Knowledge Engineering and the use of Multimedia in Adaptive Technology: Effectiveness and Qualitative Nature of Learning

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Abstract: In this research, we had two experiments. In the first experiment we focused on the comparison of learning between two groups of hearing impaired students (multimedia training group and traditional print-based method group). The results from the first experiment indicated that there was no numerical difference in test scores between the two groups of students but the students enjoyed learning with computer. We then carried out the second experiment. This time, we focused more on measuring the qualitative nature of the learning using multimedia technology. The results of the second experiment indicated that the two methods of teaching and learning affected students similarly since the average scores of both groups showed no statistically significant difference. About 89% of the students in the second experiment enjoyed learning from the CD-ROM. This result was based not just on the CD-ROM *Life in Saskatchewan*, but included any kinds and subjects of CD-ROM used in the classroom. Although multimedia training is as good as, but no better than, the traditional print-based method, multimedia can be used as a *valuable supplement* in adaptive technology.

1. Introduction

Our objective of this research was to compare multimedia training and traditional print-based method and our preparation for the development of effective multimedia led us to study the similar roles of *knowledge engineers* and *instructional designers*. Our initial studies were in the area of *expert system* and *knowledge engineering*. But we had a personal interest in training that led us away from the goal of building expert systems to the goal of building and using multimedia training material in adaptive technology. This personal interest led to our recognition of the similarities between the work of knowledge engineering and instructional design. Our experience in knowledge engineering led us to the realization that the formalism of usability testing into the development of the training material was necessary.

The term *knowledge engineers* [1] has been coined to describe the people who work with experts in a field to assemble and organize a body of knowledge and then design the software package that makes it possible to train someone to become skilled in the area or to enable anyone to call upon the skills of experts to solve the problem. The work of knowledge engineering is similar to the work that done by instructional designers in task analysis and module design.

The most important tasks of the special needs trainer are to identify what adaptations are needed for a particular student and to provide them. The following should be considered by the instructional designer and knowledge engineer (i) motivation, and (ii) communication.

Another promising area for multimedia technology with the special needs student is in the instruction of problem-solving, resigning, and basic skills, which have been difficult to teach by traditional means [2].

The objectives addressed in this study are: (1) to examine the effectiveness of multimedia training in adaptive technology. In particular, is multimedia technology effective in training those who wish to learn finger spelling? (2) to measure qualitative nature of learning using multimedia technology.

2. Research Approach

The purposes of this study are to investigate the degree of effectiveness of multimedia technology and to measure qualitative nature of learning using multimedia. We would like to examine the benefits of a multimedia program in comparison to traditional print-based training methods. Section 2.1 explains how this study was planned and conducted using a pretest-posttest. Section 2.2 is an explanation of the instructional design process. The multimedia training program: *Life in Saskatchewan* and the ten elements of instructional design plan will be discussed in section 2.3. Section 2.4 presents usability engineering. The last section details the qualitative questions.

2.1 Pretest-Posttest

2.1.1 Pretest

Pretest will be important for the following reasons [3]:

- It determines students' readiness for the program by alerting each of them to what they do and do not know about the topic.
- It indicates both to students and instructors the point at which to start the program, or to complete remedial course work before starting the program.
- It may motivate students to study the topic because as they read pretest questions or otherwise experience what they will be learning, their curiosity and interest may be aroused.

- It informs students of what will be treated during the study of the topic, so that they may be aware of what will be required of them.
- It indicates the style and methods of testing that will be used by the instructor in the final examination since there is a close relationship between the pretest and posttest.

2.1.2 Posttest

A posttest is given after completion of the lesson and is usually selected as a menu item [4]. We used a posttest to measure students' learning.

2.2. Instructional Design Process

The instructional design process used in this study, was developed from the complete instructional design plan (Figure 1). These ten elements should receive attention in a comprehensive instructional design plan [5]:

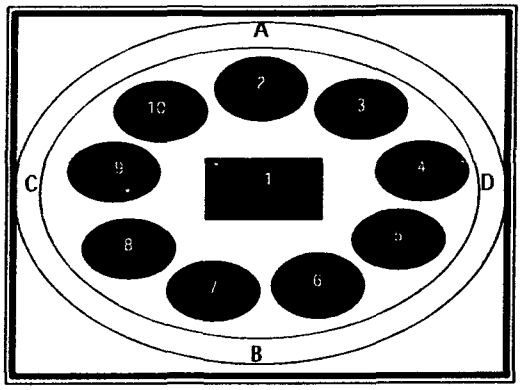

Figure 1. The Instructional Design Process

A = Revision
B = Revision
C = Formative Evaluation
D = Summative Evaluation
1 = Learning Needs
2 = Topics-Job Tasks Purposes
3 = Learner Characteristics
4 = Subject Content
5 = Learning Objectives
6 = Teaching/Learning Activities
7 = Instructional Resources
8 = Support Services
9 = Learning Evaluation
10 = Pretesting

2.3 The Use of Multimedia Training Program: Life in Saskatchewan in Adaptive Technology and The Ten Elements of Instructional Design Plan

1. Learning needs: Students can finger spell the specific words.
2. Topics-Job Tasks Purposes: Knowledge engineering in multimedia design for training: Effectiveness and potential benefits.
3. Learner characteristics: A voluntary group of hearing-impaired eighth-grade high school students from the School of the Deaf in Bangkok, Thailand.
4. Subject content: Life in Saskatchewan was divided into five items: Library, Dormitory, School, Winter Activities, and Run Around.
5. Learning objectives: To examine the degree of effectiveness of multimedia technology compared to printed-based training.
6. Teaching/Learning activities: There were two comparison groups. Group one experienced the multimedia technology program. Group two learned from print-based training method.
7. Instructional resources: Multimedia program (CD-ROM), textbooks, and pictures.
8. Support services: Macromedia Director and Internet.
9. Learning evaluation: The posttest used after the training provided comparative data.
10. Pretesting: Pretest was at the first meeting.

2.4 Usability Engineering

Usability is a key concept in Human Computer Interaction (HCI). It is concerned with making software safe, easy to learn and easy to use [6]. Figure 2 shows a model of system acceptability.

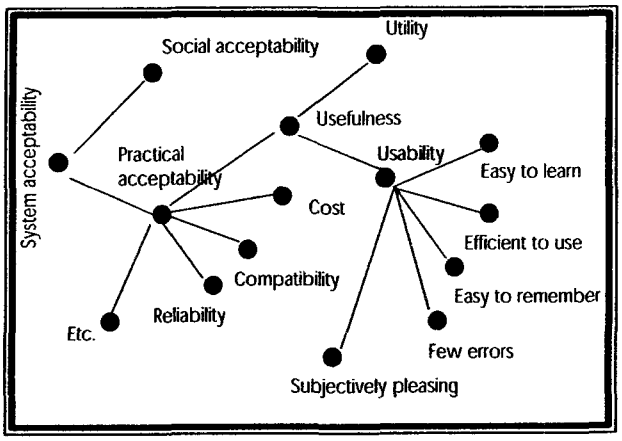

Figure 2. A Model of System Acceptability

To test the usability of our program, a questionnaire was developed and given to computer science students at the University of Regina, Canada. After fixing all of the problems and errors, the software (CD-ROM *Life in Saskatchewan*) was suitable to use in actual experiments.

2.5 The Qualitative Questions

In this study we also asked the students for their attitudes toward the computer. Figure 3 shows the results of the students' attitude.

We did not compare the attitudes towards the computer between the two comparison groups. The results were in general and from all of the students who participated in this study. When the word *CD-ROM* was used in the questions it referred to any *CD-ROM* that the students had used. The

qualitative questions were not specific to the CD-ROM *Life in Saskatchewan*.

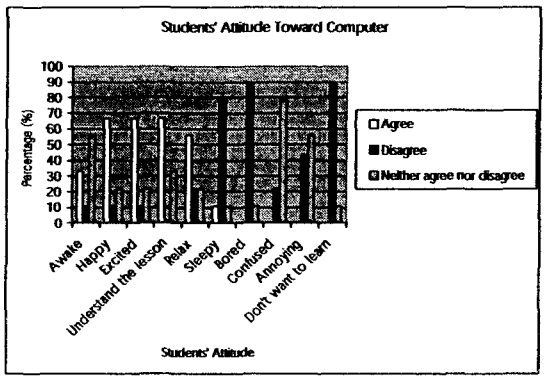

Figure 3. Students' Attitude toward Computer

3. Experiments

To test the effectiveness of multimedia technology compared to traditional training methods, the testing involved two comparison groups of learners from eighth grade high school students from the *School for the Deaf*. Group one used the multimedia training program. Group two learned from print material representing traditional methods.

3.1 Procedure for Multimedia Training Group

The Macromedia program *Life in Saskatchewan* (Figure 4) was installed in the personal computers that were used. During the first hour of training and after the pretests were done, we took about 20 minutes to explain to the students how to navigate through the program, after which the students were free to learn from the program by themselves. They had to learn how to finger spells 30 specific words. The instructor was available in the class to assist students in the group when needed.

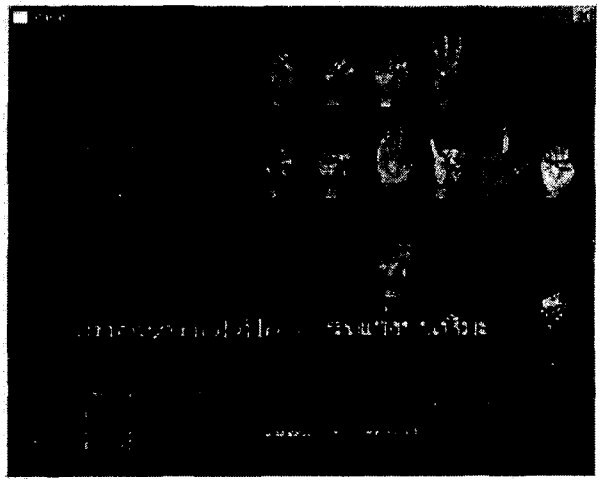

Figure 4. Multimedia Training Program

3.2 Procedure for Print-based Methods Group

The print-based methods group (Figure 5) was instructed on the same content as the students in the multimedia training group. However, the instructor represents the main visual stimulation for the learners. All tests and time limitations were exactly the same as for the multimedia training group. The students were required to take the tests on print materials. The instructor was available to assist the class at all times.

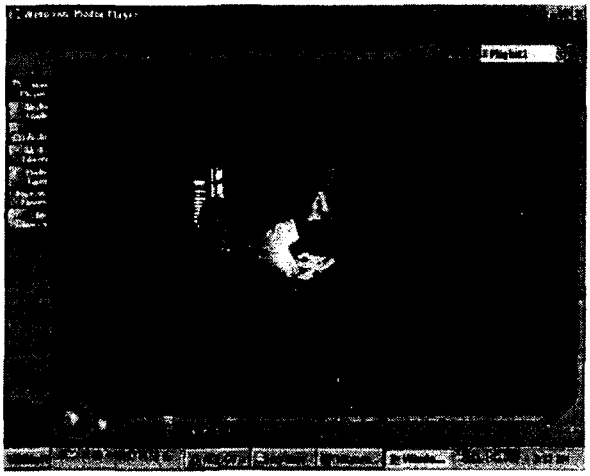

Figure 5. The Print-based Methods Group

4. Analysis & Results

- The results of the test have shown that most students improved their learning in both methods.
- Most students (eighth grade high school students at the *School for the Deaf*) enjoyed learning from CD-ROM.
- Even though the result has shown that 67% of the students preferred computer, there were 22% felt more comfortable to learn from the instructor.
- In using adaptive technology in multimedia materials, the students preferred computer rather than instructor whereas 22% preferred both.

5. Concluding Remarks

Even though multimedia technology had a similar impact on learning compared to traditional print-based method for hearing-impaired students in our study, we would like to add that multimedia technology can be used as a *motivational tool* and a *valuable supplement* in the training. The teacher's ability to be an interface between the special needs student and the computer seems to be the most critical element of successful use of multimedia technology.

The use of multimedia will not automatically result in learning. The developer, however, is aware of the financial pressures but if courseware on CD-ROM can be used both now and in the future, the cost-effectiveness will be increased. Moreover, the multimedia technology can save both time and money.

Computers alone, no matter how sophisticated, will never replace the need for the human instructor. Thus, while the computer cannot replace a teacher in the classroom, multimedia use, when used as a supplement, provides undeniable benefits for both teachers and students.

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