea is based on an innovative feedback method integrated into an appropriate learning management system. The added value lies in new information for teachers discovered by data mining, statistical and analytical data processing. The result will be clearly visualized in diagrammatic form (graphs and tables). EMEE functionalities will be available in the most widespread and most popular LMS Moodle. All fundamental principles including the conceptual database model are described in this paper.

Keywords: feedback, learning management system, analytic tool, e-learning, Moodle

1 Introduction

Electronic support of teaching contains many sophisticated features for improving education. A learning management system (LMS) is a specialized online environment, which covers basic and advanced e-learning innovative elements and often is connected to the agenda of the administration. The term LMS represents software for delivering, tracking and managing training. LMSs range from systems for managing training records to software for distributing courses over the Internet and offering features for online collaboration. In many instances, corporate training departments purchase LMSs to automate record-keeping as well as the registration of employees for classroom and online courses. These systems are very important in education in particular. Using an LMS can offer many benefits. It provides uniform learning content, enriches the learning experience, increases student participation, manages content delivery and, by using standardized content formats, users can share course content. The business use of an LMS can also reduce training costs, increase employee competency and the flexibility of a training agenda, decrease employee turnover and manage learning facilities in conjunction with human resources goals. Due to survey (1) instructors and students believed that an LMS improved teaching and learning, although students were less positive about the effect of an LMS on instructors’ teaching. There are also other benefits of using an LMS in education that are proven by this survey – for instructors it is improvement in communication with students and for students it is efficiency (saving time). However, 26% of instructors choose “efficiency (saves time)”, which indicates that efficiency is important to many instructors as well as their students.

An LMS may contain information about how long it would take to work through self-study material and the length of face-to-face courses. An LMS may give immediate access to e-learning material, it may enable people to register for a face-to-face course, and it may dispatch other forms of study material. An LMS may monitor progress and provide a record for learners on how they are doing, perhaps against their own original target or against others. For the learner the LMS gives access, feedback, and a planning tool (2). One could use the data administrated in an LMS to predict the time required by the learner as a total and in hours per week, given a target for when the training has to be complete. As LMSs continue to evolve and gain popularity, further research is needed to help instructors and students identify the most effective ways to use these technologies to improve teaching and learning, and not only in higher education. There seems to be great opportunity to develop an original feedback module for a convenient and well-arranged overview of students’ activities and results.

1.1 LMS feedback functions and analytic tools

Many educators expend enormous amounts of effort in designing their learning to maximize the value of those interactions. Regardless of the approach taken, a series of questions consistently arises: How effective is the course? How can the needs of learners be better supported? What interactions are effective? How can they be further improved?

The evaluation and analysis of learning has suffered from: the limited quantity of data that busy students and instructors are willing to share at the end of a course; the limited quality of this self-reported, retrospective data; and a significant delay (normally at least one semester) between the events being reported and the implementation of an intervention. However, as an increasingly large number of educational resources move online, an unprecedented amount of data surrounding these interactions is becoming available. For example, the amount of time spent reading content online can easily be captured by an LMS. When, why and with whom learners are connecting is also logged in discussion forums and social networking sites. There exist numerous other parameters which can be very useful for applications of data mining methods and subsequent appropriate analytical processing. The EMEE concept works with data stored in LMSs and effectively visualizes interesting relations and significant differences. It is a new kind of educational technology, which can be used to improve learning and teaching. It draws from, and is closely tied to, a series of other fields of study including business intelligence, web analytics, academic analytics, educational data mining, and action analytics (3).

The challenge with respect to data-gathering hardware and software is the integration of these diverse data sources. Open architecture solutions are therefore required that are capable of scraping data, information and context from administrative and academic systems as well as from structured and unstructured data, information, and context contained in assessment solutions (4). If LMS data were correlated with additional information gathered in other systems, a richer picture of the student learning experience, instructor adoption, and institutional usage could be generated. It could in fact be possible to track individual activity throughout the entire student life cycle – from initial admission, through course progression, and finally graduation and employment transitions (5).

2 Quality of education

The World Declaration on Education for All (1990) and the Dakar Framework for Action (2000) – the two most recent United Nations conference declarations focusing on education – recognize quality as a prime condition for achieving Education for All. The Dakar Framework affirms that quality is “at the heart of education”. It goes on to say, “What takes place in classrooms and other learning environments is fundamentally important to the future well-being of children, young people and adults. A quality education is one that satisfies basic learning needs and enriches the lives of learners and their overall experience of living.” Despite a growing consensus about the importance of quality, there is much less agreement on what the concept means in practice. Two principles, however, characterize most attempts to define the quality of education. The first, which identifies learners’ cognitive development as the major explicit objective of all education systems, sees the success with which learners achieve this as one indicator of their quality. The second emphasizes the role of education in promoting commonly shared values, and creative and emotional development – objectives whose achievement is much more difficult to assess (6).

One of the most important aspects to ensuring the rising quality of education, and not only in the academic sphere, is feedback from students to the teacher. Today many teachers use various online environments such as LMS systems. The feedback process without computer assistance is extremely time-
consuming, and there is no complex reporting application that can be fully integrated into learning management systems and provide substantiated reports to teachers.

2.1 Importance of feedback

Student support and cooperation in education is one of the areas in which e-learning differs from traditional teaching approaches. In the event that education is mostly or completely in the form of distance learning, students learn mostly by interaction with the system. Laurillard’s conversational theory promotes an approach where the education is accompanied by interactions between the student and teacher. This theory also emphasizes the constructive and meaningful feedback that allows students to reflect on teaching methods and materials (7).

Feedback helps teachers to better set targets for their students, creates independent student learners and, in the process, raises students’ performance levels. In order to have sustainable change in teachers’ practice they must be provided with ongoing opportunities for learning, including trying new strategies, followed by reflection and discussion with peers. Throughout feedback teachers can think and work “smarter,” structure learning experiences that fully engage the learner, and, most of all, provide the steps for the intended one. Learning involves taking risks, supporting each other, looking for evidence of progress and adjusting one’s plans (8). The importance of feedback also lies in teachers’ perceptions of the collective efficacy of the teachers in their schools. Appraisal and feedback have a strong positive influence on teachers and their work. Teachers report that it increases their job satisfaction and, to some degree, their job security, and it significantly increases their development as teachers. The greater the emphasis on specific aspects of teacher appraisal and feedback, the greater the change in teachers’ practices to improve their teaching. In some instances, more emphasis in school evaluations on certain aspects of teaching is linked to an emphasis on these aspects in teacher appraisal and feedback which, in turn, leads to further changes in teachers’ reported teaching practices (9).

3 Effective monitoring and evaluation of education

The underlying concept of EMEE is the idea of a clear arrangement of different feedback features, giving the teacher well-founded information on student behavior during the education cycle. A standard component of the learning management system (LMS) is access to statistics for different learning objects which, when combined with other information available, can be used for interesting statistical and analytical investigations. The key in this is the utilization of all data of available, can be used for interesting statistical and analytical processing. Initial parameters are unambiguous student identification, including name, description of studies, teacher and course repetition indicator.

The Course_chapter entity determines a wider cycle for the topic during the semester. It is clearly identified through its ID_chapter, and for the sake of clarity and easier understanding also the Title and Description attributes are at hand. It is always a compact learning area to which learning objects and student activities are related.

The actual learning objects are represented in the model by the Learning_object entity, which contains, besides the primary key ID_object, the Type_object attribute where numeric values are used to specify the type of learning material (textbook, lecture materials, exercise materials, teaching tutorials, video records, etc.).

Lectures, exercises and seminars are represented by the Learning_unit entity which, again, contains the Type_unit attribute besides the primary key ID_unit for precise identification of the learning unit. Examples include a lecture, a seminar, or practical training.

The key student activity during the semester is shown through coupling (associative) entities Attendance and View. In the Attendance entity, a new record appears if the student has not been physically present at a lecture or training. In the View entity, a new record appears if the student has accessed the particular learning object.

It is logical that each learning object and each learning unit are related to one of the thematic blocks. The link between the learning chapter and learning unit/object is represented by coupling entities Unit_chapter and/or Object_chapter.

Different questions forming part of different test specifications are represented by the Question entity. Besides the primary key ID_question, this entity features the Maximum attributes (maximum possible point gain). If the student comes to a test, the associative entity Assessment keeps information on the point gain of the respective student within different questions of the task. It is obvious that each question must be incorporated into any of the learning chapters. This relationship is represented by the Question_chapter coupling entity.

3.2 Work with data

The model designed in this way enables access to data via SQL queries. Variability and possible modifications of the database structure are very easy thanks to the generality of the design, so it can be customized for the LMS system which is in use. A practical showcase of access to data are the following examples, applied within the EMEE pilot project at Faculty of informatics Masaryk university:

![Fig.1. Conceptual model showing how data is organized in EMEE. For illustration, associative entities are differentiated and marked with a white background.](image-url)
Example 1

```
SELECT DISTINCT 
    question.maximum_point, 
    assessment.points, 
    assessment.student_ID 
FROM 
    chapter_course, 
    question_chapter, 
    question, 
    assessment 
WHERE 
    chapter_course.id_chapter=question_chapter.id_chapter 
    AND 
    question_chapter.id_question=question.id_question 
    AND 
    question.id_question=assessment.id_question 
    AND 
    chapter_course.id_chapter='chapter_11' 
ORDER BY 
    ID 
```

The SQL query in example 1 returns gained points and possible maximums ordered according to the ID_student attribute. These are only questions belonging to thematic chapter 11.

Example 2

```
SELECT 
    assessment.id, 
    assessment.points, 
    assessment.id_question 
FROM 
    assessment, 
    question 
WHERE 
    assessment.id_question=question.id_question 
    AND 
    assessment.id='123456' 
    AND 
    assessment.date='2011_01_05' 
```

The SQL query in example 2 returns the point count for different questions on a test from 5 January 2011 answered by a student with identification number 123456.

3.3 Practical use

EMEE – Effective Monitoring and Evaluation of Education has been already applied in practice within a large-capacity course at the Faculty of Informatics of Masaryk University where the data pool for further processing was provided by the Information System of Masaryk University, belonging to the LMS systems category. Data collection, editing, organization in the database and analysis were prepared, to a large degree, on an experimental basis by adopting manual procedures and simple scripts (10). The output of this pilot project was a set of statistical and analytical investigations which gave the teacher a realistic view of the teaching and vital feedback. An example can be found in the two charts showing the application output for multiple statistical and analytical methods for available data. Figure 2 shows the average point gain of students expressed in percentage points on questions from the respective chapter. The students were divided into two groups: students attending a lecture devoted to a chapter topic (grey column) and students not attending (white column). The total of all columns of the respective color always indicates 100% = all attending/non-attending students in the lecture.

The chart in figure 3 demonstrates the point gain of students in a final test (maximum 40 points) depending on how active they were over their learning cycle. The students were divided into four groups:

- Active students – students who have attended at least 75% of lectures;
- Lightly active students – students who have attended at least 50% but less than 75% of lectures;
- Lightly passive students – students who have attended at least 25% but less than 50% of lectures;
- Passive students – students who attended less than 25% of lectures.

3.4 Generalization of EMEE

The previous chapter provides evidence that the EMEE concept is fully applicable in practice. One fact is that almost all adjustments related to data retrieval from the LMS system as well as subsequent processing have not yet had any conceptual or systemic solution. Therefore, it is desirable to take a more general look at EMEE and calculate with the idea of maximum possible automation. This would mean that for example selected functions could be available in the teacher’s standard environment (LMS) which the teacher is using in his/her e-learning agenda. Based on past experience, EMEE can be divided into the following four phases:

1. Data retrieval from LMS on student behavior during the learning cycle.
2. Selection of useful data and its organization in the database.
3. Statistical and analytical processing.
4. Presentation of output.

Each of the above steps correlates to a certain degree with the environment in which EMEE is to be implemented. Now it is essential to design a specific application enabling efficient and effective feedback to the teacher on his/her students. The technical solution to communication with the selected LMS is subject to further development. Since the architecture of LMS systems is not standardized and hence varies significantly, no uniform and fully compatible solution can be developed. Development will always have to be customized for the system supporting the e-learning agenda. What will play the key role prior to implementation will certainly be the analysis and collection of requirements from teachers who themselves want to use this functionality (10).
4 Integration of EMEE into the Moodle system

Selection of the right development and integration system for EMEE was a relatively easy task. In recent years, the popularity of open-source software products has been growing. The most popular choice in the area of learning management systems is without any doubt the Moodle LMS. Also available of course are alternatives such as Claroline, Dokeos, ILIAS, ATutor, SAKAI, etc. In its number of installations and thanks to its large community, Moodle can confidently claim the leading role. Teachers and students all over the world know and enjoy this e-learning management system. In the Czech academic environment Moodle is also widely used, which is why it was selected as the environment for which the actual EMEE module was developed and integrated. The new separate module Moodle-EMEE will fully correspond with the license policy of Moodle and will be distributed free of charge in the open-source format under the GNU General Public License.

Like most software solutions, also Moodle-EMEE will undergo a development life cycle. One essential development phase is demand specification. This phase is crucial for successful completion and implementation. Extremely high emphasis will be placed on correct specifications to ensure seamless application. For this reason, a survey has been carried out among the public with the objective of collecting suggestions and ideas about the functionality of the model from the teachers for who this model will be relevant. As the function and output variability connected with data describing student behavior is rather broad, a targeted feedback should provide a list of the most desired features to be used as the core of the first version of the Moodle-EMEE analytical model. Tutors and teachers will have the opportunity to influence how the application will look in practice.

The target group in this survey are experts and senior users of the e-learning tool at universities.

- Users of LMS Moodle – teacher community working with the open-source system Moodle who attended the MoodleMoot.cz 2011 conference.
- Users of LMS systems from academic and commercial institutions (collaboration with Pragodata Consulting s.r.o.).
- Selected teachers across the MEFANET education network (pooling all Czech and Slovak medical faculties).
- Selected teachers working at the Institute of Biostatistics and Analyses at Masaryk University.
- Attendees of the Summer School of Applied Informatics 2011 in Bedřichov.
- Teachers from LaSARIS (Lab Software Architectures and Information Systems).
- Selected active teachers at Masaryk University engaged in e-learning over the long run (10).

5 Conclusions

This paper described a brand-new EMEE concept which shifts learning feedback to better optimization from the point of view of the end user. Without the need for complicated and often bothersome questionnaires and surveys, the teachers will have a tool providing a well-founded and hence valuable picture of their teaching. The pilot experiment showed clearly that the proposed principles are applicable in practice and the output opens not only an objective insight into student behavior, but also follow-up modification of teaching methods. Another logical step is the development of a new module for the LMS system environment – specifically for Moodle. Moodle-EMEE will give teachers feedback options not only on student activity but also and firstly on their own teaching. The entire chart and table output will be presented in anonymized form, used only for optimization purposes and continuous quality improvements in the teaching process. If successfully applied in the Moodle system, further spill-overs into closed university environments are foreseen. A vital prerequisite for future incorporation of advanced functionalities and new requirements is collaboration between teachers prior to implementation.

Literature:


Primary Paper Section: 1

Secondary Paper Section: AM, IN
Introduction

It is well known that new information and communication technologies significantly alter the educational practices and enhance the learning procedures. Distance learning or electronic education has become a very popular way of education, Conventional education methods used for lectures and examinations had been adopted to be applicable to the distance learning [1]. The whole process of computer-based knowledge evaluation is essential part of modern e-learning approach and helps teachers to enhance learning practices by weaknesses detecting that students might have. Computer-aided testing systems and methods might contribute to student assessment procedures through numerous ways, for example the simplification of the logistics of the examination process and the ability to provide self-examination material that can be used on a distance-based learning framework by the student [2].

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

COMPUTER-BASED KNOWLEDGE EVALUATION IN HEALTH WORKERS EDUCATION

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Abstract

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

Keywords

computer-based assessment, e-learning, electronic examination, knowledge evaluation, methodology
(e.g. links to the scientific webpages), prepare discussion forum and of course test the knowledge of students.

**Test classification**

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

**Design concept**

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

a) **The authors of the tests (teachers or tutors) should create questions that are focused on the primary course objectives.** The best way how to start is to try to develop at least one question that tests participants for each course objective. This will ensure that teacher is asking participants to demonstrate their knowledge of what course developers determined are the most important concepts to learn across the entire course.

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

b) **Only develop questions to which there were clear answers provided during the course.** Teachers should not test participants on concepts or knowledge that were not sufficiently covered in the course and create questions that don’t demand the memorization of extraneous (i.e., picky) detail. Students should not be tested on whether they remember a particular word or phrase but rather on whether they have learned important concepts and facts related to the subject matter. The level of importance should be chosen very carefully.

c) **The best tests are developed if the students can fill it in 10–30 minutes.** Of course completing a pre and post-test can take time away from covering material in the course or subject. Pre- and post-tests are not supposed to be exhaustive of the material addressed in the course but be a sample of the most important concepts and skills covered. We can say that the knowledge test that would take an average participant approximately 15 minutes to complete and if you use multiple-choice and true/false questions that could be 15–20 minutes. In case of using answers or essay questions, you should allow for 25 minutes.

d) **The teacher should use different types of questions.** Variety of knowledge questions can help make a test more rigorous and interesting and it helps students to be more motivated and active. It is important to have a balanced mix of True/False and Multiple Choice questions.

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

f) When teachers are creating the true/false questions they should construct questions that are simply worded, to the point, and unambiguous. Tutors have to avoid strange, unfamiliar or unheard words. Also vocabulary that can be interpreted in different ways makes the questions much more difficult for students to answer. In health-care workers education, have to be strictly adduced, if students should use Latin or not. Teacher should avoid using of conjunctions such as and, but, except, and or. These words imply a second idea or concept and can be confusing when students are answering.

g) Tutors can also create open ended questions. However it is sometimes too difficult to evaluate the answers from many students. It is useful if tutor want to assess the ability of students to write some scientific words (e.g. name of organs in Latin or English). For the longer answer it is not so good especially if you have big students group. For the evaluation of longer answers in pen ended questions teachers have to have strict criterion. There is another way how to use open ended question – using peer review among the students and evaluate the argumentation of their statements.

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

Analysis of evaluation agenda

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

Difficulty of test questions

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

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

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

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

<table>
<thead>
<tr>
<th>Table 1: Recommended values of the difficulty level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty question value</td>
</tr>
<tr>
<td>Difficulty level</td>
</tr>
</tbody>
</table>
Items having difficulty level lower than 20 (too easy) or higher than 80 (too difficult) are not suitable and have to be controlled by item writers (see Table 1). The whole analysis is depended upon only correctness answers attribute.

**Sensitivity of test questions**

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

$$d = \frac{n_U - n_L}{0.5 \times n}$$  \hspace{1cm} (2)

Where d is discrimination index, $n_U$ is the number of correct answers to the given question responded by good students (belongs to the upper group), $n_L$ is the number of correct answers to the given question responded by weak students (belongs to the lower group) and n is the number of all answers to the given question. The calculation has to be executed for all test items. The recommended ULI value is more than or equal to 0.3.

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

**Conclusion**

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

### Table 2: The example of difficulty and sensitivity analysis of real evaluation agenda

<table>
<thead>
<tr>
<th>question id</th>
<th>q01</th>
<th>q02</th>
<th>q03</th>
<th>q04</th>
<th>q05</th>
<th>q06</th>
<th>q07</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Difficulty</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total number of answers</td>
<td>10</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>16</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>correct answer</td>
<td>9</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>15</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>incorrect answer</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>difficulty question value</td>
<td>10</td>
<td>16,7</td>
<td>60,0</td>
<td>28</td>
<td>6,3</td>
<td>42,9</td>
<td>40,0</td>
</tr>
<tr>
<td>difficulty level</td>
<td>easy</td>
<td>easy</td>
<td>optimal</td>
<td>optimal</td>
<td>easy</td>
<td>optimal</td>
<td>optimal</td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>correct answers (U)</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>correct answers (L)</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>discrimination index</td>
<td>0,2</td>
<td>-1,0</td>
<td>0,4</td>
<td>0,3</td>
<td>-0,1</td>
<td>0,0</td>
<td>-0,4</td>
</tr>
<tr>
<td>result</td>
<td>×</td>
<td>×</td>
<td>ok</td>
<td>ok</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
</tbody>
</table>
References


A Unified Educational Platform of Multimedia Support in Education at Medical Faculties of MEFANET Project

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Abstract

The paper presents an educational network of medical faculties in Czech Republic and Slovakia. Its activities started within the project Medical faculties educational network in 2007 and the main role is to support modern multimedia information technologies usage in clinical and health care study programs. The network is based on open cooperation among faculties with respect to effective medical teaching and learning. To achieve this goal, an original and uniform platform for educational web portals was developed and it is used, together with central gateway, to offer and share digital educational content. The fundamental principles of this innovative solution are described. Both the authors and the users may utilize a wide range of sophisticated functionalities that make the processes of publication and accessibility more intuitive than ever.

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Keywords: e-publication; multimedia; education technologies; distance education

1. Introduction

Multimedia such as pictures, audio, or movies, has become an important tool in the provision of education at many levels. Teaching and learning multimedia materials are offered through the web-based systems and thanks to the recent network technologies the educators use them more trustworthy than ever. Educational potential of multimedia was explored mainly by higher education institutions as traditional leading players in this area (Schwarz, 2010; Allen, 1998). Each stage of multimedia application

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corresponds to a certain level of computer technology as well as a certain pedagogical approach. The benefits to a learning process result from the flexibility offered by new technologies. However, an initial difficulty to apply such electronic tools into the real praxis comes from apprehensions of educators. It is also difficult to encourage the usage of new technologies when computer resources are restricted by the financial constraints. Fortunately, this becomes an unessential factor because of falling costs of personal computing. On the other hand, the principles of education based on multimedia should motivate educators to use them at least as assisted materials always when convenient. The main advantage of using multimedia in education is to convey information or knowledge quickly and effectively to all students and keep them interested in learning.

A relatively short history proved the multimedia learning materials enhance learner performance even in the form of animated cartoons, engineering laboratory exploration, complex decision-making paradigms or concept development (Remus, 2008; Austin, 2009). Various multimedia technologies were applied to specific disciplines and demonstrated the pedagogical value of multimedia in terms of learning improvement (Stelzer, 2009; Cochrane, 2007; Macura, 2011). The visual presentation of ideas has been proven to be particularly important as it helps the educational process in a critical way (Dalacosta, 2009).

Using multimedia in on-line systems allows teachers to prepare attractive courses that can be easily accessed and organized as real-time two-ways interactions between remote teacher and students, but also more popularly as simpler lecture-on-demand learning models (Chen, 2008; Shi, 2003). The students often use them rather than those two-ways as they can review online materials several times without restrictions. Teachers also fill advantages as they can easily revise individual materials to offer students the most actual information. Other advantages of the web-based systems include increased students’ learning efficacy through dynamic media presentation of lectures, abilities to measure students’ performance by on-line self-assessment tools or possibilities to create own courseware and questions. Moreover, education using computer-based instruction appears to be associated with consistent time savings, in some cases students learned with it in more than 70% less time than students in traditional classrooms (Parlangeli, 1999). Research in the multimedia learning field assume that after applying the optimization principles such as cognitive load theory principles and multimedia learning theory principles the web-based learning will be beneficial for both younger and older learners (Pachman, 2012).

The use of multimedia presentations was accepted by physicians in education of students of medicine too. Individual multimedia education outputs can be utilized also for patients’ education and counseling (Ihring, 2012; Levett-Jones, 2011; Kodama, 2000; Penhaker, 2011). Here, the successful clinical implementation of multimedia support necessarily depends on high acceptance and appreciation by the physicians in charge. It is because of their everyday clinical practice and/or relevant pressure to realize clinical examinations and interventions. The purpose of this paper is to present an original approach to the collaboration of professionals from different medical faculties and countries.

2. Medical faculties educational network

The very first idea to create the MEdical FAculties educational NETwork (MEFANET, www.mefanet.eu) project has arisen as initiative of cooperation between the Faculty of Medicine at Masaryk University Brno and the 1st Faculty of Medicine at Charles University in Prague in 2006 (Schwarz, 2009). The pilot results of this cooperation that was primarily oriented on sharing of electronic and multimedia educational materials convinced other medical faculties to join this perspective project. Therefore, all seven medical faculties in Czech Republic and all three medical faculties in Slovakia have expressed the interest to be the members of the MEFANET. They were accepted by the MEFANET council and formally joined the network in 2007. Thereafter, the project MEFANET got new dimensions and represents the brand of academic cooperation between individual partners.
The main role of MEFANET is to support improvement in education of medical and health care disciplines using modern information and communication technologies (ICT). It represents an optimal platform to meet experts from different faculties who may join their forces to create qualitative better teaching materials. These materials can be accessible across the network for both the teachers and the students. To do this, several supporting activities have been initiated by the MEFANET. On the other hand, the MEFANET is voluntary network where the independence of the faculties is fully respected and where no restrictions in organization of teaching activities are stated. The activities are supported only by the grants and no expenses are required from individual faculties to cumulate certain central budget. Nowadays, the network covers teachers and medical and health care students at all medical faculties in Czech Republic and Slovakia.

Benefits of this academic cooperation include:
- horizontal cooperation and sharing the results of work from authors of multimedia teaching tools and on-line educational resources,
- unification of methods to create and publish multimedia teaching tools and on-line educational resources, in order to assure availability of these materials to the students of all involved medical faculties,
- putting together human resources and potential to develop complex technological solutions in an effective manner, and to solve possible problems with creation and/or publication of multimedia teaching tools and on-line educational resources,
- more effective usage of acquired financial resources, possibility of inter-university cooperation on awarded grants.

All the activities realized within the project are managed by the coordination council where each medical faculty has its two or three representatives. The council establishes the priorities of MEFANET activities, decides on generally acceptable standards for individual types of outputs, and helps to define and solve common projects. One of the most important outputs of the MEFANET is standardized web publication platform that was accepted and implemented by each participating medical faculty.

3. Web-based portal platform

Electronic pedagogical works that are created at individual faculties are collected and published at faculties’ web portals. All faculties decided to operate unified standalone portals rather than one centralized system, hosted for the whole network. However, a central gateway was built to integrate all the information presented on the portal instances into one common place on the web. Thus, the independence of the faculties is ensured and the users are still allowed to find education materials on one place. Interconnection of all these faculties’ portals and the central gateway compose the MEFANET e-publishing platform. The list of faculties and their portals is summarized in the table 1.

Unified web portal for multimedia support of education at medical faculties represents universal solution supporting education of medical disciplines. Each portal has its own ISSN code as well as editorial board to make sure the needs and the requirements of particular faculty are fulfilled and no restrictions are given by the MEFANET and/or by other members of the network. Web portals are installed in two language versions. It is Czech and English language combination at medical faculties in the Czech Republic and Slovak and English at medical faculties in Slovakia. Education materials prepared in Czech/Slovak language and materials prepared in English are published independently and there is no equality between the content of these versions. It is fully up to the authors’ decision whether they prepare the material in one or in both languages. Each published work may be associated to the particular course/subject taught at the faculty assigning it in the body of education material. This may be used by the users to filter the content of the portal according to the materials intended for specific course/subject.
### Table 1. List of medical faculties connected to the MEFANET and their portals.

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Portal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty of Medicine at Masaryk University in Brno</td>
<td><a href="http://portal.med.muni.cz">http://portal.med.muni.cz</a></td>
</tr>
<tr>
<td>1st Faculty of Medicine at Charles University in Prague</td>
<td><a href="http://portal.lf1.cuni.cz">http://portal.lf1.cuni.cz</a></td>
</tr>
<tr>
<td>2nd Faculty of Medicine at Charles University in Prague</td>
<td><a href="http://mefanet-motol.cuni.cz">http://mefanet-motol.cuni.cz</a></td>
</tr>
<tr>
<td>3rd Faculty of Medicine at Charles University in Prague</td>
<td><a href="http://portal.lf3.cuni.cz">http://portal.lf3.cuni.cz</a></td>
</tr>
<tr>
<td>Faculty of Medicine in Hradec Králové at Charles University in Prague</td>
<td><a href="http://mefanet.lfhk.cuni.cz">http://mefanet.lfhk.cuni.cz</a></td>
</tr>
<tr>
<td>Faculty of Medicine in Pilsen at Charles University in Prague</td>
<td><a href="http://mefanet.lfp.cuni.cz">http://mefanet.lfp.cuni.cz</a></td>
</tr>
<tr>
<td>Faculty of Medicine at Palacky University in Olomouc</td>
<td><a href="http://mefanet.upol.cz">http://mefanet.upol.cz</a></td>
</tr>
<tr>
<td>Faculty of Medicine at Comenius University in Bratislava</td>
<td><a href="http://portal.fmed.uniba.sk">http://portal.fmed.uniba.sk</a></td>
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<tr>
<td>Jessenius Faculty of Medicine in Martin at Comenius University in Bratislava</td>
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<td><a href="http://portal.lf.upjs.sk">http://portal.lf.upjs.sk</a></td>
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</table>

### 3.1. Filter of medical disciplines

To ensure better orientation at the portals a systematic map of medical disciplines was created. Each published work must be assigned to the one of these disciplines so the map categorizes the content of the portals and is also used as the main filter. This is one of three directives that are unchangeable across the faculties and is used to export information to the central gateway. Other two rigid directives include authentication/authorization framework and multidimensional quality assessment. The other features, properties and functionalities of the unified portal platform can be adapted or localized to meet all the needs of particular medical faculty connected to this cooperation. Figure 1 shows the map of specified medical disciplines.

![Medical disciplines map](image)

Fig. 1. Medical disciplines map used to categorize and filter published education materials.

At the beginning of the project the 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. However, the medical disciplines mapping according to the Conspectus method showed to be inapplicable for MEFANET purposes. Thus, an own medical disciplines map was composed, based on various taxonomies adapted from significant medical publishing organizations. Since first release of the portal it has been reedited several times. The change in
this filter has to be approved by MEFANET Coordination Council as it must be applied on all faculties’ portals as well as on the MEFANET Central Gateway (http://portal.mefanet.cz).

3.2. Authorization and the users’ groups

The access to the faculty portals is not restricted and is opened to everybody. All pages, sections and education contributions published at the portals are accessible for anyone who searches the content of the portals. Therefore, everyone interested can get an overview of educational materials available on the particular medical faculty. The content of the portal is presented as a list of articles described by the title, annotation picture and short annotation. The educational content of the article is included in attachments and/or hypertext links that contain also information about the group of users who have access to these materials. This is specified solely by the authors of published educational content who can choose one of the user groups to permit/deny access to their materials. Web portals specify several groups of users that are listed in the table 2.

Table 2. Groups of user specified at web portals.

<table>
<thead>
<tr>
<th>User</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>non registered user</td>
<td>anonymous and not registered user</td>
</tr>
<tr>
<td>registered user</td>
<td>usually anonymous user, who accepts the terms of use within his registration</td>
</tr>
<tr>
<td>MEFANET user</td>
<td>user of the MEFANET network, i.e. student or teacher from any Czech or Slovak medical faculty</td>
</tr>
<tr>
<td>university member</td>
<td>user, whose affiliation to the university has been verified at the portal via the local information system of that university</td>
</tr>
<tr>
<td>faculty member</td>
<td>user of local medical faculty, whose affiliation to that faculty has been verified at the portal via the local information system of the respective university or faculty</td>
</tr>
</tbody>
</table>

Table 3. Roles of users registered at the portals.

<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>dummy</td>
<td>registered user who may access and use education materials according to his/her users group affiliation, dummy is able to create articles and to communicate with redaction</td>
</tr>
<tr>
<td>editor</td>
<td>administrator of assigned part of the educational content at the particular faculty, the role allows basic editing of articles but has no rights to publish it, communicates with authors and guides the publication process</td>
</tr>
<tr>
<td>guarantee</td>
<td>expert of associated medical discipline, checks the materials to be published and organizes review process to verify quality according to the local rules of the faculty</td>
</tr>
<tr>
<td>reviewer</td>
<td>user who reviews particular article and recommends or refuse its publication as reviewed material on the portal and the central gate</td>
</tr>
<tr>
<td>master</td>
<td>main administrator of the portal responsible for all functionalities, master also publishes individual articles on the portal</td>
</tr>
</tbody>
</table>

Once the users are registered they may be assigned to the one of the users roles. The basic role is role “dummy” that is added automatically to all newly registered users. This role also allows users to send and
article into the redaction of educational portal. Other higher-level roles relate to the management of particular portal instance and are specified according to the list presented in the table 3.

3.3. Structure of published education materials

To make the process of publication easier the portal offers an intuitive article submission form. The authors may use it as one of the features of the main menu under the name Submit contribution. A unified structure was adopted to present all articles in the same way and to be ensured that all compulsory parts are filled in. The submission form consists of three steps in which the author offers information about his/her topic. The field like title, annotation, authors and the text are required in the first step. The second step consists of information that classifies the article to be submitted. The attachments, links and other electronic materials as well as keywords and comments for portal redaction are entered in the last step. Individual parts of published contributions are described in the table 4.

Table 2. Fields of the contributions published at the MEFANET web portals.

<table>
<thead>
<tr>
<th>Field name</th>
<th>Compulsory</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>title</td>
<td>Y</td>
<td>the title of the contribution, the length should be 10 or more characters</td>
</tr>
<tr>
<td>language</td>
<td>Y</td>
<td>specification of the language of the contribution as well as the language version of the portal in which the contribution will be published</td>
</tr>
<tr>
<td>annotation</td>
<td>Y</td>
<td>brief characteristics of the contribution in the size of at least 300 characters</td>
</tr>
<tr>
<td>first author</td>
<td>Y</td>
<td>name of the first author, it is also used to filter content of the portal according to the first author</td>
</tr>
<tr>
<td>other authors</td>
<td>N</td>
<td>other authors of the contribution separated by commas</td>
</tr>
<tr>
<td>participating department</td>
<td>N</td>
<td>information about affiliation of author/authors, the field is also used to filter content of the portal according to the authors` workplaces</td>
</tr>
<tr>
<td>text</td>
<td>N</td>
<td>the body of the contribution with more detailed information about the work</td>
</tr>
<tr>
<td>medical disciplines</td>
<td>Y</td>
<td>assignment of the contribution to one or more medical disciplines, it is also used to filter content of the portal</td>
</tr>
<tr>
<td>courses</td>
<td>N</td>
<td>information about course/courses taught at the faculty in which the contribution can be used, it is also used to filter content of the portal</td>
</tr>
<tr>
<td>associated contributions</td>
<td>N</td>
<td>associated contributions already published at the portal, used as links to move on contributions with similar topics</td>
</tr>
<tr>
<td>portal category</td>
<td>N</td>
<td>assignment to one of the portal categories (may vary across faculties)</td>
</tr>
<tr>
<td>section of portal</td>
<td>N</td>
<td>assignment to one of the portal sections (may vary across faculties)</td>
</tr>
<tr>
<td>4-D assessment</td>
<td>N</td>
<td>specification of the type and the level of contribution for review process</td>
</tr>
<tr>
<td>attachments</td>
<td>N</td>
<td>files with education content</td>
</tr>
<tr>
<td>links</td>
<td>N</td>
<td>hyperlinks to education materials</td>
</tr>
<tr>
<td>annotation image</td>
<td>N</td>
<td>picture related to the content of the contribution</td>
</tr>
<tr>
<td>creative commons</td>
<td>N</td>
<td>information about copyright</td>
</tr>
<tr>
<td>keywords</td>
<td>N</td>
<td>comma separated keywords of the contribution</td>
</tr>
<tr>
<td>comments</td>
<td>N</td>
<td>additional information for redaction and editors</td>
</tr>
</tbody>
</table>

After the contribution is send to the redaction it can be published as non-reviewed material (but not send to the central gate) or the review process will be opened. Depending on the author’s decision all the
attached materials and the links can be offered to the appropriate group of users. The network prefers quality of contribution rather than the quantity and therefore the quality of all published education materials is controlled.

3.4. Quality assessment

Several control mechanisms were designed and applied within the portal instances to assess the quality of published materials. The current version of quality assessment is based on multidimensional processes as shown on figure 2.

Fig. 2. The principle scheme of four-dimensional quality assessment of the contributions published at the portals of medical faculties in the MEFANET network.

According to the scheme shown on figure 2 the quality assessment methodology consist of four different dimensions. These are labeled as review, level, type and self-study score.

The first dimension of the system is an expert review. This ensures that only the contributions with positive conclusion from reviewers can be published on the central gateway. The contributions with no review can be published only on local portal instances and users are informed about this when using such unreviewed study materials. The review procedure includes both the binary questions as well as the 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 (undergraduate, graduate, advanced and/or complex level) of the teaching material, which is a useful piece of information for users as well as for reviewers.

The third dimension specifies a multiple-choice classification according to the types (textbooks and manuals, websites and atlases, digital video, presentations and animations, image casuistry, e-learning courses) of used attachments. Here, the enumerated scale includes static files for web-based learning as well as interactive e-learning courses encapsulated in the learning management systems (LMS).

The last dimension of the quality assessment system represents a self-study scoring mechanisms. This is the users’ feedback and shows what the users think about the usability of particular contribution for their self-studies.

There is also an open discussion of users available on the portals. It is located at the end of contributions and using it, the users can response to the presented information. This functionality of the
MEFFANET web portals is moderated by the user with the role masters, but it can be disabled if there are no human resources to keep the discussion polite and presentable.

4. Conclusion

This paper presented basic ideas of the MEFANET network and main features of educational web portals which are one of the networks’ fundamental outputs. Web portal is designed as e-publishing platform with the aim to share electronic and multimedia materials created across medical faculties. The unified platform is used at ten medical faculties in Czech Republic and Slovakia and involves over 4,000 potential authors (teachers), over 22,000 potential users (students) and many other interested users from all around the world. Local portals are managed independently and do not replace other existing systems established at medical faculties. Information from these portals is exported to the central gateway where all the reviewed educational contributions are summarized. Educational portal platform offers a lot of unique features and functionalities that were developed to meet the needs of all participated medical faculties. The priority is given to the quality of published materials which may be assessed by the well-defined rules. Further development will be oriented on implementation of standards that allow wider cooperation with other teaching institutions as well as with significant international repositories of reusable learning objects.

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References


OPTIMED - optimalizovaná výuka všeobecného lékařství: horizontální a vertikální propojení, inovace a efektivita pro praxi

Projekt OPTIMED se zaměřuje na komplexní inovaci systému výuky všeobecného lékařství na Lékařské fakultě Masarykovy univerzity a posílení výuky orientované na řešení problému v souladu s uplatněním absolventa v oblasti klinické i akademické. Nejvýznamnějším přínosem bude vznik inovovaného, parametrizovaného a tedy maximálně dynamického systému, jehož základem bude nově navržená portálová platforma. Ta poskytne zefektivnění výuky ve smyslu odstranění duplicit a redundancí na úrovni jednotlivých předmětů. Na úrovni celé výuky pak hlavní přínos spočívá ve vertikálním propojení výuky a vydefinování nepostradatelných atributů popisujících edukační proces. Zprístupnění všech relevantních informací spojených s kurikulem všeobecného lékařství umožní významně zpřehlednění výuky jak pro vyučující, tak pro studenty.

OPTIMED bude inovovat celý studijní program všeobecné lékařství a primární cílovou skupinu budou tvořit čeští pregraduální studenti všeobecného lékařství (celkem 1290), případně studenti postgraduálního studia, z nichž část je v přímo navazujícím vzdělávání (celkem 100-200). Sekundární cílovou skupinou jsou pedagogičtí pracovníci (celkem 760) podílející se na výuce všeobecného lékařství.

Vývoj komplexní metodiky, která bude v praxi realizována prostřednictvím online portálu, poskytne unikátní nástroj pro efektivní mezioborové propojení výuky.

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