A Teaching case system with a multiple viewpoint mechanism for medical education

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Abstract

In medical education, the basic science curricula are coordinated in the teaching schedule or text books, usually in organ system units. Their integration occurs in the schedule or books, not in the minds of the students. Knowledge from each basic science discipline is presented in terms of organ functionalities not in the context of patient's problems and laboratory data. Each domain expert in each department teaches the clinical knowledge and experiences from his own perspectives using his own teaching cases that were prepared in isolation by each individual. As a result, the students may experience many different teaching cases from many different clinical disciplines. All the teaching cases are isolated instances and do not have any association with each other. As a result, it is difficult for the students to relate the association with each other and fully understand the overall picture of the integrated view of the clinical knowledge within different disciplines in clinical practice. In this paper, we study how a PBL teaching case should be presented to the users in such a way that is most integrated, effective, and efficient for the users to learn about the overall viewpoints and knowledge of the patient care problems. We implement a prototype system called "HINTS" that is based on a computerized PBL system and provides many clinical teaching cases with a more integrated view in the context of the clinical cases that the students will face in the future medical practice. The system has been installed in the medical center of the National Cheng Kung University for the trials. The comments from students are in the results.

Keywords: medical education, e-learning, integrated teaching case

1. Introduction

In medical education[12], the basic science curricula are coordinated in the teaching schedule or text books, usually in organ system units. Their integration occurs in the schedule or books, not in the minds of the students. Knowledge from each basic science discipline is presented in terms of organ functionalities not in the context of patient's problems and laboratory data. Furthermore, as far as clinical practice is concerned, students in medical schools learn the clinical knowledge by going through each clinical department in a medical center for the clinical practice training during their internship.

Each domain expert in each department teaches the clinical knowledge and experiences from his own perspectives using his own teaching cases that were prepared in isolation by each individual. As a result, the students may experience many different teaching cases from many different clinical disciplines. All the teaching cases are isolated instances and do not have any association with each other. As a result, it is difficult for the students to relate the association with each other and fully understand the overall picture of the integrated view of the clinical knowledge within different disciplines in clinical practice.

In this paper, we study how a PBL[6][10] teaching case should be presented to the users in such a way that is most integrated, effective, and efficient for the users to learn about the overall viewpoints and knowledge of the patient care problems. We implement a prototype system called "HINTS"[1] (Health Information Network Teaching- case System) that is based on a computerized PBL system and provides many clinical teaching cases with a more integrated view in the context of the clinical cases that the students will face in the future medical practice[3][12][14][15]. The basic idea is to use the same clinical case as the subject matter and have the experts in different clinical disciplines to edit the teaching material for the subject so that the users can learn more integrated knowledge from different perspectives in the context of the same clinical case. In the section 2, we discuss the background and problems about the current most prevailing method used by most medical centers (ex. Medical Center of the National Cheng Kung University), commercially available PBL computerized systems, or many web sites on the Internet[2][4][5][11][13][15]. We also analyze how medical teaching cases should be presented to the learners in a more integrated fashion so that the learners can get the overall pictures of the teaching cases. The concepts of a teaching case template and different operation modes of a teaching case used by our prototype system as part of the implementation mechanisms are also briefly described [1]. In section 3, we discuss the workflow of the system from both an author's and a user's perspectives and implementation of the system from an engineering perspective. In the section 4, we present the results of the users' and the authors' experiences and experiments with our prototype system. Section 5 draws the conclusions of our system and experiments.

2. background

(a) Case templates

In order to explain how our prototype system is implemented, we first introduce the PBL teaching case template concept we use in our system. Our PBL teaching case system is essentially a multimedia CAI (Computer Aided Instruction) system[1]. Generally speaking, a CAI system is composed of three major models: a knowledge model, a student model, and a tutor model [7][8]. We further describe the details of these models here.

(a) Knowledge model.

This is a database which contains the knowledge of specific topics which an expert in that particular domain would reasonably be expected to possess.

(b)Student model.

This model provides a mechanism for assessing the state of the student's current knowledge of the information held within the knowledge base.

(c)Tutor model.

This model mimics a human tutor, and is responsible for managing the overall learning environment.

For the purpose of this paper, we further explain the knowledge model in our system. Ideally, the knowledge model within a CAI system should represent the knowledge which is to be taught in an abstract fashion in order that it is capable of dealing with different learning situations intelligently. In our system the knowledge model contains data relating to the many different clinical cases which are to be taught. Due to the volume and variety of the cases involved, it is difficult to draw simple inferences or specific knowledge-based conclusions out of the teaching cases. For these reasons, it is virtually impossible to use abstract principles or rules to represent all the domain knowledge within the knowledge model. However, since many teaching cases in the system will share similar scenarios, it is possible to use a number of "case templates" [1] to form an abstract model of the domain knowledge. In other words, the templates outline the main contents of the teaching cases, and serve as the directories of each case. Consider a template for a typical medical teaching case. It might well include the following sections: (1) basic personal information such as age and gender. (2) brief case history (3) reported complaints (4) physical examinations (5) findings (6) diagnosis (7) relevant associated cases (8) discussions, (9) comments, and (10) learning points. A single case template may be used by many teaching cases if they are all of the same type. All sections of the template can be presented via hypermedia techniques. The authors of the system are given the ability to create a case template database in which each template has a defined name and an appropriate set of titled sections, e.g. history, diagnosis, etc. Each section can be further partitioned into several sub-sections. Each teaching case within the system identifies the case template which it uses. In other words, the knowledge model is structured in both a macroscopic fashion, i.e., the case templates, and a microscopic fashion, i.e., all the teaching cases. With the concept of the teaching case template in our system, the authors have to set up a teaching case template or select an existing one in an internal template database before they can enter the contents of a teaching case.

(b) Document-view

Each department in a hospital has its own clinical data representation semantics for its teaching cases and can edit its own templates for the teaching cases suitable for the teaching material of the department. For instance, for the radiology department, the system has to present the MRI, CT, or X-ray images[9], the basic patient information, such as age and sex, and the patient's chief complaints to the user. The sound of the patient's heart beats may not be important from the radiologist point of view. However, for the internal medicine department, other than the user the patient's basic information and the patient's chief complaints, the user may want to hear the heart beats. On the other hand, if a case has a CT examination, the physician may want simply just to read the report done by the radiologist or some key images critical to his diagnoses while the users in the department of radiology may want to see the detailed analysis of the CT images. In other words, for the same case, each department has its own emphases and case templates, each of which is a specific meta-data to present a specific semantics of a teaching case for the teaching purpose.

In general, there are many different department views (perspectives) to look at a teaching case. Within these different department views for the same teaching case, some parts of the case are shared among some department views while some other parts may be used by only one department alone.

From a more abstract point of view, the situation is well fitted into the "document-view" design pattern in which a document in an interactive system may have many different views depending on what the user wants to be able to visualize the data in hand. For instance, a document may contain a set of data that represents the statistics of the number of users visiting a certain website at different time. The view of the document may be a table of a lot of numeric numbers or a bar chart or a pie chart for easy understanding of the data. The users can interactively select different views of the same data. The Document-view architectural pattern divides an interactive application system into two components. The document component contains the core functionality and data of the object of interest while the view component displays the data of the object of interest to the user and handle user interaction. There can be multiple views of the same document. If the user changes the data of the document, all the views dependent on this document should reflect the changes.

In our implementation, a rule-based mechanism is used to support the document-view concept of the teaching case system. When the author enters the case template into the system using the template authoring tool, the sections that will be used by at least one department view will be entered into the case template. The author can make use of a rule database for specifying which sections in the case template will be included in a given department view of a teaching case so that when the user browses the case latter, the system can respond accordingly.

3. Methods and Implementation

(a) the workflow from an author's perspective

For a given patient case, we ask several domain experts to edit the teaching case material from their own perspectives. This involves

(1) the generation of a case template that can accommodate the needs of all the perspectives.

Each domain expert should define his own case template first. All the templates of all the perspectives will be put together to form the overall template of the teaching case. This is because some sections are shared by many different templates of different department views and the system needs to keep only one copy of each section for the consistency control instead of making several copies of the same data and complicating the maintenance work. Therefore, at this step, we set up an overall teaching case template.

(2) Set up a "discipline-view-rule" database that specifies which sections belong to which views so that the system can present the teaching case material to the users properly. Each department view has its own case template which is a subset of the overall case template. All the case templates are recorded in a database called the department-view-rule database.

For instance, the sections for the internal medicine case(fig. 2(a)) are the Basic information, Chief complaint, Present illness, Past history, Family history, Physical examination, Laboratory test, Tentative diagnosis and Final diagnosis section while the sections for Radiology (fig. 2(b)) are Radiological images, Basic information,

Present illness, Laboratory test, Differential diagnosis. Note that they share the Basic information, Present illness, Laboratory test. (3) All the domain experts hold a meeting to discuss how the case should be presented to the users. (4) All the domain experts use the authoring tools to edit the teaching case material using the teaching case template. (5) All the domain experts review the teaching case in a meeting to discuss various issues as to how to present the case to the users in an integrated fashion. (6) Iterate through steps 4 and 5 until the results are satisfied. The details are described below.

(b) the workflow from a user's perspective

For a explanatory reason, some engineering mechanism, which works behind the scenes, is also included here. In our prototype system, there are two databases:

(a) a user profile database that includes each user's name, major such as internal medicine, sophistication level, such as an intern, a specialist, or a student in a medical school, and so on. (b) a presentation database (briefly described before) that has several fields: (1) user level, (2) department name (or user major from the user perspective, such as internal medicine), (3) case template ID, (4) section names in the case template (5) the operation mode, such as interactive mode or plain mode (6) switch flag that records how each section in a teaching case should be presented based on the user level and user major. As we will see later, the items 1 to 5 will be used as the indexes to retrieve the switch flag that specifies how a particular section in a teaching case should be presented. These two databases have to be populated using some tools by the system administrator (for the user profile database) and the authors (for the presentation database) before the teaching cases are published on the website. The overall architecture of the system is shown in figure 1. In order to ease the management of all the multimedia documents of the teaching cases in the system, all the documents are also stored in a teaching case database.

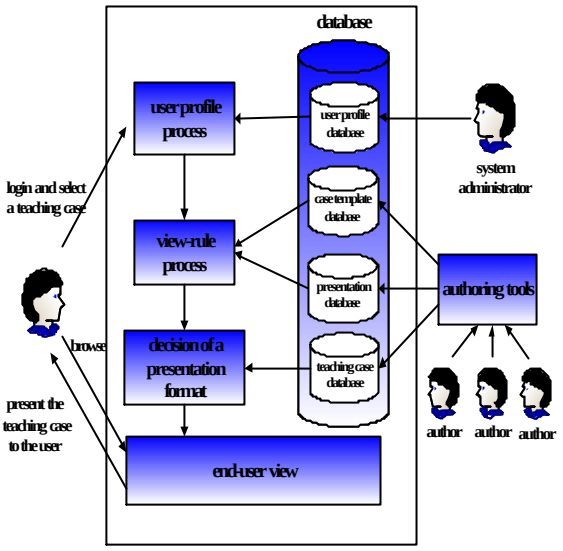
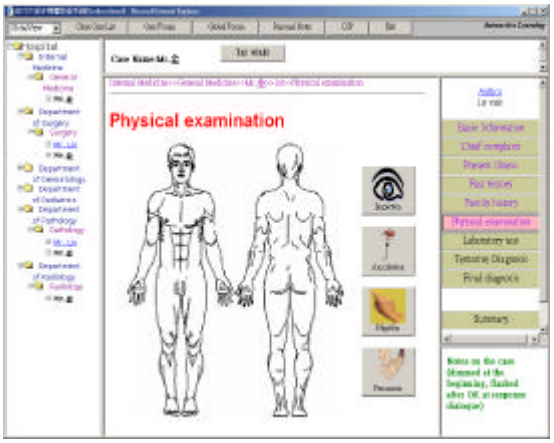


Figure 1: system architecture

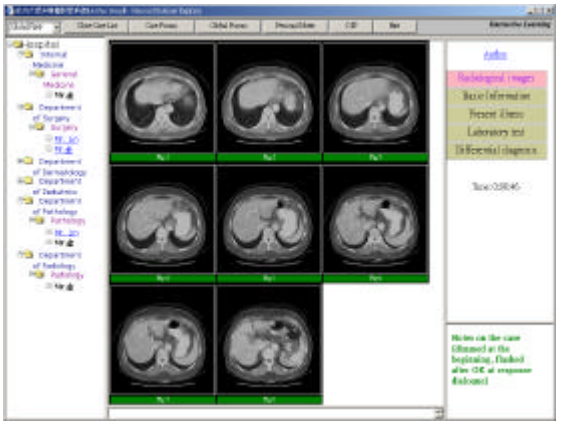
When a user uses the web browser and logins into the system, the system will retrieve, from the user profile database, his user major and user level which is used as the default user level. The user can change his level if he wants and the system will record it and use it as the user level for further processing. When he activates a teaching case for the interactive browsing, based on his user level, user major, and the case template ID (which is saved within the case), the system will retrieve the case template and the section names for the particular department view stored in the presentation database. At this point, the system is ready to present the teaching case to the user with the particular department view. On the right-hand side of the browser window as shown in figure 2, the system will show all the section names in the case template each of which is represented as a push button for this particular department view. When a section is activated, the

system, as a web service application system responding to the web browser's request, will retrieve the section from the teaching case database, reference the corresponding switch flag, and present the particular section accordingly to the user. As a result, the teaching case will be presented to the user as planed.

At the end of browsing a teaching case, a performance summary can be shown to the user to indicate how well he is doing for the given case as shown in figure 3. The summary includes the correct answer, the user's answer, the time the user has spent on this case, all the laboratory examinations the user has ordered and the total cost the laboratory examinations, and so on. When the user browses the case up to this point, a learning point section can be activated. The learning point includes the points to be learned in this case, a hyperlink to the plain view of the current case, and a hyperlink to the plain view or interactive view of the other disciplines for the same case. The user can select which mode and which department view he wants to view the case so that he can understand how other people from other disciplines view the same case and have through understanding of the case.



(a) the screen view of the internal medicine



(b) the screen view of the radiology

Figure 2. system screen layout

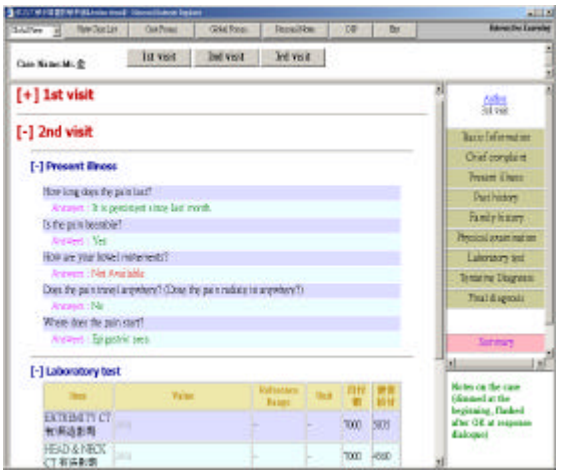


Figure 3. case summary

(c) the implementation of the system from an engineering perspective

2. Some of the engineering mechanisms have been described in the previous paragraph and will not be repeated here. Each switch flag is corresponding to a section as to how the particular section should be presented at run time.

4. Results

The system has been installed in the medical center of the National Cheng Kung University for the trials. The students ranging from the grades 5th to 7th to try out the system and have the following comments after using various teaching cases in the system:

1. As we expected that all the students felt that

the teaching cases with multiple views are much more interesting and give them more integrated view of the cases than the isolated teaching cases.

2. All the students believe that the system can significantly improve the skills for real clinical cases.
3. Based on our experience, although the system provides user friendly authoring tools for the teaching material entry, the actual teaching material collection and their entry into the system had better be done by some teaching assistants who are more skillful to work with the computers and do the time consuming work. The real authors are physicians who have heavy clinical and research workload and are mainly in charge of managing the contents of the teaching case and ensure the correctness of the teaching case and learning points of the teaching case.
4. Since the same patient case is used as the subject matter, as stated before, theoretically each view from a different perspective should be more interesting than the view of the same case described alone. It turns out that the results are somehow different from what we expected originally. We have found that in some cases a teaching case that is interesting enough to a specialist from one department viewpoint may not be interesting from another department viewpoint. Therefore, for the training of specialists, it may not be appropriate to integrate all the related departments' views in one teaching case. Instead, we can integrate only certain departments' views that are interesting enough from those departments' viewpoints. However, for the medical students' training, this fact does not concern us. This is because that the teaching cases for training the students in medical schools are relatively easy and frequently seem in the medical practice as opposed to the teaching cases for the specialists where the rare clinical cases are more suitable for the teaching case subject matters. There is no particular notion of "interesting" cases from research point of view. Therefore, for the training of medical school students, it is still important to give students an integrated viewpoint. In this situation, we still need to integrate all the possible department views and give students opportunities to see various views from different perspectives.
5. This research work also provides an opportunity for the experts (authors) in various medical disciplines to get together and discuss how the teaching material should be presented to the students. The authors also get an opportunity to learn more about how other experts view the same case and to further sharpen their medical knowledge in general.

5. Conclusions

In this paper, we propose the concept of integration of various department views of computerized PBL teaching cases. In order to experiment the concept, an interactive PBL teaching case system is implemented using the document-view technique that allows one document with many different views. Based on our experiments, the users indeed feel strongly about the way the cases are presented to them. The system appears to be more interesting to the users and also gives the students much more strong feeling about how medical knowledge are integrated in the real clinical setting they are

going to face in the future. The research work also benefits the authors of the teaching case in terms of teaching activities as well as research on medicine. This paper is to present our preliminary experiments about the concept of an integrated teaching case system and the long impact of the system for the medical education as a whole still remains to be seen.

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