

# Medical Informatics Education Needs Information System Practicums in Health Care Settings

## Experiences and Lessons Learned from 32 Practicums at Four Universities in Two Countries

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### Summary

**Objectives:** To report about the themes and about experiences with practicums in the management of information systems in health care settings (health information management) for medical informatics students.

**Methods:** We first summarize the topics of the health information management practicums/projects that the authors organized between 1990 and 2003 for the medical informatics programs at Heidelberg/Heilbronn, Germany, UMIT, Austria, as well as for the informatics program at the University of Leipzig, Germany. Experiences and lessons learned, obtained from the faculty that organized the practicums in the past 14 years, are reported.

**Results:** Thirty (of 32) health information management practicums focused on the analysis of health information systems. These took place inside university medical centers. Although the practicums were time-intensive and required intensively tutoring students with regard to health information management and project management, feedback from the students and graduates was mainly positive.

**Discussion:** It is clearly recommended that students specializing in medical informatics need to be confronted with real-world problems of health information systems during their studies.

### Keywords

Medical informatics, health informatics, hospital information systems, health information systems, education

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## Introduction

Modern information processing methodology and information and communication technology have strongly influenced health care, including the architecture and infrastructure of health information systems (e.g. [1-3]). Because of this change, medical informatics specialists are increasingly involved in managing information systems of health care institutions, in particular of hospital information systems. E.g., 60% of medical informatics graduates from the Heidelberg/Heilbronn Medical Informatics Program, actually working in the field of medical informatics, answered in a recent survey that one of their main working fields is health information systems ([4], see also [5] for earlier results). Almost all those graduates had work focusing on hospital information systems.

As a consequence of this change, health care professionals, and in particular medical informatics specialists, need sufficient knowledge and skills of the possibilities and limitations to systematically manage such information systems of health care institutions. These educational needs have been mentioned by the International Medical Informatics Association (IMIA) in its recommendations on education [6], in a series of conferences [7-12], and in a recently published conference on the future of medical informatics (in particular [13-20]). Appro-

priately designed educational programs in medical informatics/health informatics and an increasing number of well-trained medical informatics specialists will help to pursue the goal of transforming health care through innovative use of information and communication technology [21, 23].

This has been identified from the beginning by the initiators of the dedicated medical informatics programs of the University of Heidelberg/University of Applied Sciences Heilbronn [24-27]. One of its early and prominent faculty members at Heidelberg/Heilbronn was Professor Jochen Moehr, now teaching at the University of Victoria, Canada. Jochen Moehr is one of the few teachers in medical informatics, outstandingly experienced in teaching “at the seams of disciplines, cultures and nations” [28]. In arguing that “Teaching the skills and knowledge required in health informatics ... is a challenge because the skill of applying knowledge in real world life requires practice” ([29], p. 1061), he initiated practical courses, respectively projects, to be carried out by medical informatics students. These practicums were offered after lectures, providing the necessary theoretical knowledge and skills on the management of information systems at health care institutions, in particular at hospitals [24, 30]. It was Jochen Moehr’s initiative in the late 1970s to extend existing practicums, originally intended for passively introducing students to health care settings, and to establish a “practical course on sys-

tems engineering in health care" ([24], pp. 173 and 176/177), forcing students to actively carry out projects, dealing with information processing problems in hospitals and other health care institutions.

## Objectives

Following the tradition of Jochen Moehr, the authors between 1990 and 2003 were involved in organizing such practicums on the management of information systems in health care settings (or briefly health information management). This has been done by jointly giving corresponding lectures, focusing on methods, activities, and tools for tactical information management, mainly systems analysis, as well as on project management ([31-34, see also [35, 36] for subsequent courses). References [31-34] also contain details on the methodology used.

The practicums organized by the authors were organized first

- for *medical informatics students* (since 1990 [24-27], the program is an integrated B.Sc./M.Sc. program, with a duration of 4.5 years, leading to a diploma in medical informatics),
- as well as for *health information management students* (since 2000, [37], the program is an M.Sc. program for physicians, with a duration of 1 to 1.5 years, leading to an M.Sc. degree in health information management)

from the University of Heidelberg/University of Applied Sciences Heilbronn, Germany, and later, when some of the faculty moved to other schools,

- for *informatics/computer science students* of the University of Leipzig, Germany (since 1999, the program is an integrated B.Sc./M.Sc. program, with a duration of 4.5 years, leading to a diploma in informatics),
- and for *medical informatics students* from the Bachelor (3 years, B.Sc. degree in medical informatics) and Master of Science (1.5-2 years, M.Sc. degree in medical informatics) programs of the newly founded University for Health Informatics and Technology Tyrol (UMIT)

in Innsbruck, Austria ([38], see also [39] for the hospital environment).

Our aim is to report about the structure and the themes of these health information management practicums, about experiences and lessons learned as well as about feedback from students and graduates.

## Methods

First we want to summarize the topics of the health information management practicums/projects of the medical informatics programs in Heidelberg/Heilbronn, Leipzig and UMIT and briefly describe their struc-

ture. We will then focus on experiences and lessons learned, both from the point of view of the faculty as well as from the point of view of the participating students.

To assess the faculty's experiences, the authors discussed and aggregated their personal experiences as organizers of the practicums.

To assess the student's perspective, we analyzed the results of a recent survey on the first 1024 graduates from the Heidelberg/Heilbronn program [4] with respect to comments on these practicums. The survey was done as an anonymous inquiry of all medical informatics graduates from Heidelberg/Heilbronn, having finished their studies before March 31, 2001 (n = 1024), using a structured questionnaire. The ques-

**Table 1a** Health information management practicums in Heidelberg/Heilbronn, part 1. HUMC: Heidelberg University Medical Center, MI-BSc2: medical informatics students (2nd year B.Sc. level)

University of Heidelberg/University of Applied Sciences Heilbronn			
Semester	Topic of Project	Health Care Institution	Students
Summer 1990	Communication analysis between labs and ordering departments	HUMC	MI-BSc2
Winter 1990/91	Analysis of communication flow on order entry and result reporting at the Institute of Pathology	HUMC	MI-BSc2
Summer 1991	Investigating the quality of discharge diagnoses and operation data provided for the minimum basic data set	HUMC	MI-BSc2
Winter 1991/92	Communication analysis and time needs for health care professionals at the anaesthesiologic intensive care ward	HUMC	MI-BSc2
Summer 1992	Investigating patient waiting times in selected outpatient departments at the 'Heidelberg Head Clinic'	HUMC	MI-BSc2
Winter 1992/93	Assessment and possible quality improvement for the physician patient record at the Department of Clinical Radiology	HUMC	MI-BSc2
Summer 1993	Developing an IT concept for the information system of the Department of General Psychiatry	HUMC	MI-BSc2
Winter 1993/94	Assessing a computer-based application system for the ordering of materials	HUMC	MI-BSc2
Summer 1994	Analysis of the hospital's patient admission, transfer and discharge behavior	HUMC	MI-BSc2
Winter 1994/95	Analyzing potentials for computer-supported training of medical students	Med. Fac., U. of Heidelberg	MI-BSc2
Summer 1995	Analyzing the timely transmission of admission, transfer and discharge diagnoses to health insurance companies	HUMC	MI-BSc2
Winter 1995/96	Assessment of the computer-supported ordering of meals	HUMC	MI-BSc2
Summer 1996	Analyzing the structure of patient records	HUMC	MI-BSc2
Winter 1996/97	Analysis of patient waiting times at transports inside the medical center	HUMC	MI-BSc2
Summer 1997	Analysis and simulation of the workflow and organization of a haemato-oncological outpatient unit	HUMC	MI-BSc2

**Table 1b** Health information management practicums in Heidelberg/Heilbronn, part 2. HUMC: Heidelberg University Medical Center, IM-MSc1: information management students (1st year M.Sc. level), MI-BSc2: medical informatics students (2nd year B.Sc. level), MI-BSc3: medical informatics students (3rd year B.Sc. level), ph: physicians

University of Heidelberg/University of Applied Sciences Heilbronn			
Semester	Topic of Project	Health Care Institution	Students
Winter 1997/98	Analysis and simulation of the workflow and organization of the Breast Clinic	HUMC	MI-BSc2
Summer 1998	Assessment of computer-supported roster planning	HUMC	MI-BSc2
Winter 1998/99	Analysis of the archiving of radiological images	HUMC	MI-BSc2
Summer 1999	<i>Due to a curriculum revision [27] the practicum moved from the 4th to the 5th semester</i>		
Winter 1999/00	Assessing the patient treatment process at the Department of Child and Youth Psychiatry	HUMC	MI-BSc3
Summer 2000	Investigating the hospital's basic IT security standards	HUMC	MI-BSc3
Winter 2000/01	Analyzing the document structure of cancer patient records	HUMC and Thoraxklinik Heidelberg	MI-BSc3, IM-MSc1 (ph)
Summer 2001	Analyzing the health care professionals' signing behavior	HUMC	MI-BSc3
Winter 2001/02	Analysis of operation times in the department of surgery	HUMC	MI-BSc3, IM-MSc1 (ph)
Summer 2002	Evaluation of physicians' continuous medical education	HUMC	MI-BSc3
Winter 2002/03	Evaluating the management of patients' ideas	HUMC	MI-BSc3, IM-MSc1 (ph)
Summer 2003	Design of a brochure for informing patients of the 'Heidelberg Head Clinic'	HUMC	MI-BSc3

tionnaire was answered by 446 (response rate: 45.5%) graduates.

## Structure and Topics

The aim of the practicums was twofold:

- to introduce the students to the practice of tactical information management in health care organizations, and
- to introduce the students to the practice of project management in a larger project.

The practicums were mostly organized as one of the courses of a semester (duration: six months). All students worked on the same project. The fieldwork was mostly (e.g. analyzing the workflow in a clinical setting) done in blocks of about two weeks, where no other courses took place in parallel. Before, as mentioned, lectures, focusing on methods, activities, and tools for tactical

information management as well as on project management [31-34] were given.

After getting introduced to the topic, students had to write a project proposal (based on given, predefined project aims). During the project, they had to report on the project progress, and, in the end, they had to provide an extensive written report and give an oral presentation. The number of students per practicum typically (but not always) was in the range of approx. 10-40. The practicum was mandatory for the programs in Heidelberg/Heilbronn and at UMIT. It was optional for informatics students in Leipzig.

The topics of the practicums are listed in Tables 1-3.

With the exception of the two practicums in the summer semesters of 1993 and 2003 in Heidelberg/Heilbronn, all other 30 practicums focused on the analysis of information systems, including their assessment. Thirty practicums took place inside university medical centers, one (winter semester 1994/95 at Heidelberg/Heilbronn) in the

setting of a medical faculty, and one (winter semester 2001/02) took place in two independent hospitals, both focusing on and jointly treating cancer patients.

## Experiences and Lessons Learned

From the points of view of the faculty organizing the practicums the following major experiences occurred throughout the various practicums. We found that students were in fact able in the practicums to get both real-life experience in methods and tools of systems analysis (e.g. planning, execution and analysis of a process) as well as in methods and tools of project management (e.g. project planning, project controlling, team work). We now want to focus on some major critical points.

In many practicums, "transforming" a student group to a successful project team was found to be a challenge for our students. The students' project organization was intended to mirror the organization of typical health care projects, with a project management group and several sub-groups for specific tasks. Problems with regard to communication and cooperation between the several project sub-groups sometimes occurred. For example, during the field work, it came up that assigned tasks were not sufficiently clear, or that results were not delivered on time or with sufficient quality. This was however regarded as to some extent helpful, as successfully dealing with such conflicts later as professionals is important. We learned here that aspects of project management must also be thoroughly covered in accompanying lectures. In addition, comprehensive tutoring to support students in solving project management problems and in learning from them during the practicums was found to be quite helpful.

Then, we learned that, due to time constraints, it was necessary to clearly state and rigorously restrict project scope at the beginning. Writing a project plan, given the scope, usually worked out well. Those students volunteering for a project's planning group were generally very motivated. Their

achievements were often pivotal to the success of a project. In addition, we found that the “5-step method for systematic project planning” ([33], pp. 47-50, [31], pp. 200-1) was helpful to learn to define project plans.

Orally presenting the project results and discussing the outcomes with health care professionals sometimes turned out to be difficult. The presentations needed intensive training and the students had to work out a choreography accounting for the expectations and sensitivities of their audience.

One of the conflicts we often identified was that, after the students analyzed a clinical setting and suggested improvements, the project was finished. Students would often have welcomed to see whether the suggested changes really were implemented and later evaluated with regard to their outcome. However, it is hardly possible to answer these questions in the time frame of such a practicum.

Although the practicums were time-intensive, we generally had the impression that we received mainly positive feedback from our students and that the practicums were regarded as being relevant for their studies, both with regard to skills in systems analysis as well as project management.

As mentioned, 60% of the Heidelberg/Heilbronn medical informatics graduates, having answered the recent survey and actually working in the field of medical informatics (123 of 178 graduates), stated in [4] that one of their main fields of work is in health information systems. Almost all of those graduates had work that was focused on hospital information systems.

The graduates were also asked to assess their education in the medical informatics program, and they were invited to rate the courses that they felt were useful or those that they thought were unnecessary.

Graduates mentioned the following as the most valuable contents of the program (free text answers, from [4], n = 446): Database and information systems (138), software-development/-engineering (87), informatics (64), economics (61), **information systems in health care, esp. hospital information systems** (39), medical biometry (30), **practical training** (29), medicine (27), image and signal processing (27),

**Table 2** Health information management practicums in Leipzig. LUMC: Leipzig University Medical Center, CS-BSc3: informatics/computer science students (3rd year B.Sc. level)

University of Leipzig <sup>a</sup>			
Semester	Topic of Project	Health Care Institution	Students
Summer 2000	Data flow analysis of the Department of Internal Medicine II	LUMC	CS-BSc3
Summer 2001	Workflow analysis of patient admission and patient data communication at the Department of Neurosurgery	LUMC	CS-BSc3
Summer 2002	Workflow analysis and economical assessment of the patient records archiving areas	LUMC	CS-BSc3
Summer 2003	Workflow identification and identifying evaluation criteria for introducing mobile computers at the Department of Neurosurgery	LUMC	CS-BSc3

<sup>a</sup> The first practicum in Leipzig (not organized by one of the authors) started in 1999 with the topic: requirement analysis for application software products to support nursing tasks on wards.

**Table 3** Health information management practicums at UMIT. IUMC: Innsbruck University Medical Center, MI-MSc1: medical informatics students (1st year M.Sc. level), ph: physicians, inf: informaticians/computer scientists, minf: medical informaticians

UMIT <sup>a</sup>			
Semester	Topic of Project	Health Care Institution	Students
Winter 2001/02	Workflow analysis for the ordering of meals and suggestions for change management	IUMC	MI-MSc1 (ph & inf & minf)
Winter 2002/03	Workflow analysis of patient scheduling in selected outpatient units	IUMC	MI-MSc1 (ph & inf & minf)

<sup>a</sup> From winter semester 2003/2004 on 3rd year B.Sc. medical informatics students also participate.

mathematics (23), **systems-analysis/-engineering** (20). The underlined topics refer to the practicums mentioned here.

None of them mentioned that the health information management practicums were felt as not necessary to fulfill their job or that they were taught too extensively.

The graduates were also asked to mention subjects that were not treated in enough detail in the program, but that would have been helpful for their job. Here the most frequently mentioned topic was project management (64). This indicates that project management could even have been taught more intensively.

Another experience with our practicums was that there has to be a strong link of the faculty to or integration in health care institutions. In addition, for such courses, faculty should be involved in research in the field of health information systems and its management, and should also have close connections to the practice of health care.

## Discussion

Reports on related project-based educational approaches can be found in the literature, e.g. from the health informatics/health information science programs at the Universities of Athens, Greece [40, 41], Victoria, B.C., Canada [42-44], and Aalborg, Denmark [45, 46].

The importance of professional analysis and evaluation of health information systems, as trained in these practicums, has meanwhile been raised several times (e.g. [47, 48]), and can also be regarded as relevant component in a broader international (e.g. [49]), research (e.g. [50]) or medical context (e.g. [51]).

In following the arguments of Professor Jochen Moehr, mentioned in the beginning, in considering the experiences of other groups with related educational approaches, and in summarizing our own experience

since 1990, we can clearly recommend to have such practicums in medical informatics/health informatics curricula or in related programs. As mentioned in the title, in our view, medical informatics education needs information system practicums in health care settings. Students specializing in medical informatics need to be confronted with real-world problems of health information systems during their studies. Besides theoretical knowledge on information management and project management methods, activities, and tools, it is helpful for their future professional career to obtain experience in how to approach and solve problems of health information management, including project management issues (e.g., conduct a successful systems analysis in a real-world clinical setting, create a thorough project plan, cooperate in a large project team). But they must in each case be thoroughly supervised and guided by faculty that is experienced in health information management projects.

The additional introduction of didactic methods like e.g. moderation, instructed group work or the jig saw method [52] could support students in gaining important social competencies like the ability to work on a team, acceptance to take on responsibility, and dealing with conflicts.

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#### References

- Ball MJ, Garets DE, Handler TJ. Leveraging IT to Improve Patient Safety. *Methods Inf Med* 2003; 42: 503-8.
- Hasman A, Safran C, Takeda H. Quality of Health Care: Informatics Foundations. *Methods Inf Med* 2003; 42: 509-18.
- Kuhn KA, Giuse DA. From Hospital Information Systems to Health Information Systems – Problems, Challenges, Perspectives. *Methods Inf Med* 2001; 40: 275-87.
- Knaup P, Frey W, Haux R, Leven FJ. Medical Informatics Specialists: What are their Job Profiles? Results of a Study on the First 1024 Medical Informatics Graduates of the Universities of Heidelberg and Heilbronn. *Methods Inf Med* 2003; 42: 578-87.
- Frey W, Haux R, Leiner F, Leven FJ. Medical Informatics Heidelberg/Heilbronn: Graduates' Experiences and Job Situation. *Methods Inf Med* 1994; 33: 290-8.
- Recommendations of the International Medical Informatics Association (IMIA) on Education in Health and Medical Informatics. *Methods Inf Med* 2000; 39: 267-77. See also <http://www.imia.org>.
- Anderson J, Grémy F, Pagès JC (eds.). *Education in Informatics of Health Personnel*. Amsterdam: North Holland Publ Comp; 1974.
- Pagès JC, Levy AH, Grémy F, Anderson J (eds.). *Meeting the Challenge: Informatics and Medical Education*. Amsterdam: North Holland Publ Comp; 1983.
- Salamon R, Moehr JR, Protti DJ (eds.). *Medical Informatics and Education*. Victoria: University of Victoria Press; 1989.
- Van Bommel JH, Zvárová J (eds.). *Knowledge, Information and Medical Education*. Amsterdam: North Holland Publ Comp; 1991.
- Haux R, Leven FJ, Moehr JR, Protti DJ (eds.). *Health and Medical Informatics Education*. *Methods Inf Med* 1994; 33: 246-331.
- Haux R, Swinkels W, Ball MJ, Knaup P, Lun KC (eds.). *Health and Medical Informatics Education: Transformation of Healthcare Through Innovative Use of Information Technology*. *Int J Med Inf* 1998; 50: 1-300.
- Kulikowski CA. A Micro-Macro Spectrum of Medical Informatics Challenges and Opportunities: From the Informatics of Molecular Medicine to that of Transforming Health Care in a Globalizing Society. *Methods Inf Med* 2002; 41: 20-4.
- Lun KC. Challenges in Medical Informatics: Perspectives of an International Medical Informatics Organization. *Methods Inf Med* 2002; 41: 60-3.
- Musen MA. Medical Informatics: Searching for Underlying Components. *Methods Inf Med* 2002; 41: 12-9.
- Musen MA, van Bommel JH. Challenges for Medical Informatics as an Academic Discipline. *Methods Inf Med* 2002; 41: 1-3.
- Shahar Y. Medical Informatics: Between Science and Engineering, Between Academia and Industry. *Methods Inf Med* 2002; 41: 8-11.
- Talmon JL, Hasman A. Medical Informatics as a Discipline at the Beginning of the 21st Century. *Methods Inf Med* 2002; 41: 4-7.
- Van der Lei J. Closing the Loop Between Clinical Practice, Research, and Education: the Potential of Electronic Patient Records. *Methods Inf Med* 2002; 41: 51-4.
- Haux R. Health Care in the Information Society: What Should be the Role of Medical Informatics? *Methods Inf Med*. 2002; 41: 31-5.
- van Bommel JH, Musen MA (eds.). *Handbook of Medical Informatics*. Heidelberg: Springer; 1997.
- Hasman A, Albert A, Wainwright P, Klar R (eds.). *Education and training in health informatics: guidelines for European curricula*. Amsterdam: IOS; 1995.
- Mantas J (ed.). *Health and Medical Informatics Education in Europe*. Amsterdam: IOS 2000.
- Moehr JR, Leven FJ, Rothenmund M. Formal Education in Medical Informatics. Review of Ten Years' Experience with a Specialized University Curriculum. *Methods Inf Med* 1982; 21: 169-80.
- Leven FJ. Curriculum for medical informatics at the University of Heidelberg/School of Technology Heilbronn. *Methods Inf Med* 1994; 33: 262-7.
- Haux R, Leven FJ. Twenty years medical informatics education at Heidelberg/Heilbronn: evolution of a specialized curriculum for medical informatics. *Methods Inf Med* 1994; 33: 285-9.
- Leven FJ, Haux R. Twenty-five Years of Medical Informatics Education at Heidelberg/Heilbronn: Discussion of a Specialized Curriculum for Medical Informatics. *Int J Med Inf* 1998; 50: 31-42.
- Moehr JR. Teaching Medical Informatics: Teaching at the Seams of Disciplines, Cultures and Nations. *Methods Inf Med* 1989; 28: 273-300.
- Moehr JR, Berenji GR, Green CJ, Kagolovsky Y. Project-Based Teaching in Health Informatics: A Course on Health Care Quality Improvement. In: Patel V, Rogers R, Haux R (eds.). *MEDINFO 2001. Proceedings of the 10th World Congress on Medical Informatics*. Amsterdam: IOS; 2001. pp 1061-5.
- Moehr JR. Projektstudium: Ein didaktisches Modell zur Realisation von berufspraktischer Ausbildung im Studium der Medizinischen Informatik. In: Reichertz PL, Koeppe P (eds.). *Die Ausbildung in der Medizinischen Informatik*. Berlin: Springer; 1982. pp 91-104 (in German).
- Knaup P, Haux R, Häber A, Lagemann A, Leiner F. Teaching the Fundamentals of Information Systems Management in Health Care: Lecture and Practical Training for Students of Medical Informatics (Heidelberg/Heilbronn). *Int J Med Inf* 1998; 50, 195-205.
- Haux R, Winter A, Ammenwerth E, Brigl B. *Strategic Information Management in Hospitals. An Introduction to Hospital Information Systems*. New York: Springer; 2004.
- Haux R, Lagemann A, Knaup P, Schmücker P, Winter A. *Management von Informationssystemen*. Stuttgart: Teubner; 1998 (in German).
- Häber A, Haux R, Knaup P. Analysis, Modelling and Simulation of Information Systems as Part of the Medical Informatics Program at Heidelberg/Heilbronn. In: Mantas J (ed.). *Health and Medical Informatics Education in Europe*. Amsterdam: IOS; 2000. pp 162-9.
- Haux R, Ammenwerth E, Ter Burg WJ, Pilz J, Jaspers MWM. An International Course on Strategic Information Management for Medical Informatics Students: Aim, Content, Structure, and Experiences. *Int J Med Inf* 2004; 73: 512-4.
- Jaspers MWM, Ammenwerth E, ter Burg WJ, Kaiser F, Haux R. An International Course on

- Strategic Information Management for Medical Informatics Students: International Perspectives and Evaluation. *Int J Med Inform* 2004; 73: 807-15.
37. Haux R, Schmidt D. Master of Science Program in Health Information Management at Heidelberg/Heilbronn: a Health Care Oriented Approach to Medical Informatics. *Int J Med Inf* 2002; 65: 31-9.
  38. Haux R. Biomedical and Health Informatics Education at UMIT – Approaches and Strategies at a Newly Founded University. *Int J Med Inf* 2004; 73: 127-38.
  39. Lechleitner G, Pfeiffer KP, Wilhelmy I, Ball MJ. Cerner Millennium: The Innsbruck Experience. *Methods Inf Med* 2003; 42: 8-15.
  40. Diomidous M, Verginis I, Mantas J. The Construction of a Simulation-Based System for the Development of Powerful and Realistic Models and Practicals for Healthcare Professionals. *IEEE Trans Inf Technol Biomed* 1998; 2: 174-82.
  41. Diomidus M, Mantas J. Assessing the progress of the M.Sc. course in health informatics under the ERASMUS programme. *Int J Med Inf* 1998; 50: 159-63.
  42. Coward JH. Description of Training Undergraduates in Health Information Science Using a Co-operative Education Model. In: Salamon R, Moehr JR, Protti DJ (eds.). *Medical Informatics and Education*. Victoria: University of Victoria Press; 1989. pp 544-8.
  43. Protti DJ. Health Information Science at the University of Victoria: The First Ten Years. *Methods Inf Med* 1994; 33: 254-72.
  44. Miller K, Protti, DJ, Wright I, Guerriere M. Innovative Informatics Education: Aligning Theory and Practice Through Strategic Partnership. In: Cesnik B, McCray AT, Scherrer J-R (eds.). *MEDINFO 98. Proceedings of the 9th World Congress on Medical Informatics*. Amsterdam: IOS; 1998. pp 89-92.
  45. Bygholm A, Hejlesen O, Nohr C. Problem-Oriented Project Work in a Distance Education Program in Health Informatics. In: Cesnik B, McCray AT, Scherrer JR (eds.). *MEDINFO 98. Proceedings of the 9th World Congress on Medical Informatics*. Amsterdam: IOS, 1998. pp 740-4.
  46. Nohr C, Andreassen S. Theory and practice of medical informatics professionally balanced in problems and projects. *Methods Inf Med* 1995; 34: 446-9.
  47. Kaplan B, Shaw NT. Future directions in evaluation research: people, organizational, and social issues. *Methods Inf Med* 2004; 43: 215-31.
  48. Ammenwerth E, de Keizer N. An inventory of evaluation studies in information technology in health care trends in evaluation research 1982-2002. *Methods Inf Med* 2005; 44: 44-56.
  49. Jaspers MW, Gardner RM, Gatewood LC, Haux R, Schmidt D, Wetter T. The International Partnership for Health Informatics Education: lessons learned from six years of experience. *Methods Inf Med* 2005; 44: 25-31.
  50. Lindberg DAB. Research Opportunities and Challenges in 2005. *Methods Inf Med* 2005; 44: 483-6.
  51. Moehr JR, Blankenbaker R, Collen MF, Hyner G. Methods of information in the age of prospective medicine. *Methods Inf Med* 2005; 44: 270-2.
  52. Aronson E, Patnoe S. *Jigsaw Classroom*. New York: Longman; 1997.

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