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Lost in hyperspace: linearity versus exploration in the design of multimedia for independent learners

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Abstract: We are developing multimedia tutorials for independent learners based on a generic software shell. In doing so, one of the pedagogic issues we are addressing relates to navigation. This is a key factor in the effectiveness of multimedia teaching, since it affects how easy students find it to extract and integrate information. Multimedia tutorials tend to be either highly structured, with materials presented in a relatively linear fashion, or an encyclopedia-style explorative resource. The former is restrictive and provides the student with little freedom to study the materials in the order they choose; the latter makes systematic study difficult and students can easily become 'lost'. Disorientation in explorative-style packages is a particular problem for Field Dependent people (Witkin et al., 1971). We have incorporated the best features of both linear and explorative packages in our shell and our tutorials, with the aim of supporting Field Dependent people as much as possible, while not denying those students who prefer to work in an explorative way the freedom to do so.

Key Words: multimedia, independent learner, navigation, hypermedia, learning strategy

1. Introduction

We are producing multimedia tutorials for independent learners using a software shell that we have developed. Our tutorials are on biological topics but the shell is generic and can be used to present materials on any subject. One of the pedagogic issues addressed by the design of the shell, and the tutorials we are producing with it, relates to navigation and the problems faced by both students and teachers using linear-style versus explorative-style multimedia packages.

Distance learners, like our students at the Open University, have always been required to learn independently for much of the time but, in recent years, there has also been an increase in independent learning in conventional higher education institutions that have traditionally relied on face-to-face teaching, often as the result of pressures on staff time. The materials provided to these independent learners are increasingly in the form of computer-based multimedia packages. In the immediate absence of the teacher, the effectiveness of these teaching materials depends on how easy the student finds it, on their own, to extract and integrate the information necessary to allow them to achieve the learning objectives. Ease of navigation through a package is a key factor here.

2. Linearity versus Exploration

Multimedia teaching packages tend to fall into two main types: linear and explorative. In the former, the contents are highly-structured, with materials presented in a relatively linear fashion. There is often only one, or

very few, paths through the package: the student moves from one page to the next in a relatively predetermined order. In the latter, the package provides an encyclopedia-style resource, with materials presented as a set of multiply-interlinked items (hypermedia). The student can explore the items in any order, moving from each page to any one of several other linked pages. The numbers of possible paths through the package is potentially enormous.

A linear package has a number of advantages: the student can see what they have to cover, it is not usually possible for them to get 'lost', and it is clear when they come to the end. It is also easier for the teacher to produce the materials because information can be presented in an ordered way. The main disadvantage is that the student cannot study the materials in their own chosen order, so cannot develop their own learning strategy. The student lacks control and, as a result, may lose interest in the materials (Stoney & Wild, 1997).

The main advantage of an explorative package is that the student can go wherever their interest takes them and study in the way that suits them best. There are, however, a number of disadvantages. The student may find it more difficult to study in a systematic way. The teacher may find it more difficult to produce the materials because they cannot assume that the student has studied one page before looking at another: this becomes a problem if, for example, understanding A is necessary before learning about B. Students can also get 'lost' in hyperspace: having followed a succession of hyperlinks, they may find themselves unable to get back to where they were, going round in circles, looking at the same page several times over, and incapable of assessing how much of the content of a package they have actually seen (Grabinger et al., 1993; Korthauer & Koubek, 1994). This kind of disorientation can be a particular problem for Field Dependent (FD) people (Ring & Ring, 1997). Field dependence (Witkin et al., 1971) describes how people get information from what is around them so as to make sense of their 'field', or environment. FD people are more global in the way that they process information. They find it difficult to extract detail from a complex background. Field Independent (FI) people are more analytical. They can impose a structure on their environment even when none is provided. FI people can cope more successfully with explorative packages since, in such systems, the 'field' is complex and only small parts of it are visible at any one time. FD people, on the other hand, need to be given a visible structure if they are to function at their best, and need more navigational support to help them find an effective learning strategy.

In developing our shell and producing our tutorials, we wanted to incorporate the best features of both linear and explorative packages and to support FD people as much as possible, without restricting FI people.

3. The shell

The shell has been developed from software (the 'Scholar's Desktop') originally produced by the Biodiversity Consortium. The Consortium is a group of over 40 UK universities which was funded by the UK Higher Education Funding Councils, as part of the Teaching and Learning Technology Programme, to develop educational multimedia on biodiversity topics suitable for university-level students (Davies, 1995). The original shell was designed specifically to present tutorials in an explorative format. We have modified its appearance and functionality to address the issue of navigation for FD people.

The shell provides a series of buttons that allow students to access various features such as a contents page, a list of objectives, self-assessment multiple-choice questions, etc. In Figure 1, which shows a screen from a tutorial produced in the shell, these buttons are located down the right-hand side. They are always available to the student. The materials to be presented in the tutorial appear in the central 'window' of the screen. The title of the particular section within the tutorial that the student is studying is always visible at the top of the screen.

4. Navigation

Navigation in the shell is based on a three-level structure (Figure 2). Level 1 (shown in Figure 1) is a linear series of pages that the student moves through by means of forward and back arrows. This provides the main route through the materials. Each page may have a number of hyperlinks. Some of these may be in the form of additional buttons that appear as part of the page within the central window area. A Text button, for example, brings up any text associated with the page in the form of a (movable) 'popup' superimposed over part of the page the student is studying, a Video button plays or replays a video clip, and an Audio button plays or replays an audio clip. Other hyperlinks may be in the form of hotspots in graphics, or hotwords in text. Some hotspots or hotwords play, for example, audio clips, or bring up further text 'popups'; others take the student down a side-path to another page, or to the first of a linear series of pages, at level 2. Similarly, each page at level 2 may have links that bring up popups, play audio or video clips, or take the student farther down the side-path to level 3. To

get back to level 1 from level 3, the student must close the level 3 page (by clicking in the top left 'close box') and then the level 2 page (they can go direct from whatever page they are on; they do not need to return to the first page in the series). There are no cross connections between sets of level-2 pages, even between those accessed from the same level-1 page: the student must return to level 1 and descend again to level 2 via the appropriate side-path. Similarly, side-paths to level 3 from a single page at level 2 are all independent of each other.

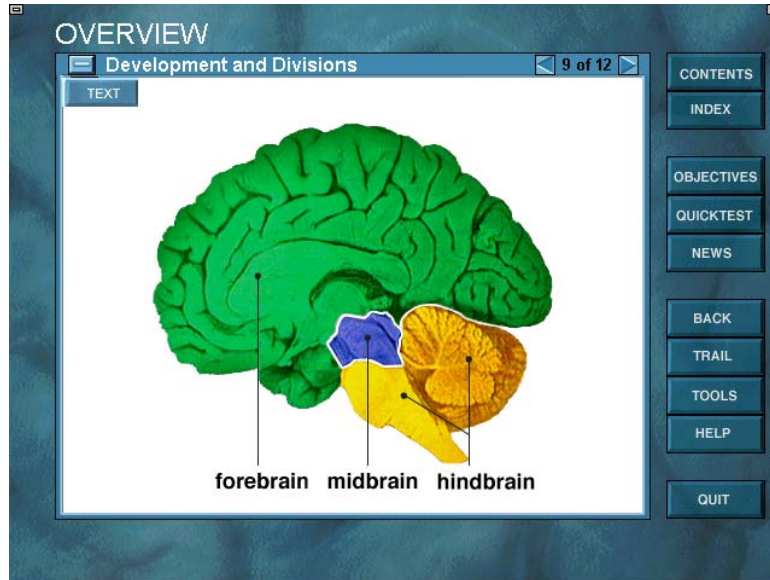


Figure 1 A screen from the 'Overview' section in a tutorial on the human brain produced in the shell.

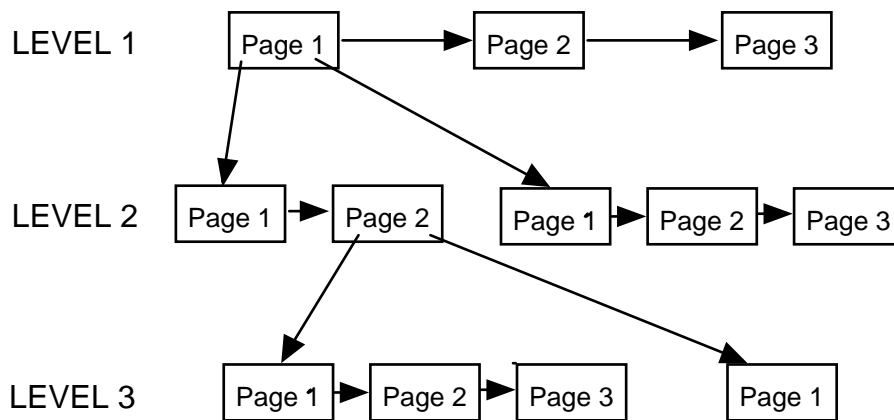


Figure 2 Three-level structure of the tutorial shell.

The three levels appear on screen as a cascade of pages (Figure 3). The title of each page remains visible so that the student always knows which route they have taken to get to where they are now. Each series of pages is numbered in the form '2 of 6' so that the student knows how many more pages they have to look at.

For those students who prefer to work in a more explorative way, navigation tools are available, via the buttons, to allow them to move to any page in the tutorial at any time. The contents page allows movement between major sections, and an index provides direct access to pages on the basis of their subject matter. A map shows the hierarchical organization of the pages (by page title) within the tutorial and again allows direct access to each page. The Back button takes the student to the previous page studied and the Trail button allows them to see a list of the pages they have already studied, and in what order, and to go back to any of those pages at any time.

5. Knowing what to expect and what you have done

As well as hyperlinks leading to e.g. popups or level changes, the shell allows for 'hyperjumps' that can take the student anywhere else in the tutorial, e.g. to a completely different section, but these are accompanied by a warning message which gives the student the choice of whether or not to jump. For each type of hyperlink there is a cursor change to show the student whether to expect a popup (a question mark), an audio clip (a loudspeaker), a move to a lower level (a downward-pointing arrow), or a jump (a kangaroo).

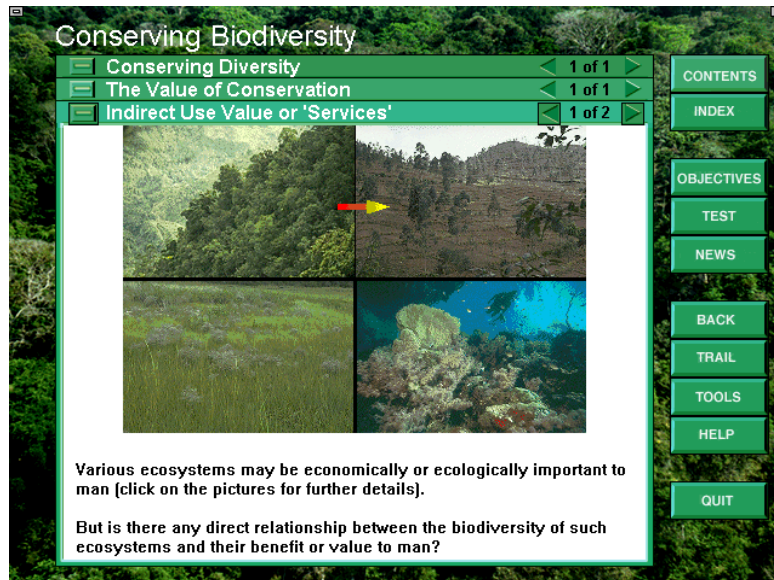


Figure 3. Screen at level 3 in a tutorial on Biodiversity, showing the cascade of pages from the three levels.

A colour coding system provides students with information about which materials they have looked at and which they have not. Hotwords are coloured differently from the rest of the text and the position of hotspots can be revealed by a 'show hotspots' button which puts a coloured outline around them. In each case, the colour changes once the hotlink has been accessed. Pages that the student has looked at are also marked in the map with an asterisk

6. Discussion

'In any multimedia experience, learners should have a good mental picture of where they are; what they can do here; how they got here; where to go next; and how to get there' (Stoney and Wild, 1997). Our tutorial shell fulfils all of Stoney and Wild's criteria: the three-level structure and numbered pages shows students where they are; consistent, clearly labelled buttons, coded cursor icons and hotlinks show students what they can do here; the three-level structure, the map and the trail show them how they got here; the forward/back arrows, the downward pointing cursor, the contents page, index, map, Back button, and Trail button show them where to go next and how to get there.

In the tutorials we have developed so far, we have used the shell to provide a structure that is basically linear while still giving students the opportunity to explore, in that the number of side paths is fairly limited and the number of hyperjumps very small. We have also organized information in a structured way, such that the most basic information is provided at level 1 and the amount of detail increases as the student moves down the levels. The section heading, cascade of three levels and the numbered pages make the structure highly 'visible'.

Our tutorials still provide students with a high level of control, however. Control by the student is important because it is not possible to predict the exact sequence and pacing that each individual student needs (Laurillard, 1995). Laurillard argues that a number of control features should be available in a multimedia tutorial, for example a structured map of the content, concealed multiple choice questions, access to a set of learning objectives, meaningful feedback, and an indication of the amount of material in each section. We have included all of these features in the design of the shell and the tutorials we are producing in it.

We thus provide a ‘visible’ and structured learning environment for the student in which they always know exactly where they are and what they have and have not studied, while still allowing them the opportunity to explore and develop their own learning strategy. Field Dependent people are supported but Field Independent people are not denied the freedom to explore at will. A preliminary evaluation of the three-level structure has revealed that most students find it very or fairly helpful; a more detailed evaluation is planned.

We should note, however, that, although we are producing tutorials that compromise between linearity and exploration, the shell itself is extremely flexible in terms of the degree of linearity it imposes on a tutorial and thus the amount of learner control it allows. Depending on the subject matter and the amount of student control thought appropriate, the shell could be used to produce a strictly linear tutorial, by putting materials into a series of pages all at level 1, with no hyperjumps. It could also be used for a highly explorative tutorial, by increasing the number of side-paths off each page, reducing the number of pages in each linear series, and increasing the number of hyperjumps.

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