The Role of Multimedia in Interfaces for On-Line Learning: a Two Group Study

Dimitris Rigas, Deborah Hopwood and Hongian Yu

Department of Computing, School of Informatics, University of Bradford, Bradford BD7 1DP, UK, Email: D.Rigas@bradford.ac.uk

Abstract. This paper describes three experiments with two groups of users in order to investigate the role or effect of multimedia metaphors for on-line learning systems. The platform of this investigation involved different complexity learning interface circumstances for the three on-line learning applications. These applications consisted of a basic, an intermediate and an advanced complexity. The basic complexity application involved the Microsoft Display Properties, the intermediate involved the Excel Formulas and the advanced involved the Access Database. Each of these applications had two versions, one with text and graphics and one with multimedia metaphors. The text and graphics applications had a graphical display to simulate the environment of the on-line learning system, text to communicate the instructions, graphical (non-animated) arrows and transparent icons as navigational aids to communicate to users the position to click. The multimedia (text, graphics, animation and sound) applications had graphical display to simulate the environment of the on-line learning system, text and recorded speech to communicate instructions, animated arrow and transparent graphical icons with animated text and earcons with stereophony as navigational aids to communicate to users the position of the area to be clicked. These two conditions were tested with two groups of 8 users each. Group A evaluated the text and graphics versions and group B evaluated the multimedia versions for all three applications. The experiments were performed with controlled laboratory conditions. Results showed that multimedia metaphors helped users to successfully complete complex tasks but did not have a significant effect upon users for the successful completion of simple tasks. In intermediate and complex tasks, multimedia metaphors helped users to make fewer mistakes and in some cases reduced the time taken to complete. A series of issues have been identified for the role of multimedia in interfaces for on-line learning systems. The results also suggested that other multimedia metaphors could be used for high complexity learning systems. These metaphors could include the use of combinations of auditory icons, earcons, synthesised and recorded speech in addition to special sound effects.

1 Introduction

There are many different terms that are used to refer to on-line learning. Examples of these terms include Web-based training, computer-based training, and on-line learning. In this paper, the term on-line learning is used. Historically, the routes of on-line learning started by a company called 'Control Data' that developed the 'Plato' system

in the 1960's. It was considered to be the basis for many authoring languages and approaches taken in on-line learning. Thus, on-line learning systems can be traced back to the Plato system. IBM developed the first PC in 1981 and learning applications were developed on floppy disks which meant that the learner was learning in isolation. There were, of course, limits to the amount of information that could be incorporated into the applications given that it was distributed on a floppy disk. When Local Area Networks were developed, on-line learning applications improved but there was still a media richness limit. In the late 1980's CD-ROM enabled on-line learning applications to be more media rich as developers started experimenting with sound and visuals. In recent years, internet based on-line learning applications started to be developed. The demand for richness of information was growing and networks allowed users to learn in collaboration. On-line learning went from very much a hardware based platform to a software based platform [1].

1.1 Multimedia Metaphors in Interactive Systems

People perceive information and learn by using the visual, aural, haptic, and other senses. Different types of people have different learning styles. For example, some people may learn better from visual or auditory stimuli. Diagnostic studies, at Rockville, Maryland, suggest that the learning style of a typical student consists of 29% from the visual metaphors, 34% from the auditory metaphors and 37% by the haptic metaphors [1].

Many different types of learning systems have been developed over the past years [2]. However, there is still a need for more efficient and effective on-line learning systems. Currently, more than half of the American universities have facilities in place for on-line learning systems [3] and there is a continuous trend for Universities to offer courses by distance on-line learning systems [4]. Furthermore, industry also provides training on web-based on-line learning systems [5]. For example, Cisco provides over a 100 training presentations over the internet [6]. Internet based on-line learning systems often make users feel in control and therefore they often learn more effectively [7]. Users could be provided with access to large sets of real world data [7, 8], a more in-depth learning experience [7] and users may also develop better thinking skills [9]. One of the problems of on-line learning systems is often considered to be the excessive use of text [2]. The use of multimedia metaphors could provide a solution to this problem. Multimedia metaphors include animated graphics and sound. Speech is one of the most common forms of sound used. However, different types of auditory metaphors could be used in addition to speech. For example, it could include earcons, stereophony or auditory icons [10, 11].

Today, multimedia on-line learning systems offer many different types of facilities. For example, good quality content and learning tailored to the individual needs of learners, interactive simulations, collaboration tools, mentoring facilities, learning management systems to track progress and produce statistics, easy to use and navigate, bite size learning objects, and web conferencing for training [2]. Although many of the current learning systems offer some multimedia facilities, there is still a need to establish the contribution of multimedia metaphors (including auditory metaphors) to on-line learning. For example, the contribution of one type of metaphor from another (e.g., visual graphics with animation) to the learning experience of users in an on-line

learning system is also not very well defined. This paper reports the initial phases of our investigation that aims to better understand the role of multimedia in on-line learning applications.

2 Experiments with Learning Tasks

The aim of the first phase of the investigation was to explore the use of text, graphics, speech and animation in different circumstances of on-line learning platforms and whether users could perform learning tasks easier in the presence or absence of multimedia metaphors. These applications consisted of a basic, an intermediate and an advanced complexity. The basic complexity learning application was based on the Microsoft Display Properties program, the intermediate was based on the Excel Package and the advanced was based on the Access Database Package. Each of these applications had two versions, one with text and graphics and one with multimedia metaphors. The text and graphics applications had a graphical display to simulate the environment of the on-line learning system, text to communicate the instructions, graphical (non-animated) arrows and transparent icons as navigational aids to communicate to users the position to click. The multimedia (text, graphics, animation and sound) applications had a graphical display to simulate the environment of the on-line learning system, text and recorded speech to communicate instructions, animated arrow and transparent graphical icons with animated text and earcons with stereophony as navigational aids to communicate to users the position of the area to be clicked.

The study had a control and an experimental group of 8 users for each group. The control group (group A) completed the text and graphics on-line learning applications and the experimental group (group B) completed the multimedia on-line learning applications. The experiments described below examined the combined effect of text and graphics only and again the combined effect of text, graphics, animation and sound as communication metaphors. Therefore, two versions (i.e., a multimedia version and a graphics and text version) of three experimental simulations of on-line learning applications were designed. These applications have been designed using existing guidelines [2]. They were created in a simulated environment using a window for instructions and navigational aids. The Macromedia Director Tool was used to develop the prototype versions of the learning systems. They were based on the training material available for the European Computer Driving License (ECDL). The ECDL is an accredited qualification and is often considered as a European standard in industry for knowledge in information technology and for some Microsoft applications. During the experiments, users were provided with instructions of how to use the applications and a set of tasks that they were required to complete, an anonymous questionnaire that aimed to collect information about the particular user, the MIDAS learning style questionnaire, and a questionnaire on the interaction experience. The personal questionnaire determined the technical competence and expertise of the users. The Multiple Intelligences Development Assessment Scales (MIDAS) questionnaire determined the favoured learning style of the users. This questionnaire measured eight constructs of intellectual disposition for each user. These were linguistic, logical and mathematical, spatial, musical,

kinaesthetic, naturalist, interpersonal and intrapersonal. The questionnaire identified twenty four relevant skills within each of these constructs.

2.1 Simple, Intermediate and Advance Learning Tasks

As a simple task, the display properties application was chosen. The display properties application is a Microsoft Windows function that allows users to change their display settings. The system developed aimed to teach users the various features available and how to use them. The display properties test incorporated seventeen basic questions, four of which were definition questions and thirteen were small tasks. Tasks 4, 9, 14 and 16 involved the recall of definitions. Tasks 11 and 12 were tasks that they had not done in the training, but were similar. The control group was provided with the text and graphics learning application and the experimental group was provided with the multimedia application. As an intermediate task, Microsoft Excel formulas were chosen. The learning tasks included the use of functions and formulas to calculate, for example, sums and percentages. The tasks requested to be performed increased in difficulty. This experiment had ten tasks, three of which were recalling definitions and seven were formula constructions. An animated keyboard to show how to input the numerical symbols was also provided. For the advanced task, the learning platform chosen was the Microsoft Access Database. The tasks included the design of tables, enter data into the tables, linking tables by primary key, creating a query from two tables, and using filter criteria. This experiment had thirteen tasks. The tasks increased in difficulty and in order to complete the last few, earlier tasks had to be completed correctly.

3 Results and Discussion

Figure 1 shows the percentages of successfully completed tasks for the control (text and graphics) and experimental (multimedia) groups as well as the results of the post-experimental questionnaires in which users were requested to express preference for particular types of media or metaphors. It can be seen that the experimental group (multimedia) performed better than the control group in the intermediate (Excel formulas) and advance tasks (Access Database). However, the control group performed better in the simple tasks.

In the Display Properties experiment (simple tasks), both groups had difficulty to recall definitions. These tasks were testing to see if the concept was grasped. There are lower marks on this score although still similar for each group. The experimental group averaged slightly lower than the control group. These results demonstrate a prima facie case that there was not significant difference in using multimedia for small on-line learning tasks. In the Excel Formulas, percentages of successfully completed tasks were lower in the control group, which also involved the recall of definitions. There was a noticeable difference in the successful completion of tasks that involved advance formula calculations between the control and the experimental groups. In those tasks, it appears that the experimental group performed better. Thus the use of speech and the

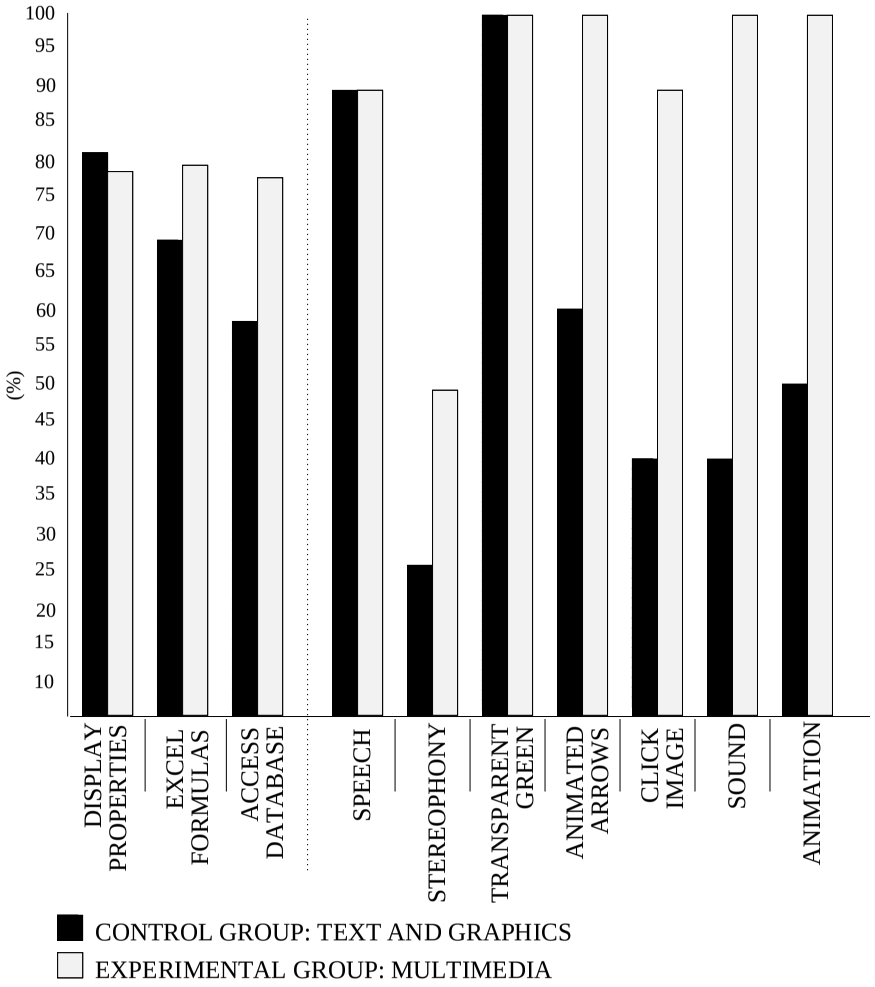

Fig. 1. Figure shows the percentages of successfully completed tasks and the preference of users for the different types of multimedia metaphors for the control and experimental groups.

animated keyboard to demonstrate the relevant keys to press contributed to the successful completion of those tasks. In the Access Database experiment, definition tasks were performed better from the experimental group. On overall, for most of the tasks the experimental group performed better and therefore demonstrates a prima facie case that multimedia helped users to learn more material and performed different tasks more successfully. Post experimental questionnaires asked the control group to identify multimedia metaphors that they would have preferred as part of an on-line learning system and the experimental group to identify those metaphors that they found most useful in their interaction with the on-line learning applications. It is interesting to note that the control group that had not used any of the multimedia features did not

appear to favour those features. However, users in the experimental group preferred multimedia metaphors with an exception to stereophony. This demonstrates that once individuals had experienced multimedia metaphors, they realised the benefit to on-line learning applications. During the experiments, it was observed that iteration of the presented information was very important for both text and graphics and multimedia modes. Both groups successfully completed tasks that involved repeated information in the on-line learning application based on the Excel functions. Users also needed to be guided in all the functions of the applications again for both modes. Furthermore, definitions were not communicated satisfactorily to the users using text and graphics or text, graphics and speech. The use of multimedia with semantic association and reiteration in an animation form appeared to be more successful.

4 Conclusions

A prima facie case for the use of multimedia in on-line learning systems has been established. Multimedia metaphors did not significantly influence simple learning tasks (i.e., display properties) but, as the complexity of the tasks increased, the multimedia group performed better than the text and graphics group. The multimedia group would prefer to have most of the multimedia metaphors but the text and graphics group did not express the same interest for the multimedia metaphors. Therefore, users must first experience the multimedia metaphors in an on-line learning application in order to be convinced that these metaphors could contribute positively in the learning experience. The most useful metaphors were speech, transparent graphical icons, arrows and the 'click image'. The use of multimedia metaphors helped users to learn and perform complex tasks more accurate but very small effect was observed for simple tasks. A series of issues have been identified for the role of multimedia in interfaces for on-line learning systems. The design of the multimedia metaphors must be balanced with other text or graphical metaphors used. A user controlled facility to forward, accelerate, slow or pause a speech message, an earcon, an animation is necessary so that individual needs of users can be accommodated. For the design of on-line learning applications, a learning strategy must be first identified and the communication metaphors used should be an implementation of that strategy. User trials are very important to identify strengths and weaknesses of the metaphors chosen. These metaphors could also include the use of combinations of auditory icons, earcons as well as special sound effects. Larger scale experiments are now planned to explore further the prima facie case identified for the use of multimedia metaphors in on-line learning applications.

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