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A Hypertext Tutorial for Teaching Cephalometrics†

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Abstract. *Hypertext is a non-linear method of text presentation. It necessitates the use of a computer to store data as a series of nodes that can be called up in any desired sequence and, as such, is a new form of discovery-based learning.*

This paper describes a Hypertext tutorial in cephalometrics and its subsequent testing on first-year clinical dental students. Students were divided into two groups: the first received a conventional lecture; the second used the Hypertext tutorial. Testing was by means of conventional multiple choice questions.

The results showed that there was no statistically significant difference between the two groups, although the computer tutor was shown more consistently to improve the knowledge of the students than did the conventional lecture. Most students who used the computer program found it enjoyable, but time consuming; less than half found it easy to follow.

Index words: Cephalometrics, Computer-assisted learning, Hypertext.

Refereed Paper

Introduction

Computer-based learning packages are developing rapidly. In early programs the material was presented in a simple way, as text and pictures very similar to the presentation style used in textbooks. The student either read text directly from the screen of the display unit or had the facility to print out sections as required. Such systems made little use of the full potential of the computer and were essentially electronic note pads.

Improvements in both knowledge and computer technology have allowed the development of non-linear hypermedia systems (Poor, 1992). Systems in which the human teacher is replaced by a personal computer, were foreseen by Vanevar Bush who was scientific advisor to President Roosevelt. Bush imagined a machine which would allow large databases to be stored, and accessed rapidly and intensively in any pattern that the learner chose (Horton, 1990). This concept was extended in the 1960s by several workers, including Theodore Nelson to whom the term Hypertext is usually accredited (Nelson, 1967).

The essence of a hypermedia system is that it allows the user to depart from following the information in a linear fashion as in reading a book and, instead, to move freely through the material by following leads provided by highlights on the screen. Such a system permits users to study on different levels; core material can be supplied in a compact form for easy access, whilst more ambitious users are able to move through the package according to their interest and needs (Keisch *et al.*, 1992).

The use of computers provides an exciting addition to the learning facilities of a dental school and at a time of financial constraint the use of systems that do not require the presence of staff has obvious attractions. However, it is crucial that new methods are properly evaluated and demonstrated to be equivalent to, or better than, more traditional methods of instruction. The results of several studies have been encouraging. Evaluation of a computer program for endodontic diagnosis showed that the computer was at least as effective as a self-teaching booklet and preferable to a standard lecture format (Puskas *et al.*, 1991). Other studies have indicated that students may retain knowledge better and thereby achieve higher test scores after the use of computer-assisted teaching learning (CAL). This aspect was tested during the University of Nebraska introductory orthodontic course. All students received written material relating to mixed dentition analysis, half of the participants attended an additional lecture, whilst the others were not allowed to attend the lecture but had access for 2 weeks to a CAL program. The computer group achieved marginally, but statistically significantly, better scores in the post-test than the lecture group (Irvine and Moore, 1986).

A review of the dental education literature for two decades up to 1980 discussed 22 schemes for self-instruction (Williams, 1981). It was concluded that self-instruction was capable of increasing cognitive knowledge significantly in a shorter period of time and with increased student satisfaction than conventional methods. It is a clear indication of the advance of technology that only two of the schemes included in the 1981 review were computer-assisted.

The increasing availability of powerful personal computers has encouraged the development of software to support interactive systems such as Hypertext. A program with multi-media capabilities has been developed by one of the authors of the present study (Turner and Weerakone, 1993). This current paper describes a comparative study between a Hypertext system and a conventional lecture

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†Review of this software is included as an appendix to this paper.

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used to teach cephalometrics to undergraduate dental students.

Subjects and Methods

A study was designed to compare the effectiveness of a lecture and a computer Hypertext program for introducing cephalometrics to undergraduate dental students. The students were in their first clinical year and had received no previous orthodontic instruction.

Students were randomly allocated either to the lecture group or the computer group. The lecture group received a 45-minute lecture in which the principles of cephalometrics were explained, and simple tracing techniques were described and demonstrated. Three tracings were included. First, students were shown how to create an outline of the calvarium and facial bones and then to identify nine cephalometric points: S, N, A, B, ANS, PNS, Go, Me and Pog, along with the outlines of an upper and lower incisor and molar. A simple tracing was produced and the significance of the Eastman Standard measurements explained (MacAllister and Rock, 1992). Two predictive tracing techniques were then introduced, a method for assessing the incisor retroclination produced following overjet reduction by means of an upper removable appliance and a simplified visualized treatment objective (VTO) tracing based upon repositioning the lower incisors to the A-Pog line (Ricketts, 1981).

Usually orthodontic lectures at The University of Birmingham are accompanied by guidance notes, but on this occasion no written material was distributed in order to reduce the possibility of contamination between the groups. Students in the lecture group had therefore to rely upon their own notes.

The Hypertext tutorial was developed by one of the authors (RDC) after consultation with the lecturer (WPR). The CAL program included similar material to the lecture, similar terminology was used and the same tracing techniques were described. A sample screen layout is shown as Table 1. The words in bold type indicate links to other screens, the shaded words have been highlighted by use of the cursor keys. The program was loaded onto personal computers in the School of Dentistry self-instruction room to which members of the computer group had free access for 6 weeks, beginning on the day of the lecture. Students were shown how to access the material and how to navigate on the basis of the first screen, but were given no information concerning the structure and contents of the program. Each member of the computer group was asked to keep a log of Hypertext access time. Lecture group students received no information concerning the Hypertext material and were requested not to use it during the study period.

Two weeks before the lecture the cephalometric knowledge of the whole year of students was assessed using 50 multiple choice questions. At the end of the 6-week study period the students were retested using 150 questions which included the original 50 randomly distributed throughout the test paper.

The date of the post-test was arranged at the beginning of the study so that all students had the chance to prepare accordingly. A two-sample *t*-test was used to compare the scores of the two groups at the pre- and post-test. A paired *t*-test, on the basis of data from the 50 questions repeated in both tests, was used to determine the possibility that a change in scores for either group could be attributed to their method of tuition.

A brief questionnaire was included with the post-test in order to elicit the views of the students concerning the strengths and weaknesses of the Hypertext program.

Questions were:

Did you enjoy using the Hypertext tutor?
What were the good features?
What were the bad features?

TABLE 1 *Layout of the first screen on the Hypertext program*

This tutorial considers some aspects, both practical and theoretical of **cephalometry.** The **objectives** are that you will be able to:

1. Locate **cephalometric points**
2. Locate **cephalometric planes**
3. Trace a **cephalogram**
4. Define cephalometric points and planes
5. Carry out a **prognosis tracing**
6. Carry out a **VTO**
7. Demonstrate the clinical significance of 5 and 6

Bold print indicates link words. The hatched words have been accessed for a move to the next screen.

Results

Scores for the pre-test MCQs are shown as Table 2. There were 26 students in each group. Results are presented as percentages for clarity since the number of questions differed in the two tests. No significant difference was found between the groups for either test.

Results for the pre- and post-test scores relating to the 50 common questions are shown in Table 3. Although the computer group scores were 5·9 per cent higher at the post-test than those of the lecture group the difference was not significant.

The amount of time for which students in the computer group used the program varied considerably. The shortest time was only 15 minutes, whilst the longest was 5 hours 20

TABLE 2 *Pre- and post-test MCQ scores for the lecture group and the computer group (per cent)*

	Lecture group		Computer group		*t*-Value	Significance
	Mean	SD	Mean	SD		
Pre-test	62·2	10·6	63·5	6·8	0·53	NS
Post-test	67·7	14·0	70·2	8·5	0·30	NS

TABLE 3 *Pre- and post-test scores for the 50 common questions (per cent)*

	Lecture group		Computer group	
	Mean	SD	Mean	SD
Pre-test	62·2	10·6	63·5	6·8
Post-test	69·4	38·8	75·3	20·6
95% confidence intervals for change	−4·2	11·5	1·8	10·1

minutes; the mean access time was 109 minutes. Nineteen (73 per cent) of the group enjoyed using the tutor, but only 12 students found it easy to use. The most common criticism, made by 11 (42 per cent) of students, was that the tutor was time consuming. This assessment would appear to have a basis in fact since the average time of 109 minutes that students spent using the computer program was more than twice the 45 minutes duration of the lecture.

The correlation between time spent using the computer and improvements in test scores was low. The correlation coefficient for time in minutes and post-test scores was 0·18; that for time and the difference between pre and post-test scores was 0·15.

Discussion

The MCQ tests had Yes/No responses so that guessing would produce average scores of 50 per cent. Thorndike *et al.* (1991) suggest that an average score of 75 per cent would indicate that the test was at the correct level of difficulty. In the present study, the overall average score in the pre-tests was around 63 per cent.

Since crucial questions were to be re-used after tuition when a higher level of knowledge would be expected it is reasonable to assume that the degree of difficulty was appropriate.

There was no significant difference between the lecture and computer groups at the start of the study. Although the performance of both groups improved after tuition there was no significant difference at the end, although the confidence intervals for the computer group post-test scores indicated greater consistency. Comparable figures for the lecture group indicated that some post-test scores were lower than the pre-test scores.

The study was not able to assess the important area of long-term retention of information since results would have been affected by teaching presented in further lectures and seminars as the orthodontic course developed. However, it was encouraging to find that the Hypertext program was at least as good as the lecture, as a teaching format, since it was an innovation to which students had to become accustomed before they could begin to learn. In the present study less than half of the students in the computer group found the program easy to use, although around three-quarters found it enjoyable. The two most common criticisms were that it was time consuming and that the structure was confusing. However, it is a feature of Hypertext that as many links as possible should be provided to permit ready navigation around the knowledge network. It is possible that other similarly designed programs would be of more immediate benefit since the students would, with practice, become more proficient.

Conclusions

1. There was no significant difference in cephalometric knowledge between the two groups of students at the start of the study.
2. Although there was no significant difference between the groups after tuition the 95 per cent confidence limits for the post-test scores indicated that improvement was more consistent in the computer group.
3. Three-quarters of the computer group students enjoyed using the program, but less than half found it easy to use.

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Appendix—Hypertext Tutorial: a Review by a Student

Having virtually no experience of computers, the prospect of reviewing a new program was rather daunting! However, this program was much more straight forward and easier to use than I imagined.

This program was clearly set out with six main areas, including tutorials, catalogues of information, and a self-test quiz.

The browse section enables the user to obtain information, ranging from definitions of malocclusions to the use of cephalometry, and its use in diagnosis and treatment of malocclusion.

The information was logically and coherently presented. This was further aided by numerous clinical photographs, labelled diagrams and radiographs, all of which maintained a good clear quality.

There is a huge array of information in this section, so much so that it is unlikely you could cover the whole program. The highlighting of keywords enables added descriptions of important concepts, expanding the information that can be obtained. This is useful for someone using the program as a teaching tool as it provides a methodical way of learning and one is less likely to become confused by words that are unfamiliar.

The index section acts like a dictionary; this I found particularly useful as rapid scanning of the choices available and descriptions of those choices means the user does not become buried in words or phrases they don't understand. Instead, they can be explained quickly and the user can then continue without confusion.

The opportunity to print pages from the program is very helpful as the user can obtain hard copy for study away from the PC.

Having worked through the programs fairly successfully, I attempted the self-test quiz. The multiple choice questions cover the information that has been presented throughout the program. When unable to answer the questions, the program provides not just the answer, but also an explanation.

I felt this program was a useful teaching tool, especially in a subject that dental students often find difficult to understand. The interaction required by the user helps to maintain concentration and interest in the subject. The program was easy to follow, even for someone with minimal experience of computers. The help facility was coherent, and easy to follow and use when I was struggling! The actual content was no more complicated than that found in text books and I think that a student probably absorbs more form this program than by purely reading a book alone.

Orthodontics is a subject that most dental students find quite difficult and, in comparison to other subjects, has less teaching opportunities. Therefore, interactive educational programs such as this help to maintain interest, as well as allowing the student to learn and understand a complicated subject.

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