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Pauline Sobreperez
University of Salford

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ISSUES CONCERNING THE USE OF HCI GUIDELINES IN THE PRODUCTION OF AN INTERACTIVE MULTIMEDIA TUTORIAL: A CASE STUDY

Pauline Sobreperez
University of Salford
P.sobreperez@salford.ac.uk

Abstract

An interactive multimedia tutorial was created with a target audience of first year degree students who have been introduced to data normalisation through formal lecture and require consolidation and reinforcement in the form of practice of the technique. A multimedia solution was adopted owing to the ability to directly interact with screen items to create solutions to problems and to gain feedback before moving on. The paper discusses the design decisions made and the benefits and limitations of using HCI guidelines to justify these decisions.

Introduction

This paper provides an account of the production of an interactive multimedia tutorial to meet the requirements of students studying relational databases. The content of the tutorial is a demonstration of the three stages of normalisation up to third normal form and the tutorial then provides the opportunity for students to reinforce their knowledge of this method by a series of exercises using a different scenario.

The report begins by reviewing and summarising existing research into human computer interaction. A justification of the choices made in terms of product structure, screen design and navigational issues is included in this section. The report highlights the strengths and weaknesses of the finished product and includes an account of issues encountered and the surmounting or otherwise of these problems.

Overview of Existing Research

The purpose of the interactive multimedia tutorial is to reinforce previously explained information. In view of this, it is necessary to incorporate findings from studies of human interaction with computers in order to build the most effective learning situation. The constructivist approach to HCI underlines our ability to bring prior knowledge to immediate perception (Newman & Lamming 1995), (Hodges & Sasnett 1993), (Schank 1994), (Gregory 1974). People learn better when they can do as well as see (Geismann 1988), (Piaget 1970) and thus an interactive system using a familiar scenario and allowing actual screen manipulation, tracking of pace, direction and feedback is the most suitable medium for the tutorial (Newman & Lamming 1995). Although new information is stored in short term memory, meaning or context is stored in long term memory, (Brown 1958), (Peterson and Peterson 1959), (Murdock 1962) and hence the scenarios used include students on courses and soccer players in teams. These were chosen as the context is familiar and populist in that users are likely to have prior knowledge.

The guidelines have many common themes including consistency, use of colour, screen arrangement, navigation, intuition, anthropomorphism, direct manipulation, colour and presentation of text and recommendations for prototyping and evaluation.

The emergence of Interactive Multimedia has brought many design issues to the fore. The sets of guidelines with common themes are in existence and are justified by the results of experiments by Quintanar et al (1982 in Shneiderman 1992) in Shneiderman 1992. Elements from the guidelines have been utilised in the design and production of the tutorial and the section entitled Application of Guidelines will draw attention to where they have been utilised.

Production of the Multimedia Tutorial

Tutorial Structure and Content

The overall navigational design of the Tutorial is linear (Vaughan 1988) in that each screen follows directly to another single screen. There are minor diversions in the options submenu to allow the user to look at a course overview, a glossary of terms and stated objectives. Similarly there are several ‘hypertext’ (Nelson 1980) links to the same definitions that can be found in the glossary. The reason for the linear structure is partly due to the highly structured nature of the content, which is a sequential procedure, but also to eliminate the disruption to flow and loss of position which can occur as a result of many hypertext links (Nelson 1980). The advent of hypertext, which allows the user to skip from topic to topic using a self determined route has facilitated design which allows the user to get ‘lost’. Don (1990 in Laurel 1990), and Oren (1990) highlight how linearisation is likely to contribute to increasing navigational ability and comprehension.

During the use of the tutorial, a scenario is given using students on courses and sample data is deliberately included as this makes normalisation easier to understand. Normalisation to third normal form is done in the three phases as outlined by Professor E. F. Codd in 1970 and the first part of the tutorial demonstrates the movement from unnormalised data to first normal form. This is followed by a student exercise, using a different scenario of soccer teams and players, where the student must apply the concept from the demonstration to the exercise. The tutorial then reverts back to the students on courses scenario and demonstrates the transition from first to second normal form. Once again the student must perform a similar action using the soccer scenario. The next stage is to go back to the students on courses scenario to demonstrate second to third normal form and then the student must perform similar actions using the soccer scenario.

Application of Guidelines

At each stage in the normalisation exercises, the student must perform certain actions and feedback informs the student whether s/he has performed the action correctly, in which case progress is allowed, or incorrectly where they must go back and try again. Correct answers are met with a short musical sound, a text message and a scorecard; incorrect answers are met with ‘sorry, please try again’ and a cuckoo sound. Regular feedback is recommended by many of the guidelines (Chabay & Sherwood 1992), (Shneiderman 1982), (Molich & Neilsen 1990). Although the ability to utilise timed responses is available in the development software, it was only used when presenting the welcome screen and the goodbye screen. Guidelines suggest that it is better to wait for a signal from the user before moving on to the next item, facilitating user paced progression through the tutorial (Chabay & Sherwood 1992). Users will read and act at different paces and this is one of the chief advantages of using interactive multimedia. It would be counterproductive to eliminate this feature by using a method that does not take advantage of this.

In screens which require tasks to be performed, inactive control options are removed so that when the student must select from the screen, the option to move forward without performing the required action is removed (Chabay & Sherwood 1992). Other guidelines suggested ‘greying out’ - changing the colour of the forward button to indicate that it is no longer available (Shneiderman 1989). This solution was rejected because although it is suitable for black and white menus, the use of speckled colours on buttons was difficult to make unavailability clear and thus affordance was lost. Similarly a way out is always provided in the event of emergency, time constraint or inability to perform tasks in the form of an EXIT button which always appears in the same position (Chabay & Sherwood 1992), (Shneiderman 1989).

The metaphor used for the tutorial borrows controls from the video recorder and player. The controls are very simple: forward, back, fast forward and fast back buttons. It is clear, without further explanation, that clicking on the forward arrow will take you to the right or next screen in line with the affordance theories of Norman (1988). The organisation of the menu items suggests that they are followed in logical order, from top to bottom. If they are followed in any other order however, there will be no errors, and the system will still work both technically and conceptually.
The screen design is consistent in the placement of navigation icons, text styles and user tasks and in the use of colour (Kellogg 1987), (Wolf 1989), (Reisner 1990), (Neilsen 1989). Feedback uses the same messages in the same positions and the same sounds. The backgrounds used are pink speckled for the demonstrations and green speckled for exercises. This is to ensure clear switching from demonstration to exercise.

For the reasons outlined by the experiments of Shneiderman (1982) the Tutorial uses the You nonanthropomorphic interface especially during the exercise sessions. Throughout the tutorial, simple natural dialogue is used (Molich & Neilsen 1990) to reduce the need to translate before moving on. For example ‘row’ is used instead of ‘tuple’ because it is more familiar. Similarly a low number of words per screen is used to reduce complexity and to encourage reading (Muter et al.1982). Screens which require reading and understanding rather than simply titles have been produced with dark letters on pale background, and the luminance is dimmed by a speckled effect to reduce glare (Radl 1980).

The menus are arranged as full screen menus with the choices highlighted as the mouse moves over them. When the user clicks the menu option the entire screen changes to a new ‘page’ in accordance with the Chabay and Sherwood guidelines (1992).

Data entry was deliberately avoided except for the initial login screen as typing presents a multitude of opportunities for errors (Chabay and Sherwood 1992). Typing is replaced by pointing, selecting and dragging items to positions and the results of actions are immediately visible. During the exercises, the student has many opportunities to perform direct manipulation by dragging items to destinations, clicking on appropriate areas etc. Colour is used to code areas of the screen - red for primary key, yellow for data, blue for foreign keys. This complies with the findings of Travis (1991) that colour is a useful coding method for grouping information, and reiterates Davidoff’s (1987) finding that colour is most useful in tasks requiring categorisation. Table 1 summarises and consolidates these guidelines.

<table>
<thead>
<tr>
<th>Design Criteria</th>
<th>Literature Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Give clear explicit feedback &quot;it is essential to provide feedback that makes it clear that the computer has detected input, and how the input has been interpreted&quot;</td>
<td>Chabay &amp; Sherwood 1992 p177, Shneiderman 1982, Molich &amp; Neilson 1990</td>
</tr>
<tr>
<td>Don’t use timed pauses &quot;Wait for a signal from the user before moving on to the next item&quot; thus ensuring student paced learning.</td>
<td>Chabay &amp; Sherwood 1992 p173</td>
</tr>
<tr>
<td>Remove controls which allow user to move forward without performing tasks</td>
<td>Chabay &amp; Sherwood 1992, Shneiderman 1989</td>
</tr>
<tr>
<td>Provide an emergency way out &quot;do not let the student get trapped in a blind alley&quot; where a question must be answered but the answer may not be known.</td>
<td>Chabay and Sherwood 1992 p179, Sneiderman 1989</td>
</tr>
<tr>
<td>Provide a consistent interface &quot;Maintain consistent format from one display to another.&quot;</td>
<td>Smith &amp; Mosier 1986 guideline 2.0/6, Kellogg 1987, Wolf 1989, Reisner 1990, Neilsen 1989</td>
</tr>
<tr>
<td>Provide an intuitive metaphor</td>
<td>Norman 1988</td>
</tr>
<tr>
<td>Use low number of words per screen</td>
<td>Muter et al 1982</td>
</tr>
<tr>
<td>Use dark letters on pale background</td>
<td>Radl 1980</td>
</tr>
<tr>
<td>Page new screen between topics &quot;clear the screen entirely... and proceed to exploit the much larger display space now available&quot;.</td>
<td>Chabay &amp; Sherwood 1992 p161</td>
</tr>
<tr>
<td>Avoid data entry &quot;Let the user manipulate things directly …the interface should be transparent&quot;.</td>
<td>Chabay &amp; Sherwood 1992 p173</td>
</tr>
<tr>
<td>Use colour to codify</td>
<td>Travis 1991, Davidoff 1987</td>
</tr>
</tbody>
</table>
Benefits of the Chosen Methods and Techniques

During the development of the Multimedia Tutorial, use of guidelines had three main benefits. Firstly, hardware, software or content specialists will often not have the background in psychology, cognitive science, or ergonomics which underpin software design guidelines and these can be used to ensure effective navigation and movement. Secondly, designers will come across unfamiliar design problems as technology and software changes; guidelines can provide a source of help justified by past research (Newman & Lamming 1995). Finally for a novice in screen design, the guidelines are useful in raising design awareness, assisting in design choices, offering strategies and supporting evaluation (Teflatz & Schwartz in Newman & Lamming 1995).

Limitations of Methods and Techniques

The use of guidelines has several limitations including the tendency to use those which match preconceived ideas (Teflastz & Shwartz in Newman & Lamming 1995). In addition a trap outlined by Bill Verplank in Preece et al. (1994) argues that it is undesirable to create working software too early as development is so far down the road when alternatives are considered that changing direction becomes unacceptable.

Several guidelines (even within the same set) contradict each other as in the example below from Sun Microsystems guidelines (Barnard & Grudin 1988 in Newman & Lamming 1995).

- place most commonly used items at the top of the list
- place list in logical order

Other limitations include the tendency to be vague, for example ‘the content of display within a systems shall be presented in a consistent manner’, from a US military standard MIL-STD-1472C(1983) in Dix et al. (1993). This guideline has been applied to the tutorial in that screens are similar in layout, backgrounds are consistent, and the placement of navigation controls and responses to exercises are consistent.

Teflastz and Shwartz found that guidelines are often inappropriate to the context in which they are being used, inapplicable to the activity being undertaken, or inapplicable to user. This is because they are sometimes written from a particular background, for example for data entry, for primary school learning, or for menu based interfaces. Interactive multimedia is a new and evolving area and creativity can be inhibited by strict adherence to guidelines which predate current technologies (Hill 1995).

One of the problems encountered was that of portability. Vaughan (1998 p311) suggests that multimedia products are created to run on the lowest possible platform. ‘If you wish to reach the widest audience for your multimedia, you must design for the minimum design configuration’. Therefore the product was created to run on 640 by 480 pixel screen size with 256 colours and this means that the screen must be adjusted to see the product run properly. When the product was tested, several machines had to be changed to run this size and then changed back afterwards. Although the user guide clearly states how to do this, it detracts from the smooth running of the system and does not utilise the full potential of the screen area. Fast and efficient installation is one of the major aims of delivering a multimedia tutorial (Vaughan 1998) and this is not achieved because of this decision. In retrospect, it may have been better to create the tutorial to run in 800 x 600 SVGA mode as the standard platform rather than accommodating the lower and far less common configuration.

Vaughan (1994), Lopuck (1996), and Burger (1995) draw attention to the team approach to multimedia production where, ideally, graphic designers, hardware and software experts, script writers and video and sound specialists work together under a project manager to create a professional package. ‘The design of visual elements should be left to people schooled in their creation: graphic designers’ (Tognazzini, 1992 p340). Clearly this is not always possible and personal lack of creative design skills is revealed in the rather tame visual impact of the entire product.

Evaluation

In line with Pressman’s(1987) view of software development, the requirements of the software are not rigorously defined and therefore in order to create an examinable model of the design, a running software prototype of the tutorial was created. This allowed evaluation by potential users in terms of both students and tutors. The storyboarding technique does not give the user the operational sequences clearly and the look and feel of the interface is not apparent. This is especially true in a multimedia environment where the interaction of sound, graphics and animations is intrinsically impossible to represent on paper.
Evaluation of software user interface used two of the four techniques outlined by Jeffries et al. (1991). These were heuristic evaluation and usability testing, as there were no opportunities to utilise evaluation guidelines and cognitive walkthrough.

The evaluation methods examined were logged data, questionnaires, interview and verbal protocol analyses (Henderson et al. 1995). In the logged data method, each user has a tracking file which records how long is spent on each screen. This method may not be as useful as it sounds as there could be many reasons for pauses such as language problem, navigational trouble, problems with understanding etc. and these are not necessarily noted. The questionnaire method was used to evaluate the prototype with two groups of users. Firstly with the end user - the student, and secondly with a tutor, or content expert. The interview method was used in conjunction with the questionnaire to expand the answers given and to add reasons to comments. Verbal protocol analyses were not used.

The final product was evaluated by student users and by a content expert using an evaluation questionnaire designed by the National Multimedia Consortium of Further Education Colleges at Waltham Forest College. A total of 25 evaluations were undertaken and 92% of respondents had not taken a multimedia course before. 80% of users answered the question 'How enjoyable was the course' with a 4 or 5 indicating a high degree of enjoyment. This is in line with the findings of Nelson (1980) who noted user excitement by what he termed the principle of virtuality. Rutkowski (1982) terms this the principle of transparency and both researchers refer to the user applying themselves directly to the task of sliding things about the screen as they might with flat easily moveable objects on a table, the tool itself, the mouse/screen become transparent. Hutchins et al (1986) describe the "feeling of involvement directly with a world of objects rather than of communicating with an intermediary" and point out that this breaches the gulf of explanation required by extra text, voice or other explanatory information.

Question 5 asked whether users thought they learned much from the course and 72% chose response 4 which suggests they were reasonably happy with the approach. This is in line with the finding of Geismann (1988) that people learn better when they see, hear and do.

Question 6 asked users to decide whether the course was too fast, too slow or about right. 92% of respondents thought the pace was about right which is as expected as one of the main benefits of this type of tutorial is the capacity for self-paced learning (Vaughan 1994).

Question 7 concerned the usefulness or otherwise of the multimedia components used in the tutorial. 72% or respondents considered the use of graphics, sound and video useful and a further 24% considered them very useful. 100% of respondents found the interactive tests and tasks useful or very useful. These findings support the work of Piaget (1970) and Geismann (1988) in that participative tasks aid learning.

Question 8 showed that 92% of respondents were not worried by the computer, a figure somewhat distorted by the fact that all of the respondents were Information Technology students and were familiar with computer usage. Question 9 found that 88% of students found the course easy to log in and Question 10 that 76% of students found the course not difficult to exit. This second figure is lower as the exit procedure is slightly clumsy requiring a return to the main menu before actual exit. Because the software does not allow conditional execution, it is not possible to have different routes in different circumstances and the exit route must be the same for completion of the tutorial as for interrupted exit.

In the final question, only 40% of respondents found the course easy to navigate with 28% finding it fairly easy. This suggests that even though the structure of the course was intended to be simple and linear, the students found it not so simple which is in line with research on the navigational problems often encountered in multimedia productions (Don 1990 in Laurel 1990).

The purpose of the evaluation by the content expert was to verify the correctness of the stages of data normalisation and to suggest any improvement to the design which might make the procedure clearer. The content expert suggested that the backgrounds to exercises were given a different colour to differentiate them from the demonstration screens and this was duly completed.

**Conclusion**

Interactive learning materials are produced by many types of organisations and a multitude of guidelines exist to assist in designing intuitive, usable software which clearly meets learning objectives.

Guidelines are useful as a reference point and to offer strategies but have limitations of over generality, inappropriateness to the situation, lack of currency and contradictory advice. Compliance with guidelines does not ensure usability and, when used in isolation, cannot ensure quality. Perhaps one of the most important guidelines is the recommendation for iterative evaluation.
with the user which aligns with the systems design approach to software production and facilitates new perspectives on the product.

The progress of new technologies is likely to provoke radical changes to learning in an ongoing process. The learner rather than the teacher will become the focus of the learning process and the facilitation of this will be determined by the quality and performance of the multimedia tutorials on offer.

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