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WASP -a generic web-based, interactive, patient simulation system

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Abstract

Computer based patient case simulation systems have during the recent years been introduced in medical education to allow students to "meet" more cases that are educationally optimized and adapted to the actual learning situation. However, three major problems exist with most computer based case simulation systems today: They are expensive to develop, experienced multimedia developers are needed for the development and teachers/clinicians can not develop and adjust cases to fit their own specific educational needs

The WASP project (Web-Activated Simulation of Patients) tries to solve these three problems, and still allow very realistic and highly-interactive simulations of clinical cases, delivered and edited via the Web. WASP is based on experience from a number of national and international visualization and simulation projects.

Most important case simulation features are available, including:
- interactive history taking , complete physical examination (inspection, auscultation, palpation, percussion, vitals, neurological exams etc.), complete lab section including chemical labs, X-ray, MRI, ultrasound, CT, phys lab, pharmacology lab, pathology lab etc.), diagnosis and differentials, therapy , interactive session feedback and integrated references and online database sources

More info available at: http://wasp.lime.ki.se and http://patientcases.org

Keywords:

Medical informatics; Simulation; Virtual patients; computer-simulated cases; case-based learning

Introduction

In all healthcare areas, the encounter between the patient and the professional is crucial. This is most often trained by means of students meeting real patients in the university hospitals. Due to several reasons, this has been more and more complicated to accomplish during the recent years. Most important of these is the severe lack of "good educational cases" at the university clinics because of the fact that nowadays, most "normal" patient cases are handled outside the university clinics. Another reason is the shortened clinical periods available at each department due to the pressure to put in new subject areas into the curriculum. A third reason is that, due to ethical considerations, some patients are not suitable for students. This means that the students at most programs in the health care sector (including but not limiting to medicine, dentistry, physiotherapy and nursing) are meeting less and less real patients. When they finally meets these patients, other factors including economy and experience, limits the learning outcome of encounters available.

These and other problems, have led to the search for new case-based learning methods, including standardized patients (real human actors) and computer-simulated cases (CSC). These methods have been proven to yield improved educational conditions for learning

based on patient cases. The possibility to repeat any interaction with the case, perform lab tests without limitations and cases optimized for learning have also been found positive in using CSC. In two recent enquiries at two Swedish universities, the overall student ranking of the usefulness of a CSC system was around 5-6 on a 7-degree scale. However, both actors and CSC have the general problem of very high costs for development and/or administration. Live actors also have other limitations such as special facilities, lack of trained actors etc. This leaves the CSC way as one interesting way to go for, if the current problems with high development costs, need of special multimedia developers to build the cases and the limitation of not allowing the teachers to set up the cases by themselves, could be solved.

Already in the 1970:s computer based case simulation systems were introduced at KI and elsewhere [1-3]. One of these projects was a collaboration between KI and US researchers dealing with communication in "natural language" (free text input) [4]. However, the development of these systems was very complicated and needed special programming knowledge and was also associated with limitation in interactivity and realism. Starting with the introduction of multimedia development tools in the 1980:s, new possibilities arrived [5-7]. However most of the systems developed during the 1980: s and 1990:s are directed towards less interactive and pedagogically limited skill-training systems. Many of these are also dealing with a very narrow scope like intensive care, endoscopic procedures and limit a wider use [8-11]. Also Internet based systems have been developed, but also with a limited realism and educational use [12]. Recently, an interesting simulation system using so called avatars have been published, where the use of completely virtual (animated) methods for the training of patient history taking is suggested [13]. However, this technique is not tested in real student courses.

Since 1990 the R & D group in e-Learning and simulation has developed and implemented more than 15 different case simulation systems in the education at Karolinska Institutet (KI). We have also collaborated and performed implementation studies together with a number of other universities including Linköping University, Umeå University and Uppsala University in Sweden and with Stanford School of Medicine. The most advanced of these systems is the so-called ISP system, which has been one of our main research and development projects between 1990 and 2002. In the ISP project we have developed and tested more than 15 different cases in the fields of infectious diseases, internal medicine, surgery, ear-nose-and throat diseases and dentistry. However, three major problems exist with most computer based case simulation systems today: They are expensive to develop, experienced multimedia developers are needed for the development and teachers/clinicians can not develop and adjust cases to fit their own specific educational needs.

The aim of the WASP project (Web-Activated Simulation of Patients) is to try to solve these three problems and still allow for highly interactive and realistic case simulations, presented and edited via the Web. The aim was also to develop such a flexible system that would allow it to be used in any health care sector program or course, where the teachers would like to use patient cases.

Methods

The WASP project is based on experience from a number of national and international visualization and simulation projects out of which a few are mentioned above. Especially the ISP project has showed that CSC systems might be a good way to present interactive and realistic cases for students. Evaluations of both old and recent tests have showed that

students like learning systems like ISP and that both students and teachers prefer CSC systems like ISP in comparison with traditional paper based case presentation methods.

The design and creation of WASP included several steps:
- Study of relevant literature and other information sources
- Studying other case simulation methods available at KI and other places
- A teacher group was formed to create the requirements of a new generic web-based system for simulation of cases
- We developed a design for the new web-based system (WASP)
- A development team was formed to make the system development tasks possible
- The team of teachers will also design and overview the implementation of WASP in pilot courses to study both pedagogical and technological aspects of the case simulations. Together with a study of the possibility of teachers creating cases

The development team behind WASP consists of graphical designers, educational experts, Web-developers, system architects and JAVA/JSP programmers. After determining specific system requirements and specifications together with the teacher group, a system architecture was created (see http://wasp.lime.ki.se/system_arch.htm).

Results

Using the system specifications and the preliminary architecture above, a Web based pilot system was developed using standard tools like SQL databases, JAVA/JSP programs/scripts and HTML front-end driven by Servlets. The developed system provide the users with a completely web-based simulation of a patient encounter, including clinical history taking via video and/or stills + texts, physical examinations (inspection, palpation, auscultation, percussion, neurological exams, ear-nose-throat exams, dental exams etc), laboratory tests (X-ray, MRI, CT, blood samples, ECG, biopsies, endoscopic exams, microbiology etc.). The system allows the users to suggest diagnosis, differential diagnoses, and treatment suggestions and give a detailed feedback on all items. The teachers have access to a detailed interaction log, for de-briefing and other discussions with the students. Literature references, on-line databases are integrated into the WASP system. All functions are freely chosen by the user and are available at any time, except the detailed feedback, which only is displayed when the user has submitted a diagnosis and therapy proposal.

To develop cases, the teacher will by means of a web-based case construction interface start with choosing from a female or a male patient, and then change the data needed to build a case. This is very straightforward and simple since all normal data (like history answers, clinical images, X-rays, lab values) are already available. The only thing needed is to for example exchange a normal x-ray with a pathological one through the Web-interface.
The layout of the patient history function is displayed in Figure1. The user can interact with the simulated patient using preformed questions divided into the following categories: present illness, past history, family/social history, review of systems, medications, allergy and misc. A list of the questions asked can be reviewed at all time by clicking on the "questions asked" button.

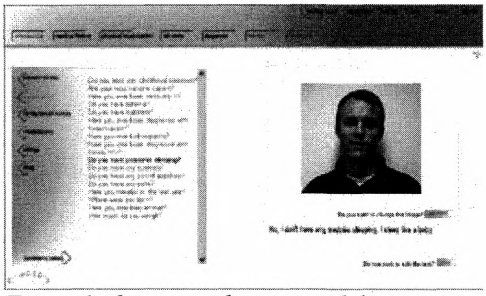

Figure 1: the patient history module

The physical examination is steered by the user selecting first what type of examination wanted (inspection, palpation, auscultation, temperature, pulse/blood pressure or reflexes), then selecting which body part to apply the exam on. The examination technique or body part can be changed at any time. All examination results are given in a realistic manner. For example, all heart and respiratory sounds are recorded from real patients. This part is very detailed and contains several hundred responses. In Figure 2 is a typical examination procedure showed.

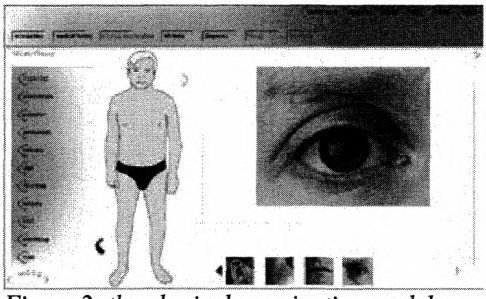

Figure 2: the physical examination module

Laboratory tests are chosen by the user from a lab menu, displayed in Figure 3. Ten groups of laboratory tests are available, covering more than a thousand different tests and including chemical, pharmacological, X-ray and other imaging labs, microbiology, immunology and endoscopy tests and more.

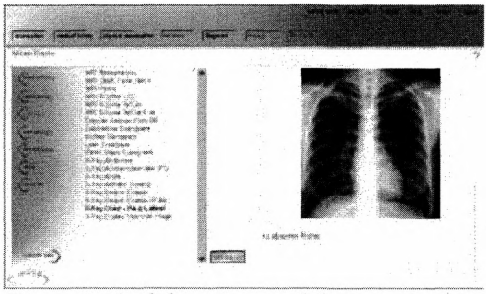

Figure 3: the laboratory module

When the user is ready to submit a proposal of diagnosis, the proposal is entered in free text in the interactive diagnosis proposal function. If correct, or within acceptable limits, a short description of the actual case is given, with medical background and discussion of

differential diagnostic procedures. The user is also asked to motivate their preliminary and differential diagnosis. The feedback provided by WASP is extensive with the possibility to contact the case author and also get a copy of the case by email. Here can the student's compare their suggestions with the diagnosis recommended by the case author (Figure 4).

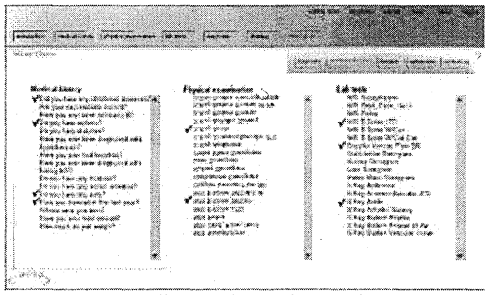

Figure 4: Feedback about the performed exams

A built-in authoring tool enables any teacher (with a minimal computer skill) to create and edit his/her own cases. The case creation interface is a straightforward interactive web-based system based on a "normal" patient case, where the case author only needs to change the pathological data. Normally less then 5% of the data needs to be adjusted to create a new case. For an overview of the authoring interface, please visit http://wasp.lime.ki.se

Discussion & conclusion

A number of case simulation systems have developed over the years to solve the problem of limited access to optimal patient cases for learning. This lack is due to i.e. a decreased number of not-to-complicated patient cases at the university hospitals, ethical considerations and limitations in time and money. Most of the case systems available are restricted in freedom of use and seldom allow a totally free interaction, especially in the case of interactive illness history. Moreover, they rarely provide the user with most physical examination procedures and laboratory tests available in a hospital of today, limiting the applicability in a real-life-like clinical student activating learning setting [8,12,14,15]. The WASP system has been developed with the focus on a more free and interactive system, allowing most procedures and interactions available in a real patient case to be performed by the user. WASP will be implemented into the programs of Medicine, IT-medicine and Dentistry at KI. Within medicine, we will use the infectious diseases course, which is pointed out as interesting because of the actual problem of finding relevant educational cases and the experience of previous CSC projects among the teachers. This is a short clinical course focusing on common infections that every active physician needs to be familiar with. A special difficulty with this type of clinical education is that some diseases are becoming very infrequent, which makes CSC a good addition.

The IT-Medicine program is chosen for two reasons. The first is the need for presenting good cases for students that are going to have a very limited clinical time, but still need to understand the complexity of the clinical patient encounter. Secondly, these students are very interested in IT and IT-tools, enabling us to have a great student impact in all stages of the project. In dentistry, a very experienced clinical teacher (but with limited IT-experience) will carry out the course and create the cases. This area is chosen because we want to evaluate the case creation potential amongst different clinical teachers with different levels of IT-experience. WASP will also be implemented at Uppsala and Linköping universities, where interested teachers and evaluators are contacted.

We will focus the evaluation on a number of specific areas, but still allow an overall and general outcome report. The evaluation will be integrated in all steps of the project and carried out by the teachers, the students and the evaluation experts at our department.
Especially, we will focus on these areas: Learning outcomes in comparison to the conventional situation, the ability of the teachers to create cases with ease, the ability of the WASP system to fit into different subject and program areas (medicine, dentistry and other), evaluation of the technical solutions used, the student's opinions and comments.

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