Towards a Mobile Intelligent Information System with Application to HIV/AIDS

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Abstract. The United Nations Security Council reports HIV/AIDS as the fastest growing threat to human development. In addition, the World Health Organization [1] reports that nearly 5 million persons (4.3 million adults and 700,000 children) are newly infected with HIV each year; more than 95% of them found in developing countries. Since STDs as a group are a personal problem which few people feel comfortable discussing, we believe that hand-held PDAs can provide an opportunity for learning about this disease while insuring anonymity. This device will employ the newest technologies including Bluetooth wireless technology, which can transmit and receive data via a short-range radio link using a globally available frequency band (2.4 GHz ISM band), enabling rapid and accurate synchronous and asynchronous data communication. The first generation of Bluetooth permits exchange of data up to a rate of 1 Mbps, even in areas with much electromagnetic disturbance. This emerging technology can facilitate HIV/AIDS outreach around the globe.

Recent advances in learning have taken a particularly cognitive perspective and these findings have implications for education in general as well as for the development of intelligent tutoring systems in particular. In the past, effective SmartBooks™ have been developed for AIDS education to disseminate the critical knowledge relevant to this epidemic [2].

Since 1993, the proliferation of the World Wide Web has created a plethora of new opportunities for the delivery of electronic distance learning systems. However, we feel that it is important that a whatever technology is employed is based on a sound educational theory. A new, comprehensive, web-based learning system called SmartTutor has been developed, at Brooklyn College of The City University of New York [3]. This technology provides a user-friendly, self-paced, easy to modify, software environment intended to serve the user's learning needs and is based on a generic SmartTutor methodology organized around the use of concept mapping. Early assessment of SmartTutor has shown that it is well received by students and helps significantly in their learning processes. It is readily adaptable to the presentation of academic and more general subject matter such as the latest available information on HIV/AIDS. Our new HIV/AIDS SmartTutor will incorporate this SmartTutor paradigm. Our new SmartTutor would provide worldwide access to medical professionals as well as the general public to learn about HIV/AIDS. This new device could also provide a survey tool to facilitate HIV risk assessment. Demonstrations of the SmartTutor learning system will be presented and the continued development of the applications will be discussed.

Keywords. Intelligent tutring system, information systems, wireless technologies, HIV education, AIDS education, SmartBooks™, SmartTutor

Introduction: The Problem of HIV

Since 1981 [1] the world has been confronted with and aware of the tragedy AIDS. In the Unites States, the disease has changed from one which was proven to be almost universally fatal within 10 years, with the progression from HIV to full-blown AIDS, to one which has been more manageable as a long-term serious chronic illness. Since 1996, with the introduction of powerful anti-retroviral therapies, has dramatically prolonged the time between HIV infection to the development of AIDS [2]. Hence, focus (in the US) has been able to change somewhat from treating a terminal disease (AIDS), to living with HIV. The adult HIV prevalence rate is estimated to be around 0.6%2, but this is only an average figure, and the US has a very diverse population. The number of HIV+ people living in America varies between 900,000 and 1 million according to different estimates – the UN estimates it to be 950,000 [5] .

In the United States we have been able to contain the devastation of AIDS through research, knowledge, and experience. Research has focused on the treatment of HIV/AIDS, knowledge has focused on establishing behaviors to prevent the transmission of disease (e.g. safe behaviors vis a vis sexual activity, blood transfusions, health-care professionals and especially high-risk populations). However, in underdeveloped, Third World countries in Asia and Africa, and even in Eastern Europe, the tragic specter of HIV/AIDS immediately threatens an entire generation of people.

1. SmartBooks

Since 1993 the proliferation of the World Wide Web (WWW) has created a plethora of new opportunities for the delivery of electronic, distance learning systems. However, one might ask, “How many of these systems facilitated by the platform of the WWW have been proven and tested as sound educational tools?” Between 1988 and 1992 we developed a technology at the University of Maine for building what we called “SmartBooks”. [6], [7]. The basis of this approach was the use of “concept mapping”, which has been demonstrated to be a sound paradigm for learning and education [8] The ability to navigate in any direction does create the opportunity for the improved effectiveness of the learning process. The actual effectiveness is determined by each individual learner. The domain of application was education of college-age populations about sexually transmitted diseases (STD’s), specifically, AIDS [9]. The importance of developing an anonymous, correct, flexible, and up-to-date source of information and education about this killer disease does not need explanation. More recently, (1996) at the U.S. Coast Guard Academy in New London, CT. we applied the SmartBook methodology to develop an effective electronic system for educating about “Rules of the Road”. All cadets at the Academy need to pass a course on Navigation where study of a book nearly 200 pages long is necessary. Cadets who used our “Rules of the Road SmartBook” responded quite favorably when asked to consider its effectiveness as a learning tool. SmartBooks were developed in essentially four stages:

1. Interviews with subject matter experts to develop an effective “concept map” for a domain (possibly involving a number of iterations over several months). Typically the maps would go through considerable revision before a “stable” map was settled upon. The process of creating the maps was worthy of study in itself and revealed the perspectives of subject matter experts on the hierarchical importance of topics in their domains.
2. Translation of the final concept map into the hypercard language on the Macintosh (later Toolbook for Windows was also used). The coding process proved fairly straightforward for a typical computer science undergraduate.
3. Implementation of a working SmartBook. After several years of development work we settled on a set a of standard features for the SmartBook interface and standard navigation tools (buttons).
4. Testing and revision of the working system with the target population, undergraduate students.

Concept maps are a graphical form of knowledge representation whereby all the important information in a domain can be embedded in nodes (rectangular buttons or nodes in this system) and arcs (the lines connecting nodes). At any time during interaction with the system a user can see how he/she arrived at where they are (the path taken through the SmartBook) and where it can lead to. This is indicated by a pictorial representation on the top of each card illustrating how the shaded circle (node) was reached and what circle(s) (nodes) it can lead to. Arrows without circles attached to them represent nodes which exist but are not shown in order to avoid cluttering the screen. These nodes can be found on subsequent screens. "General Text" refers to the node which is currently shaded in a graph on a visible screen. Typical additional navigation buttons would include a “Quiz” feature where learners can assess their knowledge of particular topic areas in the concept map, as well as obtain a comprehensive score[10].

Most people would probably agree that formal learning over the last centuries has been achieved through books. Books consist of words that comprise textual information or images that comprise graphical information. A well-written and well-structured book is naturally an excellent source of information on a subject for a student to learn from. Books tend to be complete and sequential in their presentation of material. There is also an implicit hierarchical structure for the knowledge in most books which attempt to present learning material. This structure entails the presentation of material in a top-down form. That is, the general overview of a subject is presented first and then details on specific relevant topics or methods will follow. A good text will have all the important subject information as well as a table of contents and index detailed enough to direct the reader as to where to find information on any topic of interest covered in the book. Key words may also be highlighted in some way. However, lacking in any text is flexibility in the order of presentation of information. This is due to the very static nature of this form of knowledge representation, the style and content being rigid and unchangeable once a book is published.

The primary advantage of a SmartBook is flexibility and the fact that it can developed about any domain using a sound educational methodology. It can be used and traversed in many ways. The order in which material to be learned is presented is the choice of the user. All information is represented in two forms: graphically and textually. Graphical information has been derived from a form of knowledge representation called concept maps. The structure of these maps can embellish the knowledge of experts in a domain. Typically any node (oval or button) on a screen can be "clicked" to proceed to the next screen with a new map segment and more information. The key to a SmartBook's flexibility is that one can move in many directions via the nodes and arcs in a graph. Concepts in nodes are connected by arcs. Importantly, at all times the user can quickly determine how the current node was reached and what are the possibilities for proceeding from the current node. Textual information is always presented in a brief, compact and clear form.

In essence, the SmartBook, represents a road map through any knowledge base. Transparency in form and function is fundamental to SmartBooks. In addition to existing pop up windows, there is the potential for linking to a glossary of terms, synonyms for key words, a retrace facility, expert advice, and video-based presentation of graphical information. As any good knowledge base, it is easy to modify, expand, and refine.

2 SmartTutor

SmartTutor is an innovative computer based or Personal Digital Assistant (PDA) based learning strategy originally created as an adjunct method for the learning of college level sciences. The original project at Brooklyn College created and tested on-line tutorials for a variety of gateway science courses including computer science, biology, chemistry and most recently physics [11,12]. The drop-out rate from science courses in four-year and two-year colleges has been of great concern for a number of years and tutoring in all forms is widely accepted on most college campuses as a primary tool for helping at-risk students. Brooklyn College of The City University of New York has a national reputation in the field of peer tutoring, with past programs funded by NSF, the Howard Hughes Medical Institute and the U.S. Department of Education.

The SmartTutor model builds on this work, using the best that is known about collaborative learning and computer-based instruction to respond to the needs of urban public college students in critical gateway science courses (for majors) and core courses (required for non-majors). The project employs insights from five years of campus research on on-line tutoring to ensure that students have available effective instructional materials to aid their science education. The original SmartTutor project was carried out by a team of faculty from biology, chemistry, physics, computer science, mathematics, psychology and economics. These faculty have had considerable experience with summer bridge programs, immersions and other support programs for non-traditional students. One of the important payoffs of the SmartTutor project is that our faculty have sought to understand the causes for student failure and then share what they learn with colleagues and the academic community in general. An important aspect of the project during the past five years has been the direct collaboration between faculty and two groups of students: one is a group of trained peer tutors who via direct experience have gained knowledge of the kinds of difficulties the other group has been comprised of a number of advanced students who gain experience by working on web design and computer graphics.

SmartTutor has been designed to promote ease of use, including concept maps, animated graphics, exercises and glossaries, content based on careful research into student learning, TutorTips, and answers to frequently asked questions (FAQs). Students seek help bringing with them varied levels of understanding and they follow their own idiosyncratic paths to learning. The SmartTutor project was designed to formulate a model that will support students working at their own initiative and at their own pace to integrate and synthesize scientific knowledge. It combines collaborative learning techniques with on-line tutoring techniques (individualized learning, coaching controlled by learner). It is intended to provide all students with access to the best possible content and to provide an alternate path for students who may otherwise be too busy or too intimidated to seek help in other ways.

Unlike more traditional forms of computer assisted instruction where the learner moves in lockstep through a structured hierarchically graded sequence of information, SmartTutor is designed for students to go in and out of the website at any point during their learning sequence. A basic resource for organizing SmartTutor content is SmartBooks mentioned above, an intelligent tutoring component designed by Kopec and colleagues to facilitate exploration of a knowledge base. SmartTutor is based on the assumption that ideas are linked together in meaningful idiosyncratic relationships by the learner. Concept maps are a basic port of entry for every SmartTutor subject, used to guide the learner toward the information (s)he is seeking. Concept mapping has proven to be an effective strategy for helping students build a conceptual framework on a particular topic to elucidate the main features and clarify relationships. Also, the map helps students understand how topics relate to each other more effectively than a linear list. By simply clicking on topics at any level, students are immediately taken directly to the information offered on that subject. We have found that students do not always know the technical names or categories for information they are seeking. SmartTutor uses special strategies to guide students toward the information they are seeking. Students can easily access previews of what each topic contains by moving the cursor to the boxes on the map.

Based on the success that has been accumulated both in developing and implementing the SmartTutor system to the learning of college level science, it is anticipated that this tutorial model will prove to be an excellent system for the dissemination of information concerning diseases such as HIV and others to health professionals and even to individuals lacking extensive knowledge bases concerning disease processes. Following our experience in successfully transmitting diverse knowledge to students with widely varying levels of preparation and skill sets, we anticipate similar success in transferring information concerning disease processes to the general public.

3. Dissemination

The HIV/AIDS education system we are proposing is to be storable on hand-held, portable, devices exploiting Bluetooth wireless technologies. This will enable reception of data via short-range radio link using a globally available frequency band (2.4 GHz ISM band), enabling rapid and accurate synchronous and asynchronous data communication. Given that the first generation of Bluetooth permits exchange of data up to 1Mbps, even in areas with much electromagnetic disturbance, we can expect further speedup in the near future. This gives us great hope as to the possibility of developing a fully versatile system which can be used by at risk populations in Asia, Africa, and Eastern Europe. Such a device could effectively serve medical professionals as well as the general public.

As we know, awareness and education with regard to HIV/AIDS goes hand in hand with safe behavior practices, ultimately contributing to the goal of containing and ending the worldwide epidemic. The "AIDS Companion" could serve as an invaluable educational resource to adolescents, adults, and anyone who would potentially be at risk, while ensuring anonymity, and facilitating easy revisions, updates, and improvements. Such a device would be easy to maintain, would be portable, and yet fully comprehensive. The dynamically changing information regarding this disease and its containment, would be easy to update.

Evaluation

The AIDS Companion will be assessed for its effectiveness as a learning tool through regular interviews and surveys with relevant target populations. This will give us ample opportunities for feedback, analysis, and improvement of our system.

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