Confronting the Problem of Ever Expanding Core Knowledge and the Necessity of Handling Over-Specialized Disciplines in Medical Education

M. Papaioakeim, E. Kaldoudi, V. Vargemezis, and K. Simopoulos

School of Medicine
Democritus University of Thrace
Alexandroupolis, Greece

full paper presentation in:

IEEE – ITAB 2006: The International Special Topic Conference
on Information Technology in Biomedicine
Ioannina, Greece, October 26-28, 2006

Confronting the Problem of Ever Expanding Core Knowledge and the Necessity of Handling Over-Specialized Disciplines in Medical Education

Miltiadis Papaioakeim, Eleni Kaldoudi, Vassilis Vargemezis, and Konstantinos Simopoulos

***Abstract*—The current enormous expansion in medical and biomedical knowledge constitutes a fundamental challenge in medical education. As the time frame of the medical curriculum cannot expand forever, some faculties have adopted the teaching of overspecialized educational modules as implemented by overspecialized educators. New educational approaches build on concepts of adult education, rely on situational learning and are active, self-directed, student-centered, and experiential educational programs. In order to support the emerging integrative curricula structures and accommodate the over-specialized knowledge available by different experts, information technology could be employed to develop virtual distributed pools of autonomous specialized educational modules and provide the mechanisms to create dynamically educational units by combining individual learning modules. Such a framework of a real-time information management, built on the needs of teachers, students and patients, offers the knowledge and skills necessary to practice medicine that is safe, effective, efficient and, most important, patient centered.**

The hardest conviction to get into the mind of a beginner is that the education upon which he is engaged in not a college course, not a medical course, but a life course, for which the work of a few years under teachers is but a preparation.

William Osler.

Manuscript received September 4, 2006. This work was supported in part under the grant: "Reforming Undergraduate Education in the School of Medicine, Democritus University of Thrace", which is funded by the Managing Authority of the Operational Programme for Education and Initial Vocational Training, a joined funding programme of the Greek Ministry of National Education and Religious Affairs and the European Community (European Social Fund and European Regional Development Fund) and under the grant "IntraMEDnet: A Mediterranean Research and Higher Education Intranet in Medical and Biological Sciences" which is funded by the EU Community Initiative Programme INTERREG III ARCHIMED, European Regional Development Fund.

M. Papaioakeim is Assistant Professor in the School of Medicine, Democritus University of Thrace, Alexandroupolis 68100, Greece (corresponding author, phone: +30 2551030447; e-mail: milpap@otenet.gr).

E. Kaldoudi is Assistant Professor in the School of Medicine, Democritus University of Thrace, Alexandroupolis 68100, Greece (phone: +30 2551030329; e-mail: kaldoudi@med.duth.gr).

V. Vargemezis is Professor in the School of Medicine, Democritus University of Thrace, Alexandroupolis 68100, Greece (tel. +30 2551030341; e-mail: vargem@hol.gr).

K. Simopoulos is Professor in the School of Medicine, Democritus University of Thrace, Alexandroupolis 68100, Greece (tel. +30 2551074001).

I. The Problem of Expanding Medical Knowledge

In addition to their unique mission of training the next generation of health care professionals, the seven medical schools in Greece and their closely affiliated hospitals and physician groups perform services that benefit all of society. As institutions, medical faculties conduct biomedical research to improve the quality and effectiveness of medical care and provide highly specialized health care services. Although these other missions of medical faculties sometimes receive more attention, none is more important to the future of the health care system than the education of physicians.

An enormous expansion in the knowledge relevant to medical practice constitutes a fundamental challenge to the educational mission of medical faculties restricted in the time framework of six years that has remained unchanged since their foundation. Yet the amount of knowledge that must be conveyed during that time has grown immensely.

The most commonly cited evidence of this development is the need to acquaint medical students with the genetic basis of health and disease, as revealed by the Human Genome Project and other research. Twenty years ago, medical school genetics consisted of understanding Mendel's simple rules for the inheritance of the dominant and recessive genes that were known at the time to be associated with a few rare diseases. Now, many more genes have been implicated in causing diseases, such as breast, colon, and ovarian cancers, juvenile diabetes, and certain types of chronic lung disease. In addition to understanding the structure of the human genome, aspiring physicians must master the processes that govern its expression, the ways in which those processes malfunction, and the chain of causation that leads to disease.

However, genomics is only one of several new domains of scientific knowledge that challenge the undergraduate education of physicians. The new field of proteomics covers the structure and function of proteins, particularly the ways in which proteins interact with one another in health and disease. Neuroscience is providing unparalleled new insights into the human mind and nervous system. Medicine's understanding of immunology and the inflammatory process is vastly greater than it was just a few decades ago. Epidemiology is providing understanding of the causes of disease long before underlying biochemical and genetic mechanisms are unearthed. The medical decision sciences

can help physicians make more appropriate and cost-effective use of new and existing medical treatments. Last but not least, information and telecommunications technologies are currently entering the arena to play a vital role in the overall management of disease, patient and knowledge. All these areas of fundamental new knowledge are vital to understanding new diagnostic and therapeutic agents and approaches in the 21st century.

As a matter of fact, the formal curricula of health professional schools are outdated almost as soon as students graduate. The traditional emphasis on teaching core knowledge focused largely on the basic mechanisms of disease and pathophysiological principles, with the expectation that students will memorize the hundreds of facts presented to them, is outdated in light of this ever expanding knowledge base. This traditional system places a premium on individual knowledge. The individual knowledge is memorized and is applied with an individual style, but apart from some acute problems where we can actually fix them, it does not work in a case where the rate of development of knowledge exceeds what we can learn and retain [1]. The traditional assumption that health professionals are able to diagnose and treat, evaluate new tests and procedures, and develop clinical practice guidelines, all using the training initially received from their academic education and ongoing practice experience is no longer valid as the complexity of modern medicine exceeds the inherent limitations of the unaided human mind.

As the time frame of the medical curriculum cannot expand forever trying to incorporate more and more of the core knowledge, some faculties have adopted the teaching of overspecialized educational modules easily implemented by clinically overspecialized medical staff. This provides to the faculty the fake idea of "modernized" education that can produce the feeling of self-satisfaction but only in the absence of quality assurance of the educational product as the problem remains exactly the same given the rapid expansion of knowledge even within specific areas. Furthermore, the expansion of overspecialized training promotes a monodisciplinary approach of the patient, far from the multidisciplinary real-life and the main educational objective on how to analyze, identify and solve the problems of patients.

II. Current Educational Approaches

The problem of the ever expanding knowledge, core and discipline as well, questions the educational approach where knowledge is seen as a quantity that can be transferred from one individual to another. Medical school students traditionally sat through hours of lectures on basic sciences and discussion took place in large groups, sometimes with the whole class present. Advances in our understanding of learning processes now suggest that such techniques may be suboptimal.

New approaches build on concepts of adult education. They rely on situational learning and are active, self-directed, student-centered, and experiential [2]. Learning is perceived as a qualitative change of one's conception of phenomena and ideas [3] and, consequently, knowledge must be actively processed by the student. A fundamental idea is that learning is organized in small student groups, i.e. tutorial groups, and not around lecture meetings. In the tutorial group students actively work with reality-based situations to formulate problems and learning needs that will guide their further studies. The teacher role is that of facilitating learning rather than transferring knowledge. In the tutorial group, the students discuss and defend their choices and standpoints. Using library resources, text books, databases, laboratory work, field studies, lectures and other forms of faculty resources, they are urged to find answers to and perspectives on their problems and learning needs. The aim is also to develop problem-processing skills, self-directed learning skills and group competence [4].

The expansion of clinical research in recent decades has made the physician's task of lifelong learning more exigent. Yet physicians in practice do not effectively keep up-to-date. They leave the majority of their clinical questions unanswered [5], often consult non-evidence-based sources of information, witness their grasp of current information deteriorate over the years following their training [6],[7], and demonstrate wide practice variations for clinical maneuvers with established efficacy [8]. And traditional didactic continuing medical education (CME) remains of limited utility as a remedy [9].

In response, professional organizations worldwide have called for increased emphasis on training in life-long self-directed learning. Medical educators have recognized its importance since the sweeping reforms of the late nineteenth century [10]. As laboratory experiments and systematic clinical observations came to replace inherited authoritarian "wisdom" as the foundation of medical knowledge, the reformers recognized that the knowledge and skills learned during medical school would not sustain a career in medicine. Trainees, they concluded, must also acquire the skills and inclination to keep abreast of medical information that would expand, evolve, and even replace itself. The emerging view is of learning as an active, constructive, social, and self-reflective process [11]. These basic research findings on learning suggest the need for educational environments that are learner-centered and knowledge-rich, guided by assessment, and situated in a community of learners [12].

In medical education, educational programs increasingly include case-based or problem-based learning and other small group instructional models, collaborative organizations to support student-faculty interactions, and technology-enhanced educational tools [13]. Furthermore, new integrative curricula structures are proliferating in the form of multidisciplinary block courses in the basic sciences, blended clerkships (combining two or more

specialties into one clinical experience), and integrated clinical experiences in multidisciplinary health care settings.

The USA Institute of Medicine identified "employ evidence-based practice" and "utilize informatics" among a set of 5 core competencies for all health professionals [14]. The American Boards of Internal Medicine (ABIM) and Medical Specialties, in their maintenance of certification, now place a premium on self-directed, practice-based learning. This new approach to medical education emerged after two major changes that have occurred in the processing of information in medicine in the past ten years: the widespread and easy availability of the medical research literature to both clinicians and their patients, and a push to move away from expert-led medicine to practice directed by patient-oriented, outcome-based research. This reorientation gave birth to the development of systems (e.g. learning portfolios) that could handle and provide useful real-time information. The usefulness of information could be defined as

$$\frac{\mathrm{Re}\,levance \times Validity}{Work}, \quad (1)$$

where *Relevance* of information is defined in terms of its direct applicability, *Validity* is the technical rigor that is the focus of Evidence Based Medicine and *Work* can be defined in terms of the time, money, or effort required in order to obtain an answer to a question [15].

III. Information Technology and Medical Education

Indeed, there is currently an international trend to involve computers and the Internet in medical curricula as well in continuing life-long medical learning. This practice is reinforced by active support and funding from bodies such as the European Union and local governments. Specifically, the European Council in its Lisbon meeting in March 2000 set forth the European policy for an information and knowledge-based society, stressing the need to encompass the emerging technological revolution and change in the exchange of knowledge affecting all institutions and various aspects of the society [16].

Like many other cognitive domains, medical education can be considered in terms of three levels of increasing complexity and importance [17]: information (i.e. simple facts), knowledge (i.e. information with a purpose), and understanding (i.e. conscious knowledge, achievement of explanation and grasp of reasonableness). Technology has been employed in diverse ways to support these different levels of the educational process.

Supporting the dissemination of medical information is the easiest and most straightforward achievement of information and communication technologies. They have extensively and successfully been used to give quick, easy and cheap access to information sources, such as books, textbooks, atlases, medical and biological databases, research journals etc. Current advances include the development of information processing and management tools that will help the reader and instructor with the overwhelming amount of information digitally available for network distribution. Additionally, new approaches involve tools and middleware solutions to bridge the networked healthcare domain with the classroom, i.e. to seamlessly integrate healthcare information systems with academic tools and processes, either computer-based (e.g. e-learning environments) or even traditional (e.g. the classroom or the patient's bed in a University Hospital) [18].

Structuring and organizing information with a particular educational purpose refers to knowledge. On the other hand, understanding implies experience as well as inquiring [19]. Managing and supporting these levels of the educational process is a rather complex issue. Technology can certainly help by providing digital teaching files for the student to practice, together with tools that support continuous self-evaluation and mediate teacher-learner exchange. Of major importance is the potential of hypertext technology to provide interconnected pieces information, and link questions with explanations within the wider scope of a particular medical task.

Information technology tools and environments have successfully been employed in supporting specific isolated aspects of medical education. However, their full potential remains to be exploited through technological solutions that will by and large confront the problem of ever-expanding knowledge in medical education.

In order to support the emerging integrative curricula structures and accommodate the over-specialized knowledge available by different experts, information technology can be employed to develop virtual distributed pools of autonomous specialized educational modules and provide the mechanisms to create dynamically educational units by combining individual educational modules.

Such an approach is currently exploited in the IntraMEDnet project (IntraMEDnet: A Mediterranean Research and Higher Education Intranet in Medical and Biological Sciences", funded by the EU Community Initiative Programme INTERREG III ARCHIMED, European Regional Development Fund, 2006-2007). Partners from 5 universities from 3 different European countries are setting out to develop a distributed pool of specialized educational modules in state-of-the-art scientific issues related to medicine and biological sciences. Over-specialized scientists from different institutions develop individually related educational modules which are then combined dynamically on a virtual e-classroom on the web in order to form integrated educational units. Each such complete educational unit can be shaped to support self-directed (or expert instructed) problem-based learning, enhancing patient-oriented approach to medical education. The project also considers the potential of this virtual collection of educational modules to grow into an integrated environment that will transfer the learning process from the

(e)class to the beside. Further feasibility studies address the possibility that educational program directors (or regulatory bodies) consider requiring documentation of a minimum number of self-directed learning episodes. The educational value of these could be enhanced if faculty could review a portion of these and provide formative feedback.

IV. Epilogue

The research indicates that students need just enough "external guidance" to motivate them to learn, developing over time a capacity for "internal guidance" [20]. It has been described that teachers should develop a "teaching-learning alliance" with students by being receptive, encouraging, and enthusiastic. Such teachers inspire students' self confidence and build a mutual sense of trust and respect. They help students access the workplace, interpret their experiences and feel part of the team. They help students become involved in practice, observe their performance, and give feedback. A cardinal feature of the learning environment is its social nature. Environment, process and product are interrelated. Medicine teacher should be able to create a good learning environment (e.g. by modeling excellent clinical practice), know the curriculum, be a supportive person, promote active participation, help students learn from experience (e.g. by giving constructive feedback) and be demanding (e.g. by asking questions about management and allocating realistic tasks). The clear need for already digested and preselected information to serve the needs of the future physician, changes the character of the educational outcome and competences will be restructured and made more relevant to practice as students progress through the curriculum [21]. To help students learn from brief every-day working place encounters, teachers must recognize and respond to “teachable moments”. A framework of a real-time information management, built on the needs of teachers, students and patients, offers the knowledge and skills necessary to practice medicine that is safe, effective, efficient and, most important, patient centered.

References

[1] P. Ramsden, *Learning to Teach in Higher Education*, London, UK: Routledge, 1992, pp. 152–156.

[2] National Research Council, *How People Learn*, Washington, D.C.: National Academy Press, 1999

[3] F. Marton, L.-O. Dahlgren, L. Svensson, and R. Saljo, *Inlarning och omvarldsuppfattning*, Stockholm, Sweden: Almqvist och Wiksell forlag AB., 1977.

[4] A. Fyrenious. “Lectures in problem-based learning—Why, when and how? An example of interactive lecturing that stimulates meaningful learning,” *Medical Teacher*, vol. 27, no. 1, pp. 61–65, 2005.

[5] P. N. Gorman, M. Helfand, “Information seeking in primary care: how physicians choose which clinical questions to pursue and which to leave unanswered,” *Med. Decis. Makin*, vol. 15, no. 2, pp. 113-119, 1995.

[6] P. G. Ramsey, J. D. Carline, T. S. Inui, E. B. Larson, J. P. LoGerfo, J. J. Norcini, and M. D. Wenrich, “Changes over time in the knowledge base of practicing internists,” *JAMA*, vol. 266, no. 8, pp. 1103-1107, 1991.

[7] Y. D. van Leeuwen, S.S. Mol, M.C. Pollemans, M.J. Drop, R. Grol, and C.P. van der Vleuten, “Change in knowledge of general practitioners during their professional careers,” *Fam. Pract.*, vol. 12, no. 3, pp. 313-317, 1995.

[8] E.A. McGlynn, S. M. Asch, J. Adams, J. Keesey, J. Hicks, A. DeCristofaro, and E. A. Kerr, “The quality of health care delivered to adults in the United States,” *N. Engl. J. Med*., vol. 348, no. 26, pp. 2635-2645, 2003.

[9] D. A. Davis, M. A. Thomson, A. D. Oxman, and R. B. Haynes, “Changing physician performance. A systematic review of the effect of continuing medical education strategies,” *JAMA*, vol. 274, no. 9, pp. 700-705, 1995.

[10] K. M. Ludmerer. *Time to Heal: American Medical Education from the Turn of the Century to the Era of Managed Care.* New York: Oxford University Press, 1999.

[11] D. Berliner, and R. Calfee eds., *Handbook of educational psychology*. New York: Macmillan, 1996.

[12] L. Schuable, and R. Glaser eds., *Innovations in Learning*, New Jersey: Mahwah, 1996.

[13] R. Jones, R. Higgs, C. de Angelis, and D. Prideaux, “Changing face of medical curricula,” *Lancet*, vol. 357, no. 9257, pp. 699-703, 2001.

[14] Institute of Medicine. Health Professions Education, *A Bridge to Quality*. Washington, DC: National Academies Press, 2003.

[15] D. C. Slawson, and A. F. Shaughnessy, “Teaching evidence-based medicine: should we be teaching information management instead?” *Acad. Med*., vol. 80, no. 7, pp. 685-9, 2005.

[16] European Council. *Employment, economic reforms and social cohesion - towards a Europe based on innovation and knowledge*. Document submitted to Lisbon European Council, official number 5256/00, Lisbon, March 24, 2000. Retrieved on September 3, 2006: http://ue.eu.int/ueDocs/cms_Data/docs/pressdata/en/misc/05256.en0.html

[17] T. H Davenport, and L. Prusak, *Working knowledge: how organizations manage what they know*. Boston, MA: Harvard Business School Press, 2000.

[18] E. Kaldoudi, V. Vargemezis, and K. Simopoulos, “*Information and communication technologies in medical undergraduate education,*” Journal for Quality of Life Research, vol. 2, no. 1, pp. 33-37, 2004.

[19] K. B. Williamson, Y. P. Kang, J. L. Steele, and R. B. Gunderman, “*The art of asking: teaching through questioning*,” Acad. Radiol., vol. 9, no. 2, pp. 1419–1422, 2002.

[20] C. van der Vleuten, “*Experience based learning: learning clinical medicine in workplaces*”, School of Health Professions Education, Maastricht, the Netherlands , 2006 (personal communication)

[21] ACGME, *Outcomes Project*, General competencies. Retrieved on August 26, 2006: http://www.acgme.org/Outcome/