SMARTBOOKS: A GENERIC METHODOLOGY TO FACILITATE DELIVERY OF POST-SECONDARY EDUCATION

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Abstract

Just prior to the emergence of the World Wide Web an educational technology for the delivery of anonymous, up to date, easy to modify and comprehensive educational, multimedia material had been developed. The resulting product was called "SmartBooks". Effective SmartBooks had been developed for the delivery of AIDS education to college-age populations and for Rules of the Road, an important set of rules for driving a vessel on the seas. This paper describes the SmartBook methodology and some ongoing efforts to further empower SmartBooks with today's latest technologies.

Keywords: SmartBooks, concept maps, instructional technology, world wide web

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 systems facilitated by the existence 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". (Kopec and Wood, 1993, 1994), (Kopec, Brody, Shi, and Wood, 1991) , (Kopec, Wood, and Brody, 1991). The basis of this approach was the use of "concept mapping", which has been demonstrated to be a sound paradigm for learning and education. (Gowin and Novak, 1985). 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 (Wood, 1992). 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) 2) translation of the final concept map into the hypercard language on the Macintosh (later Toolbook for Windows was also used) 3) Implementation of a working SmartBook and 4) Testing and revision of the working system with 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 the use of 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.

SmartBooks

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 be developed for 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. Table 1 (on the next page) summarizes the advantages of SmartBooks over traditional texts. As indicated in the Table, the one advantage of traditional texts over SmartBooks may be that the entire work may be held "in hand".

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. Figure 1 (page 4) indicates some of the standard SmartBook features.

We are currently planning the design of SmartBooks for a number of domains which can be applied to the undergraduate curriculum. SmartBooks for such diverse subjects as Computer Science, Medicine, Geology, Biology, Geography, Foreign Languages, Physics, Mathematics, and science education in general, etc., can be constructed using essentially the same paradigm we have discussed. Their effectiveness as a learning tool can easily be tested and evaluated. We can give pretests and post-tests evaluating subject matter knowledge. For example, performance of students in courses delivered with and without SmartBooks (which can reside on the web with a special course password) would be one way to measure their effectiveness.

The SmartBooks themselves come with a "Quiz" feature which allows us to test knowledge of any particular subtree of a learning path through the SmartBook. The quiz can refer learners back to the appropriate sections of the SmartBook where the relevant material is presented. There is also a comprehensive exam which can cover the entire SmartBook. Students can receive feedback on their performance automatically from the system. Traces of nodes visited can also be helpful in evaluating learning using SmartBooks.

Table 1. SmartBooks vs. Standard Texts

Smart Book		Standard Text
Advantages		
Concept map approach multiple expert knowledge	vs.	Author(s)' conceptual knowledge
Flexible order of use	vs.	Rigid, fixed order
Any combination of graphical and textual knowledge	vs.	Mostly textual knowledge
Virtually unlimited size authoring system	vs.	Size limited by publisher
Easy to update/revise, expand	vs.	Must republish
Automatic testing, recording, and scoring	vs.	Manual memory work
Disadvantage		
Cannot see whole work at once	vs.	Can hold entire work "in hand"

We propose to further develop the technology of SmartBooks with additional features including: color coding of information and traversal, three- dimensional representation of graphs, and animation of graphical information. SmartBooks can be developed for any discipline of discourse undergraduate or graduate curriculum.

The Pages of the Concept Map with Text at Bottom

Buttons linking to Cards Including:

- Introduction/Help
- Subject Domain Text
- Pop Up Windows
- To Map (overview)
- Map to Cards in Stack
- Glossary
- References
- Recording of Nodes Visited
- Self-Test : Quiz; Comprehensive Exam

Figure 1. Standard SmartBook Features

References

Kopec, D. and Wood, C. *Introduction to SmartBooks*. Booklet to accompany interactive educational software *AIDS SmartBook*, Jones and Bartlett Publishers, Boston, MA (1994). * Also published as United States Coast Guard Academy, *Center for Advanced Studies Report No. 23-93,* New London, CT*.,* December, 1993.

Kopec, D. Brody, M., Shi,C., and Wood, C. "Towards an Intelligent Tutoring System with Application to Sexually Transmitted Diseases" in *Artificial Intelligence and Intelligent Tutoring Systems: Knowledge-based systems for learning and teaching*, Ellis Horwood Publishers, Chichester, England, May,1992, pp. 129-51.

Kopec, D., Wood, C. and Brody, M. "An Educational Theory for Transferring Domain Expert
Knowledge Towards the Development of an Intelligent Tutoring Systems for STDs, *" Journal
of Artificial Intelligence in Education,* Vol. 2 (2), Winter, 1991, pp. 67-82.

Novak, J.D. and Gowin, D.B., "*Learning How to Learn*", Cambridge University Press, Cambridge, England, 1985.

Wood, Carol L., "*Use of Concept Maps in Micro-computer Based Program Design for an AIDS Knowledge Base"*, EDD Thesis, University of Maine, Orono, 1992.