

CAMPUS – A Flexible, Interactive System for Web-Based, Problem-Based Learning in Health Care

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Abstract

Care for patients is the best way to learn medicine and medical methods and skills. But the availability of real patients for learners is limited. Often the appropriate patient is missed or he can not be demonstrated to all students because of practical or ethical problems. A possible solution is the presentation of a clinical problem by a virtual patient using a simulative computer program. But such an approach means often a lot of work for the author of the case. We developed a flexible and realistic system, CAMPUS¹ (www.medicase.de), which supports the case authors with appropriate vocabularies and a comfortable authoring tool. There are different kinds of case presentations to the users in accordance to the level of professionalism of the user and the scenario the program is used in. An evaluation within an internship has shown, that such programs are judged as useful by medical students. But further studies are necessary to examine if the program will be used for the self-study and to develop further kinds of using scenarios within problem-based curricula.

Keywords:

Education, Problem-Based Learning, Computers, Computer-Assisted Instruction,

Introduction

Learning in the field of medicine and health care means for practitioners and nurses to become familiar with clinical cases and problems and for medical informatics and other supporting sciences to understand clinical strategies and methods. The best way to do this is to care with patients directly.

But the numbers and kinds of clinical cases learners are able to see are limited. During the short time of a term the patients with the diseases, which are relevant to the syllabus, are often not available. On the other hand it is not possible to expect to a patient to be examined by all of the students of a term or by non-medical learners, especially if the patient is a child or has a grave disease. Actors as standardized patients are a limited solution, cause most pathological results of examinations can not be simulated by them.

Physicians instead are interested in rare clinical problems often only seen and treated by experts.

Computer-based training programs (CBT), which are at the learners disposal independently from time and place, could be a solution for such problems. But the most CBT-programs, offered for the medical education, are based on a presentation concept. Data of a clinical problem are presented to the user in a linear way. Interactivity is limited to answering some questions by selecting from a default multiple-choice list. Such a concept is suitable to users with a higher level of professionalism, but not to a beginner, who want to learn a strategy to cope with real clinical problems. On the other hand simulations of patients by a computer program are often limited on a certain medical field. But for an acceptance of computer simulated patients by authors and users, the software has to be highly flexible and realistic. Flexibility means, that cases of different medical fields can be demonstrated by the same system in different manner in accordance with the different users demands. Reality means, that the examinations and mistakes a physician is able to do in practice even could be done by the user of the software.

So we developed CAMPUS as a flexible, realistic simulative computer program and used it in different settings of a problem-based medical curriculum.

Materials and Methods

CAMPUS

CAMPUS is a problem-based computer program, which demonstrates a clinical case by simulating a virtual patient (Figure 2). The user cares for the patient from anamnesis over different examinations until final diagnosis and therapy. The program provides two user interfaces for this so far, one with highly interactive capabilities, the "CAMPUS Player", and one with a more restricted case flow, the "CAMPUS Light Player".

System Modeling and Architecture

The architecture of CAMPUS is based on the separation of data and presentation layer as the most important prerequisite for a flexible simulative CBT-System. A computer case is always only a model of a real clinical case. An authoring tool provides templates for case authors to analyze real cases in accordance with the case flow implemented in CAMPUS. The case flow and

1. CAMPUS: Case-Based Training in Medicine as part of a Problem-oriented Educational Strategy

data model fixes which data represent the real clinical problem in the computer system. Data model and case flow of CAMPUS are oriented towards the clinical work flow. It starts with the basics, taking the medical history and the clinical examination. Basing on this there are first possible diagnoses. Results of further examinations speak in favor or against the diagnoses. The new information influence the hypotheses of the user. The user orders therapy, he gets a feedback about the progress of the case and so a new Diagnostic-Therapy-Loop starts (Figure 1). The data and case flow model, developed with clinical partners, is so realistic, that a case could be generated from an patient record in principle. The data of a case are stored in a database or, if the database is not available, as a XML-file. Thereby the XML-file can be used to exchange cases between different computers. The database and the XML-files are the data layer of CAMPUS representing the facts of a real clinical problem in details. The data can be used for any kind of demonstration, by the presentation layer, whereby the presentation layer is able to use the data local or online via network.

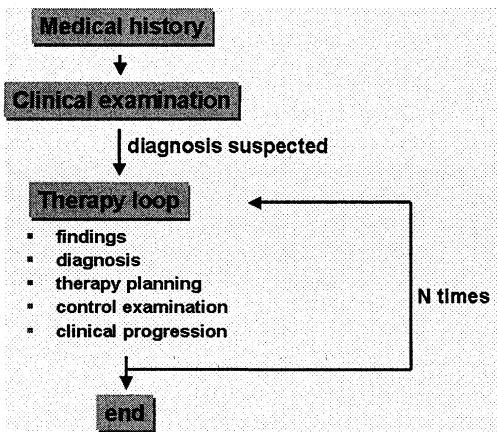


Figure 1 - The Diagnostic-Therapy-Loop as a Case and Data Model

The core implementation of CAMPUS consists of the authoring tool and a highly interactive user front-end, the "CAMPUS Player". This modules are programmed with over 100 KLOC in Java™.

The CAMPUS Player

The interactive CAMPUS Player enables the user to handle a clinical case in details close to reality.

Taking medical history doesn't mean just select some points from a default multiple choice list (Figure 3). The user has to think about his next question. He asks the virtual patient by typing in a keyword, the patient answers the question and so the user gets further information. He has the possibility to adapt his further questions according to this information. So the user exercises himself in taking medical history and developing a reasonable strategy of anamnesis.

For taking medical history CAMPUS provides an anamnesis-vocabulary for five different age-groups, for male and female and for foreign- and self-anamnesis. The vocabulary has been devel-

oped with clinical experts and is extendable and adaptable for all medical fields.

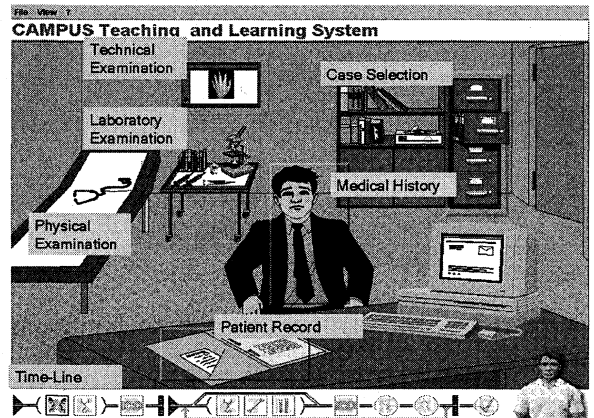


Figure 2 - CAMPUS demonstrates a clinical problem by simulating a virtual patient

All possible questions are stored in a database with suitable normal answers. So the case author has only to define the answers to the questions which differ from normality. The vocabulary makes the input of anamnesis very comfortable for the case author. For the user the vocabulary with predefined normal answers makes it possible to ask any questions he wants to ask, even if the questions are senseless and so not intended by the author

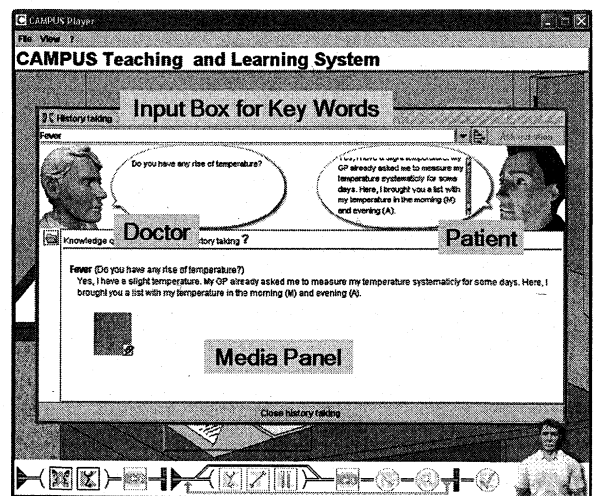


Figure 3 - Taking the Medical History

For the physical examination the patient is demonstrated by showing the surface of the body (Figure 4). The user makes an examination by clicking on an appropriate icon representing inspection, palpation, auscultation, percussion and so on. He gets the results of the examination by selecting a region of interest on the body.

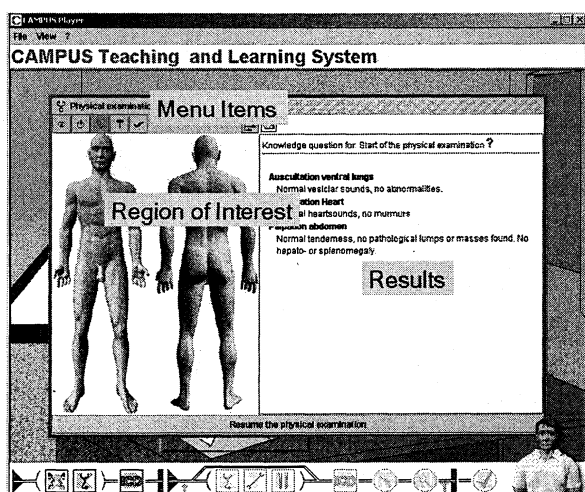


Figure 4 - Physical examination

After taking medical history and making physical examination the user has to think about possible diagnoses. He selects appropriate diagnoses from the ICD-10-catalogue.

After that the student gets a feedback. Thereby the system behaves like a “neutral teacher”. This means, that the program doesn’t comment on the input of the user directly, but compares the examinations made by the user to the examinations intended by the author for the case and shows the results of the comparison.

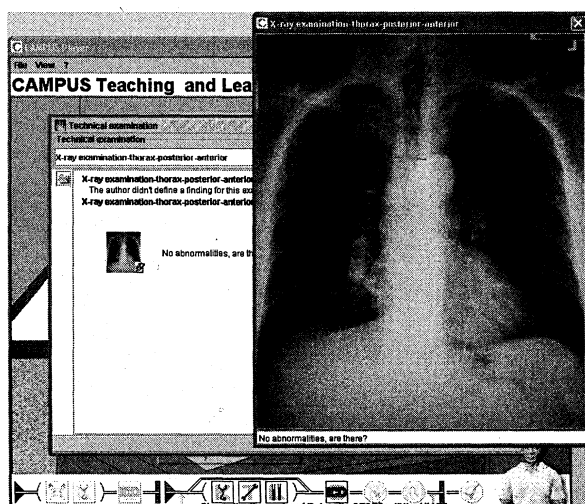


Figure 5 - Technical Examination

Laboratory is ordered by fill in different forms. Technical examinations are carried out by typing in appropriate keywords (Figure 5). So, while information are given by the system only on demand, the user is called upon first to order simple examina-

tions and then, basing on the results, further, more complex parameters. All examinations and their results may be visualized by using multi-media elements, such as pictures, video and audio sequences.

Physical examinations, laboratory and technical examinations provide information about the clinical condition of the patient. The user is able to change his diagnoses and to carry out a therapy taking this information into account.

Vocabularies for clinical examinations, laboratories, technical examinations and therapies are essential components of CAMPUS as a simulative System. They are updated regularly in accordance with the requests of the clinical authors.

The integration of knowledge in computer-based medical teaching cases is a key aspect of CAMPUS, while systematic knowledge is the basis to work through a clinical problem successfully. CAMPUS offers the user additional information on demand. The integration of knowledge is possible on different levels.

The case author is enabled to add comments to each single step of the case. Such comments can consist of definitions, interpretations, explanations or hints.

The second level of knowledge integration is to link to external knowledge sources such as web-sites, integrated articles or different kinds of documents

Finally, CAMPUS gives the possibility to the user to integrate knowledge on demand by himself, by searching in appropriate databases by selecting on a key word in the virtual patient record and using the integrated search dialog (Figure 6).

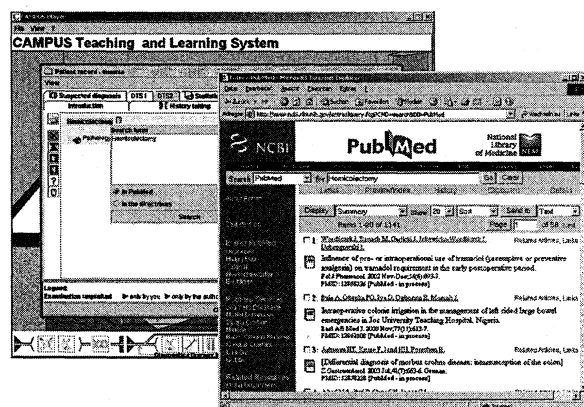


Figure 6 - Additional Information by searching in external databases

The “Light Player”

While the domain of the classical CAMPUS-Player is to demonstrate a clinical problem to a beginner in medicine, mainly to students, the “Light Player” can be used for a more restricted and less time-consuming case demonstration to advancers, which have already the basic skills to examine a patient effectively but are interested on clinical cases in a less interactive way.

The “Light Player” based upon a multiple choice concept. The data of the case are demonstrated by a sequence of questions and

answers, using multiple choices and short answer questions. Between this sections with questions, further information are present. So a clinical case presented with the "Light Player" is a sequence of cards with information and questions. The "Light Case" is thereby generated by the system automatically from the data of a classical CAMPUS case and is shown by an arbitrary HTML-browser. Even the multi-media elements of the CAMPUS-case are used by the "Light Player".

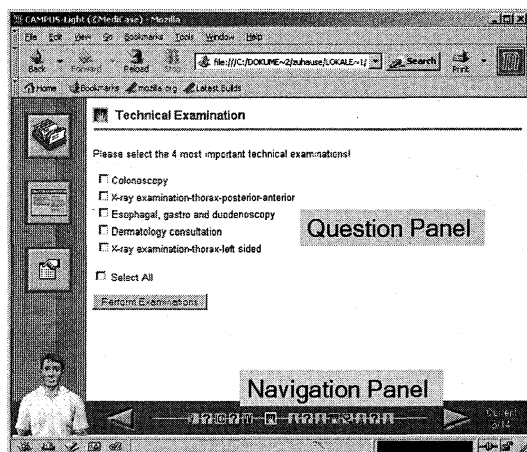


Figure 7 - "CAMPUS Light Player"

CAMPUS Authoring Tool

CAMPUS is a learning tool for different medical fields. A convenient authoring tool assists the case author to import the data of a clinical case in the system. The authoring tool enables to store the data of a real clinical case in details, which is necessary for a simulative demonstration of the case. CAMPUS makes the author's work easier by providing defined vocabularies for taking medical history, physical examination, laboratory, technical examinations and therapy. So the author has only to define pathological results. The user interface of the authoring tool consists of a well structured set of templates representing the case model in CAMPUS. Those templates make it much easier to adapt a real case to a data model of a computer system. The authoring tool separates the data layer of the clinical case from the presentation layer; which raises the benefit of the author's work. Once the data of a case are stored, they can be used in different scenarios. A case in CAMPUS can be worked highly interactive using the classical Player, or less time-consuming using the "Light Player". But there are a lot of other presentations imaginable, for example generating a paper case for a problem based tutorial. This flexibility is the advantage of a simulative system like CAMPUS.

Results

Integration into the medical apprenticeship

We are using CAMPUS in different courses in the problem based curriculum of the university of Heidelberg, to demonstrate clinical problems to the medical students.

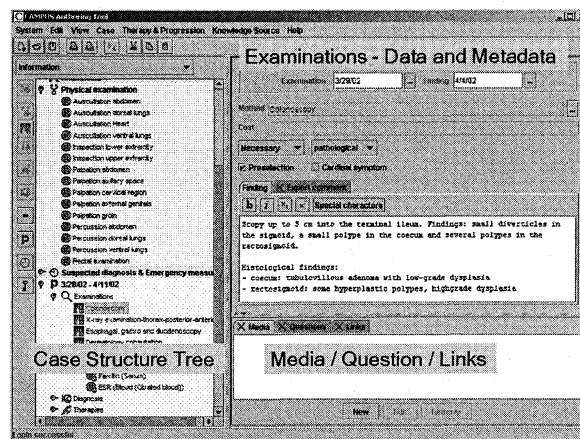


Figure 8 - CAMPUS Authoring Tool

As a part of the pediatric internship the students have to deal with two cases in a group of two members during two one and a half hour sessions. The students are assisted by a tutor. After a case is completed the members of all groups discuss the case with the tutor to clarify problems.

A connection of self-study and face-to-face lecture is implemented in the course of clinical hygiene. The students receive a CD-ROM with the CAMPUS-Player and one case. They have two weeks to deal with the case at home. Afterwards the case is discussed in a session with a tutor.

Students doing their course in internal medicine take part in computer assisted problem based small group learning. CAMPUS is used to present a clinical problem instead using a paper case.

Table 1: Results of evaluation within the pediatric internship

Not at all	I agree			Totally
	Little	Much		
Learning with CAMPUS is enjoyable				
3	37	126		50
Learning with CAMPUS is effective				
2	52	131		26
Learning with CAMPUS motivates for further learning				
5	48	116		44
I would like use CAMPUS more often for my studies				
8	51	90		61

Evaluation

The program was evaluated within the pediatric internship during two terms. 218 medical students were asked for their opinion about the program (Tables 1).

81 % of the students enjoy learning with CAMPUS and 74 % say, that CAMPUS enables an effective learning. 75 % are motivated for further learning by using CAMPUS in the internship and 72 % would like to use CAMPUS more often.

Discussion

It is very difficult to simulate a real clinical problem using the computer for learners in medicine and in health care. A beginner in medicine has to learn strategies to get the information which is necessary to solve a clinical problem. Such skills can not be learned by selecting some points from a default multiple choice list. As in reality the user should have the possibility to do all the things with the virtual patient, he could do in practice. So appropriate vocabularies are necessary to enable this. Vocabularies are the core components of CAMPUS. The authoring tool provides the vocabularies to the authors for comfortable case developing. The player provides the vocabularies to the learner as a part of the user interface. The vocabularies in CAMPUS are easy to adapt to requests of the authors. On the other hand in CAMPUS the vocabularies are used to describe a real case in detail. Describing a clinical case in such way is very time consuming for the author. But once the data of a case are stored in the database they can be presented in any thinkable ways. Beginners can work through a case in details using the CAMPUS Player, professionals can use the "Light Player" which present the case with fewer interactivity and less time consuming. Another possibility is to generate a paper case from the CAMPUS case for problem-based tutorials. So the advantage of flexible simulative systems like CAMPUS in contrast to presentation systems is, that if the data of the case is once defined they could be use in many scenarios.

The evaluation of the program within a pediatric internship has shown, that for the majority of medical students a simulative system like CAMPUS makes sense. But it has to take into account, that tutors cared for the students during the course. So the evaluation can not give evidence for the use in self-study. Dealing with a clinical problem in self study takes time and is laborious, even with a simulative system like CAMPUS. So further examinations are necessary to see whether CAMPUS is a useful tool, which connects present courses and self-study at home.

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