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Synopsis

Computer-Supported Education

Introduction and framing

I am a medical Doctor, not a computer scientist. The reason, why I was asked to write this synopsis, I guess, is my long lasting interest in the application of information technology for medical education. This interest resulted in several learning programs – and even in a publication about the "Use of computers in medical education"[1] where I brought 16 authors, among them pioneers like Florian Eitel (President of the GMA: German Association for Medical Education), Joe Henderson (Director of the IML: Interactive Media Lab at Dartmouth College Medical School), Rolf Schulmeister (Director of the Interdisciplinary Center for Didactics at the University of Hamburg) and Vic Spitzer (Creator of the Visible Human Project, UCHSC in Denver, CO) together. Hence, in this synopsis I will try to synthesize what I learned during the last 9 years, and on the other hand emphasize on my background as a physician with an interest in philosophy and medical history – hopefully that this approach may expand the view of computer scientists, and so contributes to a more comprehensive understanding of this very interesting matter.

In ancient times, many believed that good health was a divine gift given by the gods: good people were rewarded with good health [2]. Back then it was obvious that spirituality and health care were hand in hand [3]. Nowadays masses are held in churches to pray for health, a proof that this correlation is still in place[4] - and there is good evidence that people who are religious cope better with serious illness than people who do not: a religious faith can be a very good medication in many cases [5]. This spiritual correlation needs to be considered as we now switch our focus from the "supernatural roots" of medicine to the role of Informatics for the quality of health care.

In Informatics, Computer scientists are in charge of the action.

And because computer scientists have to rely on quantitative facts, they are more likely to measure "objective" data than indefinable facts like "happiness" or "the ability to tell well ones story of life". This tendency to rely on "countable facts" is to a certain extend understandable because it is assumed to be "objective", however, it can lead to a very narrow view of the world if we exclude what is not easily measurable. A good example of this unhealthy balance is the "Guinness Book of Records" [6]. In the pages of this book, one can learn about the fastest ascent of to the top of Mount Everest or how Peter Dowdeswell consumed a pint of Guinness stout in 2.1 seconds [7] This book contains many other unnecessary and often very unhealthy achievements of mankind. And I am not afraid to admit that this quest for records did not stop in front of hospital doors…

When it then comes to the question, "how to measure," many computer scientists enter the field of demographic and epidemiological data [8], trying to analyze and to visualize this. Let me show this with an example from Edward Tufte's Book "Visual Explanations" [9]. The chapter entitled "Visual and Statistical Thinking" is based on analyses of the London cholera epidemic of 1854. While investigation the epidemic, John Snow M.D. began counting the number of deaths directly related to Cholera and plotting the location of outbreaks on a map of London. This process enabled him to pinpoint one of the major sources of causation of the disease: the handle of the Broad Street Pump. When the pump then was sealed, the epidemic was contained. This is an example of where the display of the data, not the data itself, resulted in some important conclusions. It is also an example, how the intelligent display of data can trigger understanding.

Education of Health Care Professionals

Modern Western Medicine is the product of several hundred years of experience and investigation, brought together by thousands of ingenious individuals. The field has grown far too complex to be understood by any single mind. Therefore, a modern medical curriculum does not attempt to teach all medicine, but rather a core of basic medical concept and skills [10,11,12]. This is often done in a "Problem Based Learning" setting which encourages students to first study a problem, then to define learning goals, collect relevant information – using the Internet and other sources – and to synthesize this into knowledge. This process usually takes place in a teamwork setting. The paradigm is about hunting gathering: if you provide a beggar with fish, he will have food for a day – if you teach him how to fish, he may won't starve any more. However, do not forget to teach how to figure out which fish are edible and which are not (more important if it were about mushrooms). In the case of the medical literature: it has to be carefully taught how to detect if such information is valid or not. To perform this task, we get help from Evidence Based Medicine (EBM):

"This paradigm shift [towards EBM] is manifested in a number of ways. There has been a profusion of articles instructing clinicians on how to access, evaluate, and interpret the medical literature. Proposals to apply the principles of clinical epidemiology to day-to-day clinical practice have been put forward. A number of major medical journals have adopted a more informative structured abstract format which incorporates issues of methods and design into the portion of an article the reader sees first." [13]

Learning how to use the Internet or medical library to find accurate primary medical literature is important. However, this procedure is often far too time consuming as if it could become the primary source of medical learning. There is simply too much valid information out there as if a student could condense this down to what is needed for the primary understanding of a matter. This is where I like to come up with the need for computer-supported education.

The role of computers in Medical Education

People often talk about computer-supported education as if it were a term describing a method and not a tool. They couldn't be more wrong. The fact, that a computer is used, does not offer any clue about what a program is like – and what it can be used for. But it implies the use of the computers capabilities, which are: display of audiovisual content including movies, providing feedback and allowing the fast access to information using the Internet. What is done with these premises is up to the creators of educational programs. And like the fact that only a few people know how to paint with artistry – nevertheless the fact that brushes, paint and paper are accessible to all of us – there are many programs out there, but only a few that are done with real artistry (which is one of these indefinable terms mentioned in the introduction to this synopsis).

Let me go on with a discussion of the most important models that came to my attention. I will exemplify each model with several award-winning programs:

Models for Problem Based Learning (PBL)

CASUS [14] / CAMPUS [15] / DxR [16]

When Howard S. Barrows noticed that "medical students and residents, for the most part, did not seem to think at all" [17], he introduced as a consequence the "Problem Based Learning" in order to "..allow all students to learn the way good students always learn." [18]

There are quite a few programs out there that are based on the principles of problem-based learning. Because of the assumption made by PBL that knowledge has to be worked out in an active process, some of these programs are not addressing an active thinking alone but allow even an active authoring of cases (CASUS, CAMPUS).

Though all of these programs apply Barrows PBL algorithms for clinical decision-making, they differ in some aspects:

CASUS allows the learner to draw the reasoning process as a semantic net – and then to compare this with the "ideal" one provided by a specialist.

CAMPUS shows always the users progress on a graphic representing the PBL algorithm.

DxR is to a high grade complete in simulating possible responses to the learner's actions and provide the learner as well with accurate feedback. This allows "explorative" learning to a certain extent, which makes it the link to the next topic.

Models for Case Based Learning (CBL)

LAENNEC [19] / NEUROLOGY INTERACTIVE [20] / HEADACHE INTERACTIVE [21]

Most of the PBL programs for clinical education are case based, but case based learning does not necessarily rely on PBL algorithms.

Case based learning is mainly build on the fact that the patient is the center of a physician's world. Many students like the feeling of being in the position of a physician and having the chance to interact meaningfully with a patient. When the cases are carefully done, they can become quite natural – and then the learner can enter a continuum where he/she is driven by feelings similar to those occurring in real encounters: empathy, care and responsibility – to name a few. In such a continuum, the primary information that the learner obtains consists of symptoms and signs presented by the simulated patient. The goal of the learner is then to understand the causes of an illness – and the specific situation of the individual patient. To achieve this, the programs allow the learner to perform virtual history taking (HEADACHE INTERACTIVE), virtual physical exams (LAENNEC, NEUROLOGY INTERACTIVE) and virtual further investigations.

Models to train specific skills

ECHO EXPLORER [22] / HEMOSURF [23] / HEART SOUNDS AND MURMURS [24]

The learning of medical skills plays an important rule in the formation of a physician. Some skills like the manual examination of an abdomen in surgery are not likely to be taught on a computer screen because it's about haptic, invisible and inaudible informations. But many skills base on audiovisual information – like the auscultation of heart sounds (cardiology) or the interpretation of skin lesions (dermatology) - and therefore can be demonstrated, explained and trained using computers capable of displaying multimedia contents. Besides, modern methods like MRT and Ultrasound result in a shift from "other" towards visual information when it comes to diagnostics.

ECHO EXPLORER enables the learner to understand in depth the ultrasonographic imaging of the heart using sophisticated interactive visualization and animation techniques.

HEMOSURF teaches how to interpret blood smears. This is mainly achieved with exposing the learner to a lot of pictures depicting hematological conditions - and make so "pattern recognition" happen.

HEART SOUND AND MURMURS explains the physiological origins of heart sounds and murmurs using audio, visualization and animation.

Complete models bringing together most of the above… adding even more to it

THE VIRTUAL PRACTICUM [25]

In the "Virtual Practicum" model, a mentor guides the student through a simulated clinic. There learning takes place in an idealized setting where carefully scripted simulated patients make learning by experience happen, case discussions explain about clinical decision making, lectures provide the theoretical background and interviews with "real patients" make the personal dimension of being affected with a condition understandable.

This is all done with intense use of high quality multimedia. In the simulated cases, actors behave as patients who act directly towards the learner. The stories they tell are very realistic and made to trigger the learner's interest for a medical condition. But the learner is not left as a passive listener - the simulated patients are demanding participation quite often by asking for clarification of medical terms and by demanding medical decisions concerning their case. That is where the learner experience how "swampy" clinical medicine is, because there is often more than one "solution" – and sometimes there is none at all.

Another very important element of the "Virtual Practicum" model is that the best specialists are asked to do case discussions on the simulated patients (expository learning). This creates an opportunity for providing the learner with priceless "pearls" of medical expertise.

Joe Henderson, the creator of the "Virtual Practicum" model, emphasizes on..

> "..the application of technology to promote more comprehensive clinical education in the biopsychosocial aspects of primary care. Comprehensive refers to the inclusion, in addition to scientific and technical knowledge, of knowledge that is less easily characterized, quantified, and taught: empathy, intuition, the demonstration of artistry." (Henderson 1997)

Papers presented in this section

"Do Computers Teach Better? A Media Comparison Study for Case-based Teaching in Radiology" compares the outcome of using problem-based teaching in radiology with and without computers and/or interactive elements. The models used are Problem Based and Case Based Learning.

"Enhancing Social Problem Solving in Children with Autism and Normal Children Through Computer-Assisted Instruction" shows how problem-solving skills in autistic children can be improved using computer-aided instruction. The model to train specific skills is used to achieve this goal.

"Design and Development of Computer-Aided Chemical Systems: Virtual Labs for Teaching Chemical Experiments in Undergraduate and Graduate Courses" presents a model for the construction of virtual experiments in chemistry.

“DiasNet – A Diabetes Advisory System for Communication and Education via the Internet” describes a method to use the Internet for patient empowerment in dealing with diabetes.

Closing remarks

I hope that you enjoyed reading this synopsis – and that it did contribute some aspects to a comprehensive understanding of the many faces of Computer Supported Education in Medicine.

Last but not least I would like to thank Raphael Bonvin MD (Université de Lausanne, Switzerland), Joe Henderson MD (IML Dartmouth Medical School, USA) and Bill Tishler BA (IML Dartmouth Medical School, USA) for their contributions to this synopsis.

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