Interface Navigation by Grade-Six Students: A Case Study of Three Multimedia CD-ROM Products

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Reports research to investigate how two primary school classes retrieved information from CD-ROM multimedia information sources in support of a class project. The students demonstrated confidence in operating the interfaces, but did not find them equally easy or effective. They were able to distinguish between the enjoyment of using an interface and the utility of the CD-ROM as a source of relevant information. The confidence demonstrated by students in interface manipulation must be distinguished from their problems in devising effective retrieval strategies. They preferred browsing to searching strategies. Students were unlikely to explore retrieval features, no matter how powerful, if these were not prominently displayed in the interface. Textual information was valued more greatly than images or sounds. Overall, students enjoyed using multimedia sources and many asked when they would be able to repeat the experience.

Introduction

The research investigated how grade-six students in a primary school use three CD-ROM multimedia information sources to support a class project on life in the Middle Ages. This is the first part of a larger study to identify design criteria for multimedia classroom products and to investigate more generally how best to integrate new technologies into classroom teaching.

Children as Information Seekers

Children as information seekers have only gained research attention in recent years. They constitute a distinct user group, approaching an information system differently from adults and consequently placing different demands upon it. As Druin and Solomon (1996) state, "when developing multimedia environments for children, we as designers must remember that children are not just short adults. We cannot water down multimedia environments designed for adults and expect them to be valuable environments for children."

A number of important studies are helping us to understand how children find information from databases. Kuhlthau (1989) developed a model of the Information Search Process (ISP) with six stages: initiation, selection, exploration, formulation, collection and presentation. The last three stages were the specific concerns of the current project. Marchionini (1989) explored how primary school children searched for information on a CD-ROM encyclopedia; he found that in general young novice searchers could use command-driven Boolean retrieval software with minimal training, but seldom took full advantage of the available retrieval capabilities. Although the students were able to identify key facets in search queries they encountered difficulties in formulating effective search terms. Borgman and colleagues investigated the use of OPACs in school environments. They conducted empirical studies of children's information-seeking behavior and found that higher success rates were achieved when they used concrete search terms that matched the catalog's terminology (Borgman, Hirsh, Walter and Gallagher 1995). Although their findings suggest that children are highly successful at finding bibliographic information, Hirsh (1997) concludes that more information retrieval tools designed specifically for children are necessary. In particular, they need help in formulating and articulating search queries that are appropriate for the systems. Large, Beheshti, Breuleux and Renaud (1994) investigated the use by grade-six students of multimedia encyclopedias on CD-ROM. In studying retrieval behavior in an experimental setting, they found that young novice searchers could use an information retrieval system that incorporates several different retrieval paths with minimal training. The students were willing to explore and experiment with the inter-

face, and overall their use was highly interactive. Oliver and Oliver (1996) identified disorientation, navigation inefficiency and cognitive overload as the most serious problems encountered by children using interactive multimedia information sources in educational settings. Solomon (1993) investigated OPAC use in a primary school, and was struck by the success achieved by even the youngest grade-one students.

Interface Design

A great deal of research has been conducted to identify interface design principles, although rarely with children in mind as users. Mandel (1997) believes that "the best interface is the one that lets users do what they want to do, when they want to do it, and how they want to do it." Marchionini (1992) argues that most users want to achieve their search goals with a minimum of cognitive load and a maximum of enjoyment. They will also perform better and continue to use systems that give them pleasure or are interesting. Microsoft's Windows Interface Guidelines (1997) state that "a well-designed user interface is built on principles and a development process that centers on users and their tasks." Shneiderman (1992) and Head (1997) list the advantages offered by direct manipulation interfaces, but recognise that the graphics can become irksome gimmicks for the frequent user. Beaulieu (1997) has called for further investigation into the cognitive load which different interface environments or features may impose.

Methodology

A case study methodology was selected to focus on several groups of students retrieving information over a period of time in order to satisfy genuine information needs. It has similarities with the methodology adopted by Solomon (1993) in his OPAC research with children. Two grade-six classes (53 students) in a Montreal suburban primary school participated in the research.

Beaulieu (1997) has argued the value in interface design of undertaking "a more closed type of operational trial with a homogeneous

group of users, who would access the system *repeatedly* to support a range of on-going information-seeking tasks or activities." In conformity with this argument, the multimedia CD-ROMs were made available at three workstations in the classroom itself. They could freely be used by the students during regular sessions time-tabled by the teachers over the course of four weeks. The students worked at the computer in groups of three. Students were also free to find information from other sources—both print and electronic—available in the classroom, school or public library, or from home. Additionally, the students had an incentive to undertake the task—the final results would be incorporated in the assessed school project.

The students' objective was to gather information for a class project entitled "The Middle Ages." The project comprised three components:

- a written assignment on people in the Middle Ages and the manorial system, alongside a comparison with their modern counterparts;

- an oral presentation, with accompanying poster(s) on three medieval history topics;

- the construction of a three-dimensional model of a manorial system.

Three identical workstations were installed in the classroom during the project. Each comprised a 486 IBM-compatible computer with a SVGA monitor and 8x CD-ROM drive, a Microsoft mouse and a Desk Jet 400 Hewlett Packard printer. Three sets of the three multimedia titles were made available at each workstation so that the students could use at any time whichever one they so wished. A converter was used to capture screen images directly from the workstation's system unit on to VHS tape. A microphone enabled the searchers' voices also to be captured synchronously with the screen image on the videotape.

The students were given a relatively brief introduction to each of the three CD-ROM multimedia titles so that they could begin searching. More extensive training was not offered as all three CD-ROMs are intended for the home or school environment, and the interface designers cannot assume that users will be given training sessions

beyond what is provided by the products themselves. The students were then free to explore the interfaces and decide for themselves how exactly they would conduct their searches. The 17 groups of students conducted in total 50 hours' searching, or on average around three hours per group. A typical search session by one group lasted for around 15 minutes, but some were considerably longer.

Student Characteristics

All but one student (aged 11) were either 12 or 13 years of age: 64% were boys and 36% girls. A majority of their homes (88%) contained a computer, and in all such cases the students had access to it (40% daily, 47% weekly and 13% monthly on average). Even the students without a home computer reported computer use at friends, neighbors or a parent's office. A majority also had used CD-ROMs outside school, and all had used CD-ROMs in the School's Information Technology Laboratory (but not the particular CD-ROMs used in the project).

CD-ROMs

Three CD-ROM products were selected, each representing a different interface design concept. A number of general multimedia encyclopedias are available on CD-ROM, any one of which would have served the research purpose. The *Encarta 96 Encyclopedia* (Microsoft Corporation 1995) was chosen because it has garnered very positive reviews and is widely used in schools, but was not available in the specific school involved in the research. It relies on pop-up and pull-down menus and offers search options on article titles (Pinpointer Search), or on words within articles where Boolean operators, phrase searching and stem truncation can be used to combine terms (Word Search). *Encarta 96* contains information relevant to the students' project scattered through many different articles.

The other two CD-ROMs are specialist products dealing with castles in the Middle Ages. *Castle Explorer,* one of a family of products published by DK Multimedia (1996), has a 3-D multimedia interface that encourages information retrieval by exploration of images of

the castle itself, various sections of the castle and surrounding countryside, and individual rooms within the castle. Several subsidiary navigational aids are offered: "Library" reveals six chained books (Health, Society, Warfare, Trades, Crime and Food) whose pages can be scrolled, and "Word Search" displays a vertically scrollable index of terms that link the user to the relevant page in a book or the relevant caption from the castle scenes.

Exploring Castles, published by Anglia Multimedia (1995), relies heavily upon hierarchically organised menus as well as button, icons and scrollable alphabetical lists of terms. A "Find Text" pop-up window allows a search to be undertaken on any word or part of a word

Information-Seeking Behavior

Overall, the students proved remarkably skillful at manipulating the three interfaces. The only one to cause real problems was *Exploring Castles*. Its interface employs a number of different devices and is inconsistent in structure and operation. It is easy to get lost within its hierarchically structured menus, a problem not helped by the fact that it is possible to exit from any part of the program only to the main menu, and not to an intermediate menu level.

The most innovative interface was that employed by *Castle Explorer*. Its object-oriented approach encouraged the students to explore the information store in a visual and tactile manner. In order to retrieve information it was necessary to use a variety of manipulation techniques: image rotation (for example, revolving the 3-D image of the castle on both a horizontal and vertical plane in order to "enter" a particular section such as the lower bailey or the castle surrounds); horizontal and vertical screen scrolling; clicking on objects to reveal what is 'inside,' and so on. The students demonstrated impressive competence in undertaking such manoeuvres, and required little practice to achieve such dexterity.

Ironically, the visual sophistication of the interface proved to be its main downfall, at least when *Castle Explorer* was being used to find specific information for a class project rather than to explore

in a more serendipitous fashion. The opening screen offers an opportunity to start a new game or open a saved game. The scenario for this game is "a dangerous secret mission inside the stone walls of Baron Mortimer's castle" in fourteenth-century Europe. It is intended to introduce users to the CD-ROMs' interface and to make them explore the castle. In other words, it supports a browsing rather than a searching mode. Not surprisingly, all student groups, on their first encounter with *Castle Explorer*, chose to undertake the game rather than delve deeper into the interface in order to discover the other search options. Some groups became engrossed in the game and spent more than 45 minutes on it without explicitly identifying relevant information for their project, though it could be argued that they familiarised themselves thoroughly with the castle interior and its environs.

When exploring the castle, students opened the caption windows, but in many cases they scarcely paused to look at the text before moving to the next visual stimulation. The visual richness of the interface encouraged a high level of interactivity with the interface, but the constantly changing screen left little time for information absorption. By the second or third search session, students were discovering alternative navigational aids such as Library and Word Search.

On *Encarta* almost all searches began with an article title search (Pinpointer). There seemed to be an expectation that any search term typed in the Pinpointer search box would find an article with that specific title, resulting in searches that had already failed to find anything relevant being repeated several times. The searches undertaken on *Exploring Castles*, of which there were relatively few, tended to be long. The students seemed to have less grasp of direction than on the other two CD-ROMs and moved around the interface with little sense of purpose. The word search capability on *Exploring Castles* was not used at all. In the early stages of the project *Exploring Castles* was used as frequently as the other two titles, but its usage quickly declined as the project progressed.

Generally speaking, students employed single-word search terms, but occasionally entered search phrases (such as "people of the mid-

dle ages"). Search terms were usually directly linked to the project, and in many cases students searched only on the terms used by their teachers to present the project.

The students showed little inclination to utilise the help screens provided by all three CD-ROMs; less than half the students reported they had used the on-screen glossaries or dictionaries. Although hypertext links are found on the CD-ROMs, they were infrequently used. The links from the text to a dictionary on *Castle Explorer*, for example, were largely ignored even though it is clear from some of the taped discussions that students were not always sure of words' meanings.

None of the interfaces employed a primary search approach that depended upon terms being typed accurately at the keyboard. Although spelling problems occurred—"shepherd" and "manorial" in particular caused problems for several students—they did not greatly handicap retrieval, because in most cases inputting a search term merely scrolled an alphabetical index of terms to that approximate location; the term itself was then selected from the list (with its correctly spelled version).

Students were influenced in their choice of search devices by the way in which they were presented in the interface. More prominent facilities which were thereby given an emphasis in the interface were much more likely to be used than those facilities afforded a secondary location. This can best be illustrated with *Encarta*. On choosing Find from the main menu, users are presented with the Pinpointer search of article titles. All students opted for this on first using *Encarta*, and most continued to opt for this as their first move even after repeated experiences with the interface. Searching on subject categories, and especially the powerful word search capability, were much less used, and it is hard to avoid the conclusion that in part this is a result of their lack of prominence. In quantitative terms, analyses of 20 searches revealed that Pinpointer was used 89 times compared with 20 for Subject Categories, three for Timeline and two for Word Search. Hypertext links were only followed on four occasions.

A reluctance to use word search on any of the three CD-ROMs leads to another conclusion: students may demonstrate a confidence and

capability in physically manipulating the interface, but their grasp of retrieval strategies is much less well developed. Searching effectively for information via such interfaces is by no means intuitive. When given the opportunity, students preferred browsing to searching strategies. The browsing environment provided by *Castle Explorer* was more popular than its retrieval features, although the latter were used, especially as students became more familiar with the CD-ROM. On *Encarta* students opted for the browsable Pinpointer title index rather than Word Search. A preference for browsing rather than searching can be explained either by the lower cognitive and prior subject knowledge demands placed upon the user, or by the previously mentioned prominence given to browsing in both the interfaces (or a combination of the two). Frequently it was not clear to the students how they might modify a strategy. This problem was compounded by a belief that if the teacher had asked for information on a particular topic then that information must be present on the CD-ROM and must be retrievable via the actual term used by the teacher to describe the topic (for similar findings with high school students, see Neuman, 1997). The failure to distinguish between a concept and the variety of terms that might be employed to find that concept proved a major cause of search failure. Generally synonyms were not tried when a keyword search failed.

One interest of the research team was to explore whether the students demonstrated a learning curve over several weeks' use of the CD-ROMs. Inevitably, the students exhibited initial hesitations in operating the interfaces, and false trails were followed. In the case of *Castle Explorer*, students initially used the game and only later began to explore the other browse and search options. Nevertheless, they very quickly mastered the mechanics of the interfaces and from then onwards used them confidently and competently. At the same time, the problems encountered in designing effective search strategies remained with them throughout the duration of the project. Only in a few cases at the end of the project period is there a sense that new searching skills are being acquired.

Despite the availability of multimedia resources with relevant still images, video (with sound) and animation sequences, the students concentrated their attention largely on textual information. This was notwithstanding the fact that the oral presentation had to include at least one poster, and that the students had to construct a

model of a medieval village. In the post-project questionnaire students were asked which medium was most helpful in supplying them with information for their assignments. Taking all three CD-ROMs together, 92% answered the text only. There are several explanations for the relative lack of attention to non-textual information. One CD-ROM did not allow students to print retrieved information. Notes could be made without too much difficulty, but still images are quite a different matter. In the absence of printing capabilities, images cannot be directly used. A second CD-ROM allowed textual but not visual information to be printed. The third CD-ROM did permit images to be printed, but the results were often too small and lacking in clarity to be useful. Theoretically, visual information could have been highly relevant to the model building exercise. None of the CD-ROMs, however, contained a picture of a medieval manor as such. They certainly included images of manor buildings such as castles, churches and windmills. That the students did not use them for this purpose can be explained by several factors. Firstly, as commented above, the students were very focused in their searching. If the objective was to find a manor, then it, and it alone, would be sought. Second, the model seemed to be considered both by the teachers and the students as the least significant part of the project. The model was produced at the very end of the time period allotted, and by then most students had spent as much time as they wanted on the CD-ROMs. Video and animation can both convey a lot of information, and it may be information that would be difficult to present in textual form. Nevertheless, written, oral and model-building projects do not provide good scope for the incorporation of such moving visual information. The only remotely relevant sound was incorporated in the video sequences on *Exploring Castles*, and these sequences were not in fact directly relevant to the project objectives.

The students in general were more than willing to print retrieved textual information, although this was less evident in the case of images. This does not support Small and Ferreira (1994) who found that sixth through eighth graders tended to take more notes from print sources than extract information from multimedia sources. It could be, of course, that in the intervening few years students have become much more familiar with electronic sources of various kinds.

In many cases entire sections, uncredited, were copied into their projects, but there seems no reason to think that such "plagiarism" is any less prevalent in the case of digital than print sources.

Student Assessment

The students' reactions to the CD-ROMs were gathered in two ways. Firstly, comments made by the students at one of the three workstations were captured by a microphone. Additionally, on occasions the research assistants did ask the students at the workstation why they had taken certain decisions. Secondly, all students were asked to complete a post-project questionnaire which in part gathered assessments of the CD-ROMs.The student responses from both these sources are in conformity. They answered overwhelmingly that they had most enjoyed using *Castle Explorer* in comparison with the other two CD-ROMs or other resources such as printed books or the Internet. *Encarta* also scored well in enjoyment, and these two CD-ROMs scored far higher than *Exploring Castles* or the non-CD sources. Conversely, very few students least enjoyed either *Castle Explorer* or *Encarta*; *Exploring Castles*, was the clear "winner" here. Students found it both difficult to use and relatively unhelpful for their written assignment, oral presentation or model building. In the case of *Castle Explorer*, they also found it relatively unhelpful for any of the three assignments, but clearly this did not prevent them enjoying it. It is interesting that the students could distinguish clearly between finding an interface easy and even fun to use on the one hand, and finding the information content of the database useful or useless for their project.

Ancillary Information Sources

Despite the availability of the three CD-ROMs in the classroom, students continued to use other sources. These included other CD-ROMs such as *Compton's Multimedia Encyclopedia*, *Grolier's International Encyclopedia* and *Encarta 97*, printed encyclopedias such as the *World Book Encyclopedia*, and various monographs. One student commented: "It is faster and there is more information on the CD, but if the book is specific then it is better." On the other hand, another student said that it was easier to use *Encarta* than a printed encyclopedia because

information could be printed out and because it was easier to look up. Some students also consulted Web sites from their homes.

Conclusions

The students were asked to find information about certain people, occupations and equipment, as well as several concepts. This required them to retrieve factual information on a number of specific topics and to present this information in a written project and an oral presentation. The class project was not about gaining a feel for life in a bygone age, but about assembling concrete factual information to present for assessment. This helps to explain why much more information was taken from *Encarta* than either *Castle Explorer* or *Exploring Castles* (and the heavy use of other encyclopedic sources, both on CD-ROM and in print). *Castle Explorer* and *Exploring Castles* try to give students a sense of life in and around a medieval castle, and in this objective they are in all probability successful. *Encarta* has no such aim. As a general encyclopedia, its objective is to deliver information on a wide range of topics, a few of which are relevant to the medieval project. This is the kind of information that the students' projects above all demanded.

Furthermore, moving images and sound cannot easily be incorporated into traditional school projects. Very considerable cognitive effort must be made to transform such visual information into static textual information - why bother when sufficient textual information is on hand? So long as the educational tasks can better be accomplished by using more traditional text presentations, then more traditional information sources will continue to play an important role. Before multimedia information can play a full role, as Neuman (1997) says, "students and teachers alike must develop new conceptions of the best ways to access, evaluate and use multimedia information for learning."

The prominence of retrieval features in the interface will influence use. If a full-text word searching capability is considered an important part of the search software, it must be displayed prominently in the interface if it is to be chosen. Regardless of prominence, however, the lower cognitive load and reduced need for prior subject

knowledge both favor browsing lists of search terms. Such a preference, of course, may not be confined to young users.

Identifying suitable concepts in which to encapsulate an information need, and then converting these concepts into effective search terms (including synonyms) are not intuitive actions. Children who have not been trained to do this will find it challenging. If the ability to retrieve required information from databases is a necessary skill to acquire in school then it will have to be inserted into the curriculum.

The students appreciated having the CD-ROMs on hand in the classroom and enjoyed using them. Many asked when they would be able to repeat the experience. In order to exploit them fully, however, it will be necessary to rethink the objectives of class projects. One solution is to have students download information from such sources and incorporate them into their own multimedia projects. Students can utilise simple authoring software to produce new multimedia products on specific topics covered in the class curriculum.

The current phase of this research is employing a similar methodology but to investigate how grade-six students navigate the World Wide Web to retrieve information for a classroom project on the 1998 Winter Olympics. Here they have access to a vast reservoir of textual as well as audiovisual information; the results should be interesting to observe.

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