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Research and Education

Education in medical informatics on the basis of the information technology curriculum at the Veszprém University

Introduction

Historically, medical informatics developed as an application of information technology, and, as a matter of course, is based on it even today, but - with regard to its importance and growing size - it can be considered more and more as an independent field of informatics. We have seen this growing independence as it became accepted in developed countries with a strengthening of the literature and institutional background of the field. There is high demand for related educational activities with both health and technical emphases. There are numerous publications and projects such as the "concerted action" EU EDUCTRA (Education and Training in Health Informatics), which began in 1992 under the supervision of the AIM (Advanced Informatics in Medicine) program [1]. It may be said that the educational requirements and the essential thematic characteristics of a health informatics program have taken shape by today. Since medical informatics applications overlap with other disciplines such as economics, management and law it is also necessary to teach such relevant subjects. In Hungary, the demand for education in medical informatics arose from the computerization of the family doctor system years ago and was significantly accelerated by a World Bank program assisting hospital informatics. According to preliminary surveys, parallel to the modernization of public health, approximately 500 to 1000 health information technologists trained at the university level will be needed in the long run to meet the requirements of the 150 Hungarian hospitals, basic health care providers, the organizations operating, supervising and managing public health (OEP, ÁNTSZ, etc.), health research, and the institutions responsible for health care development and distribution. The above estimate includes the number of experts able to occupy application-oriented job positions, develop systems and elaborate on new methods. In practice we feel that the former should be trained in health sciences institutions of higher learning while the latter are best trained in technical universities. Obviously, it would be an advantage to coordinate the two paths of training. In the present paper we give a brief overview of the philosophy and practice of education based on the information technology curriculum at Veszprém University.

Background for medical informatics curricula at Veszprém University

Veszprém University, as the first in Hungary, started a graduate level health informatics module based on the Information Technology program. It was formed in 1991 under the direction of Professor Tamás Roska, a member of the Hungarian Academy of Sciences. Initially, the module included three and later four optional subjects, which were supplemented by medical topics in the courses of "Self-guided study", "Engineering project work" and "Self-guided laboratory" for advanced students [2]. After five years' experience with such a scheme, the Engineering Faculty at Veszprém University decided that education in medical informatics would be carried out within the Information Technology curriculum as a specialization starting from the academic year 1998/99. This specialization is supervised by the Department of Information Systems. Its aim is to train information technologists who are ready for engineering level research and development work for medical health applications. We also have a PhD

sub-program in this field, not detailed here, for those who want to develop advanced research and development experience.

The Information Technology program of Veszprém University runs on a credit system: 300 credits must be accumulated in the 9+1 semesters of training. 240 credits come from core professional subjects, 30 from subjects revolving around language, cultural and communication skills and 30 from a master thesis which is the first major independent engineering task. Taking into consideration only the narrower group of professional subjects, 62 % of the 240 credits come from the basic, introductory and core courses and professional subjects, 13 % from self-study in laboratory work and engineering project work, and approximately 25% from special (elective) subjects. For choosing material involving 60 credits (25%), a selection of 253 credits, totaling 79 subjects, was available in the academic year 1999/2000.

Embedding Medical Informatics in the Information Technology Curriculum

As we began developing the Medical Informatics Specialization which is embedded in the Information Technology program, the starting point was that the training must fit into the group of special (elective) subjects. According to our design, those students who besides their informatics engineer degree want to also get a certificate for their medical informatics specification, are required to take a group of seven obligatory subjects representing the core (beginning in the 5th semester). This core is worth 24 credits, while the subjects of the remaining 36 credits are optional, though as guidance we provide a few groups of subjects which are considered to be especially useful from the point of view of a medical informatics educational program [3]. For medical informatics students, just as before, further training options are available through subjects involving "Self-guided laboratory work", "Engineering project work" and "Self-guided study", which can be filled with content in compliance with the interests of the individual student. A maximum of 32 credits in total for these can be obtained, though 19 credits are more realistic. Based on all this, the structure of the topics taught is shown in Figure 1. The structure of one of the oldest European training programs, developed by the University of Heidelberg jointly with the School of Technology Heilbronn, is also shown in the figure. The similarity is conspicuous, the difference being a higher proportion of mathematical-physical subjects taught at Veszprém [1].

The core of medical informatics involves 7 subjects. They can be found on the first 7 lines of the training schedule shown in Table 1. The first subject of the group is "Physiology for engineers", which lays a foundation of medical interdisciplinary knowledge for the information technologists. It is essential to acquire this knowledge not only for the knowledge's sake but also to learn the special language of health care. "Medical measurement theory" systematically deals with the principles of medical measurements, starting from measuring simple biophysical signals to the underlying physical and mathematical background for modern imaging processes. The first semester of the subject "Health information systems" provides knowledge about the requirements for basic and specialized health care, starting from small units to hospital information systems. Teaching is based on the governing thought that the essential element of modern health care will become a standardized electronic patient record capturing the longitudinal history of a patient which will be in principle available to all authorized users from any location in the country. This electronic patient record can also provide basic data for modules serving the economic operation of the health care system [4]. In the first semester of the subject, the laboratory practice, with the help of special educational programs and based on the MATLAB system, teaches how to solve typical

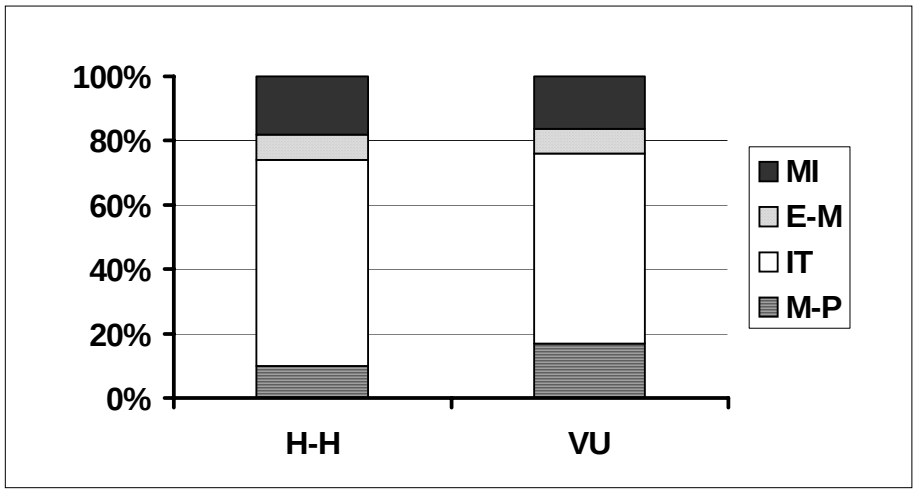

Figure 1. Normalized quantity of basic and specialized subjects taught at the University of Heidelberg and School of Technology Heilbronn (H-H) as well as at the Veszprém University (VE) in the framework of Medical Informatics [1]. (M-P: Mathematics-Physics, IT: Information Technology, E-M: Economy, Management, MI: Medical Informatics)

Table. 1. Compulsory subjects (1-7 lines) in the Medical Informatics specialization at Veszprém University, with examples of optional subjects recommended for the specialization.

Item	Subject	5. semester	6. semester	7. semester	8. semester	9. semester	credit
1.	Physiology for engineers	4+0					4
2.	Medical measurement theory		4+0				4
3.	Health information systems			2+2	0+2		2/4
4.	Statistical decision support				2+1		3
5.	Biological modeling					2+2	4
6.	The finance of health care		2+0				2
7.	Medical code systems			2+1			3
8.	Organizational theory				2+0		2
9.	Micro economics					2+0	2
10.	Image processing	4+0					4
11.	Cellular neural networks		2+0				2
12.	Computer graphics			2+1			3
13.	Use of colors in computer programs			2+0			2
14.	Multimedia systems				2+2		4
15.	Artificial intelligence				3+0		3
16.	Theory of databases				4+0		4
17.	Database applications					4+0	4
18.	Virus protection			2+2			4

medical signal and image evaluation problems. The second semester is exclusively practical work from topics of hospital information systems. It is taught in close co-operation with trainers from SMS Hungary Ltd. and using the CLINICOM systems installed by SMS Hungary Ltd. The next two subjects cover two broad groups of methods for the computer-based evaluation of clinical data, namely statistical analysis (statistical decision support) and modeling (biological modeling). When derived from the electronic patient record, computer-aided decision making could be a corner stone for health care in the future, and these two subjects provide an introduction to this. Subjects on "The finance of health care" and "Medical coding systems" deal with important operational questions of health care by teaching the essence of the financing systems and the coding processes used in health care. The remaining lines of Table 1 show examples of possible subject groups, in which economical, organizational subjects and widely needed subjects such as image evaluation, computer graphics, data bases, and artificial intelligence can be found. Recently, in accordance with the plans and possibilities of the host department, emphasis is placed on topics such as: foundations of communication, mobile communication, and internet applications. Growing interest in these directions is signaled by the number of master thesis topics developed in these areas recently.

Closing remarks

A basic view of the organizers of university education is that this education should provide important, hopefully longterm, valid knowledge and methods. Besides this, the level of demand for medical informatics experts must be given a thought at all times. An education that is over-specialized can risk restricting the jobs for which students are best suited. We do not believe that such a danger of over-specialization exists for those taking our program since the proposed approach to topics covers certain subjects in depth, but permits all aspects of information technology to be dealt with comprehensively for a specific health-related problem.

So hopefully, we have a program in which the methods and tools acquired by the student in the basic and special subjects become familiar and well-practiced, as a result of applying them with strong motivation to a realistically diverse set of problems and solutions in medical informatics.

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