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AUTHOR Lucas, Leslie A.; Tuscher, Leroy J.
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ABSTRACT

This study investigated whether the visual forms of buttons influenced learning and satisfaction when early adolescent students were asked to perform tasks using computer-assisted instruction (CAI). Ninety subjects participated. Three visual forms were designed for buttons located in a CAI application. One contained pictures for commands, the second contained words for commands, and the third contained the combination of pictures and words. Each subject was assigned to one of six groups. Each group used two of the three styles of buttons. The groups performed two sets of three tasks. Response time, accuracy, and satisfaction were measured. The results indicated that groups performed faster with the second task set. The results also indicated that groups were more accurate in their responses when the buttons illustrated words than when the buttons illustrated the combination. Results for satisfaction indicated that groups were more satisfied with the combination than they were with the words. (Contains 8 references. (Author)

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The Effect of Interface Types on Learning and Satisfaction for Computer-Assisted Instruction

Authors:

Leslie A. Lucas
Leroy J. Tuscher

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This study investigated whether the visual forms of buttons influenced learning and satisfaction when early adolescent students were asked to perform tasks using computer-assisted instruction (CAI). Ninety subjects participated. Three visual forms were designed for buttons located in a CAI application. One contained pictures for commands, the second contained words for commands, and the third contained the combination of pictures and words. Each subject was assigned to one of six groups. Each group used two of the three styles of buttons. The groups performed two sets of three tasks. Response time, accuracy, and satisfaction were measured.

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INTRODUCTION

Students who use CAI will not tolerate a poorly designed interface that is not intuitive at first sight. Since students infrequently use the same CAI application they are less motivated to learn its use. Shneiderman (1987) stated that if the students do not understand the CAI application at first sight the students will likely abandon the use of the computer or try a competing package. Hence, the CAI application's interface must meet their needs. Learning users should be able to point and click with the mouse at commands illustrated on the computer screen. See-and-point interfaces usually contain buttons illustrated as pictures, as words, or as the combination of pictures and words (Apple Computer, Inc, 1987). For adult learners of computer applications it has been found that performance and satisfaction are affected by the visual form in which the commands are illustrated. In fact, studies have found that pictures (Temple, Barker, & Sloane, 1990), and the combination of pictures and words (Egido & Patterson, 1988) are preferred to words by adult learning users.

Research on cognitive development seems to support the notion that pictures and the combinations are preferable for adults when adults are required to understand them as representations of information. According to Bruner et al. (1966), the development of the representations of information in the mind is identifiable during the early stages of life. By adolescence through adulthood the number of mental representations increases depending on experience and maturity and may include visual images and words that denote a single idea. Viewing a picture or the combination of a picture and a word helps adults understand and discriminate ideas that are represented by them.

One of the questions that arises is if early adolescents will perform as well as and be as satisfied as adults when using CAI that includes pictures and the combination of pictures and words for buttons. Do early adolescents have the aptitude to understand picture labels as well as word labels? Finally, does the combination of pictures and words used to illustrate commands on the screen tax the early adolescent's memory load? In order to answer these questions the following study was conducted. The purpose of the study was to determine the effect of the three styles of buttons (pictures, words or the combination of pictures and words) on ease of learning and computer interaction satisfaction when early adolescent school students were required to use a CAI application.

METHOD

Ninety (44 males and 46 females) early adolescent school students participated in the study. Each student was randomly assigned to a group. The groups saw two of the three styles of buttons: picture, words, or the combination of pictures and words. Group A used pictures first and words second, while group B used words first and pictures second. Group C used the combination of pictures and words first and words second, while group D used pictures first and the combination of pictures and words second. Group E used words first and the combination of pictures and words second, while group F used the combination of pictures and words first and words second. The tests were administered during and after school. The study took approximately forty to fifty minutes to complete.

The CAI application contained a collection of facts on history. The students were able to search through subject areas contained in the application easily by pointing and clicking with a mouse on the buttons located at the bottom of the computer screens. The picture labels for the buttons were black and white and the words were displayed in Times Roman at 10 points. The buttons were approximately 1/2" square.

The CAI application was a commercially available package that was modified for experimentation. It originally had picture labels for the buttons. These labels were revised to words and a combination of pictures and words based on the description of the function of the buttons found in a Help section of the CAI application.

Each group performed a set of tasks (i.e., a set of three tasks) while using one of the two styles of buttons assigned. One task at a time appeared on the computer screen when the subjects in the groups selected a button labeled Show Task. After completing the set of tasks, the computer prompted the subjects to complete a satisfaction questionnaire. After completing the questionnaire the subjects viewed the second set of buttons and performed the second set of tasks. After completing the second set of tasks, satisfaction was assessed again.

Each of the tasks required the same amount of mouse motion on the screen and required the same amount of branching through the application. The computer recorded the subject's ID number, the buttons selected, think time which was the elapsed time between button selections, task time which was the total elapsed time on task, and total task time which was the total elapsed time on the set of tasks. The computer process time, which was the computer's time to perform the operation required when a button was selected was recorded independently.

The button selections were identified and a rating of response accuracy was recorded for each set of tasks. The scores could range from 0 to 3 (0 = no correct responses, 3 = all correct responses).

The students had access to each task while searching for the answer. The tasks were displayed on the computer screen when the button labeled Show Task was selected. The time spent reading the task was not included in the subjects' performance scores.

A user interaction satisfaction questionnaire was used to measure satisfaction. Positive satisfaction was indicated by high scores. The questionnaire contained 13 items with 9 point scales. Possible scores ranged from 0 to 117.

DESIGN

The dependent variables response time, response accuracy, and satisfaction were recorded and analyzed in three two-by-two Latin squares with repeated measures designs. The Latin square with repeated measures design was selected because it allowed the researcher to economize on subject

numbers and it allowed the researcher to collect data on a number of variables while exposing them to more than one treatment. See Figure 1 for an illustration of the design.

Group	Task Set 1	Task Set 2
A	$X_1O_1O_2O_3$	$X_2O_1O_2O_3$
B	$X_2O_1O_2O_3$	$X_1O_1O_2O_3$
C	$X_3O_1O_2O_3$	$X_1O_1O_2O_3$
D	$X_1O_1O_2O_3$	$X_3O_1O_2O_3$
E	$X_2O_1O_2O_3$	$X_3O_1O_2O_3$
F	$X_3O_1O_2O_3$	$X_2O_1O_2O_3$

Measurements	Treatments	Conditions
O_1 = Time	X_1 = Picture Interface Type	Task Set 1
O_2 = Number correct	X_2 = Word Interface Type	Task Set 2
O_3 = Satisfaction	X_3 = Picture and Word Interface Type	

Figure 1. Diagram of experimental design

RESULTS

DESCRIPTION OF THE STUDY

The study was conducted over the course of a month and a half. Initially, the researcher tried conducting the study after school so that there would not be a conflict with the other studies in which the subjects might be involved. However, it was found after several days of testing that many subjects were not willing to participate after school. Some students had other activities to attend, and others lost interest. Due to poor attendance, the researcher tested the remaining subjects during school.

Testing the subjects during school resulted in other problems. The computer laboratory at the school was frequently used by classes. The researcher found that there was little time between classes to collect the data from the computers before another class wanted to use them. In addition, during the time when the computer laboratory was not scheduled for use, teachers and students came to the laboratory to work independently on assigned tasks.

During the testing periods, the procedures were explained to the subjects and the CAI application was demonstrated. When the subjects were told to start, many seemed confused as to what to do. Some asked their peers what they were to do. The researcher helped many subjects get started. After these initial delays, the subjects appeared to have little difficulty in understanding what was expected of them. The researcher accounted for these initial delays during the data analyses.

ANALYSES

Latin square with repeated measures design analyses were performed to determine whether there were significant mean differences in the groups, tasks, and interfaces on the dependent variables: response time, response accuracy, and satisfaction. The groups and tasks were evaluated as independent variables.

Response Time

The results from the analysis of each independent variable for response time indicated that there were significant differences in the two sets of tasks. All groups performed significantly faster when using the second set of tasks. Table 1 and Table 2 display the results.

Table 1.
Analysis of Performance by Task for Response Time

Source	SS	df	MS	Error	F	p
Grps A & B (Task Unit)	171396421.350	1	171396421.350	Error	5.491	<.05
Grps C & D (Task Unit)	369614476.017	1	369614476.017	Error	14.649	<.05
Grps E & F (Task Unit)	247786146.017	1	247786146.017	Error	9.701	<.05

Note: Response time was measured in ticks. There are approximately 60.15 ticks per second in HyperCard (Apple Computer, 1989).

Table 2.
Analysis of Mean Scores by Task for Response Time

	Task Unit 1		Task Unit 2	
Source	M	SD	M	SD
Grps A & B	13175.73	7921.23	9795.43	6002.28
Grps C & D	13508.67	7230.07	8544.70	4056.48
Grps E & F	12235.60	8382.43	8171.23	4573.16

Note: The number of subjects in each group = 15. Response time was measured in ticks.

Response Accuracy

There was a significant mean difference in response accuracy for two of the styles of buttons between groups E (word / picture & word) and F (picture & word / word). Table 3 and Table 4 display the results from the analyses.

Table 3.
Analysis of Performance by Interface for Accuracy of Response

Source	SS	df	MS	Error	F(df)	p
Grps A & B (Interface)	.017	1	.017	Error	.041	n.s.
Grps C & D (Interface)	.017	1	.017	Error	.039	n.s.
Grps E & F (Interface)	3.267	1	3.267	Error	5.834	<.05

Note: Overall ratings for accuracy of response could range from 0 to 3 (0 = no correct responses, 3 = all correct responses).

Table 4.
Analysis of Mean Scores by Interface for Accuracy of Response

	Pictures		Words		Pictures & Words	
Source	M	SD	M	SD	M	SD
Grps A&B	1.30	.85	1.27	.83	–	–
Grps C&D	1.47	.78	–	–	1.43	.68
Grps E &F	–	–	1.50	.90	1.03	.62

Note: The number of subjects in each group = 15. Overall ratings for accuracy of response could range from 0 to 3 (0 = no correct responses, 3 = all correct responses).

Satisfaction

There was a significant mean difference in satisfaction for two of the visual forms between groups E (word / picture & word) and F (picture & word / word). Table 5 and Table 6 display the results from the analyses.

Table 5.
Analysis of Performance by Interface for Interaction Satisfaction

Source	SS	df	MS	Error	F(df)	p
Grps A & B (Interface)	1.067	1	1.067	Error	.015	n.s.
Grps C & D (Interface)	1.667	1	1.667	Error	.061	n.s.
Grps E & F (Interface)	576.60	1	576.60	Error	4.710	<.05

Note: Computer interaction satisfaction scores could range from 0 to 117. Positive computer interaction was indicated by high scores.

Table 6.
Analysis of Mean Scores by Interface for Interaction Satisfaction

	Pictures		Words		Pictures & Words	
Source	M	SD	M	SD	M	SD
Grps A&B	75.83	16.03	76.10	15.03	–	–
Grps C&D	81.30	15.55	–	–	81.63	15.92
Grps E&F	–	–	76.53	17.39	82.73	15.77

Note: The number of subjects in each group = 15. Computer interaction satisfaction scores could range from 0 to 117. Positive computer interaction was indicated by high scores.

DISCUSSION

The styles of buttons used for the commands in see-and-point interfaces can influence a learner's ability to use CAI. The goal is to select the appropriate type. The learner dealing with new information should be able to easily navigate through a CAI lesson. Understanding the most appropriate way to display the commands becomes increasing important as students are required to use technology to learn. Some might argue that the type of button used for a command depends on what concept is being represented. Sometimes it might be easier to use a word to illustrate a command, in other cases it might be easier to use a picture. However, when faced with designing the interface it is important to understand what type of button, in general, works best for a particular group of learners. Thus, the present study provides some tentative conclusions that can help guide learner interface design.

The results from the present study indicated that the early adolescent school students in groups E (word / picture & word) and F (picture & word / word) were more accurate in responding to the computer interface that included words only compared to the interface that included the combination of pictures and words. Perhaps, computer interfaces that incorporate words are easier to identify

because words tend to be less ambiguous for early adolescent school students. For example, for a concept such as "print an image to the printer" the word Print might be more explicit. A picture of this concept might be difficult to represent especially in a small space on the computer screen.

Another possibility is that the combination of pictures and words provided too much information compared to words. The computer screen may have appeared overwhelming in a testing situation. The subjects may not have been able to focus on each button in order to infer a meaning from it. According to Galitz (1989), the degree to which a user's memory is being used to understand the information can have a significant impact on their comprehension of the information. If the amount of information is too much the user's performance will be negatively influenced.

It is interesting to note that the groups who used the words and the combination of pictures and words were more satisfied with the combination even though they didn't perform as accurately with the combination. This finding illustrates that user satisfaction is not necessarily a good predictor of user performance. According to Long, Hammond, Barnard, Morton, Clark, (1983), the opinions of users do not predict how well users will perform.

All groups were faster the second time with the second set of tasks. Possibly, as students developed an understanding as to how to navigate through the program the speed with which they performed increased. However, the accuracy in their performance was not affected. It is possible that the subjects felt pressured to finish the second set of tasks quickly but not necessarily more accurately because other subjects had finished. The researcher instructed subjects who were finished to quietly leave the computer laboratory or do another activity. However, it was difficult to keep the students quiet after finishing the tests. The other subjects who were still working were probably distracted by this commotion and felt a need to quickly finish.

An important issue is whether the results obtained in the present study can be generalized. The CAI application used in the present study represented a general layout which is seen in other CAI applications. The buttons appeared in black and white on the bottom portion of the screens. However, the results might be specific because only a small sampling of representations for commands were evaluated.

"Which style button should CAI use?" This question remains unanswered. However, the present study provides some tentative conclusions to guide learner interface design. The study found differences between the words and the combination of pictures and words when early adolescents were required to perform search tasks using CAI. In addition, it was found that satisfaction with an interface does not necessarily indicate how well an early adolescent school student will accurately performed search tasks when using CAI. From these findings it appears that there is a difference between words and the combination of pictures and words. However, further research needs to be done in order to substantiate the significance of these findings.

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