INFLUENCE OF AUDIO-VISUAL PRESENTATIONS ON LEARNING ABSTRACT CONCEPTS

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ABSTRACT

Previous research found that without audio instruction, students could benefit more from static graphics than text and animation for abstract concept learning. In this study, the researcher further incorporated audio instruction in a multimedia based learning program to investigate whether various types of visual illustration will influence abstract concept learning. One hundred and sixty nine college students were randomly assigned to one of three treatment groups. Each treatment group completed a computer-based learning (CBL) program with identical content in one of the following conditions: text with full-audio delivery (control group), text and static graphics with full-audio delivery (static group), or text and dynamic illustration with full-audio delivery (dynamic group).

Major findings of this study were: (a) with audio, students' performance under dynamic illustration was significantly higher than students in the other two groups; (b) there were no significant differences among the three treatment groups in attitude toward the computer-based program; and (c) with audio, students in the control group took a significantly longer time to complete the program than students in the other two groups.

(Key words: multimedia, audio, visual, illustration, computer-based learning)

PURPOSES AND OBJECTIVES

Previous research (1) indicates that without audio, presenting abstract concepts with static graphics could help novice learners understand more than presenting through text (control) or dynamic formats. On the basis of the initial findings, this study further incorporates the audio instruction into the teaching process to see if the integration of redundant audio will affect the results. The hypotheses are stated in this way:

1. Does the degree of visual (text, static, or dynamic) presentation with audio instruction produce any difference in learning performance?
2. Does the degree of visual presentation with audio instruction produce any difference in attitude toward the computer-based program?
3. Does the degree of visual presentation with audio instruction produce any difference in time to complete the computer-based program?

PERSPECTIVES AND THEORETICAL FRAMEWORK

Recent advancements in computer technology have allowed the educator to incorporate text, visual, and sounds resources into a rich computer mediated program. However, relatively little research in the use of audio-visual presentation n instruction has been conducted that might assist the multimedia producer in using visuals and sound effectively and efficiently (1-4). The effectiveness of multimedia as an instructional medium is based on Paivio's (5) dual coding theory. Paivio's theory assumes that memory and cognition are served by two separate symbolic systems, verbal information and visual image. Paivio (6) defines visual image as nonverbal memory of concrete objects or events, and distinguishes visual image from information verbal which relates to speech or a language system (6). Although each system can function independently, most processing involves connections and reinforcement between the two.

Visual image can be presented in many forms to illustrate an abstract concept. The use of static and dynamic graphics are frequently incorporated into a computer-based program to make the concept and idea more comprehensible and memorable (1, 3, 7 ,8). Literature suggests that different presentation strategies should be considered to help novice learners capture the central concepts of the graphics, such as dissecting procedural tasks into small pieces or presenting sequential change step by step (9-11). Modern technology allows computers to easily generate animation and dynamic illustration that allows learners to mentally construct connections for processing information (12, 13). The increased availability of multimedia elements also permits the design of instructional programs that incorporate unlimited variations and forms of verbal and visual information for presentation (14).

However, research on the other hand, also suggests that the use of dynamic visuals might lead to misconceptions due to the fact that the to be learned concepts are often oversimplified (3, 15). To help students gain the correct concepts, the graphics should explicitly identify relevant elements in the teaching process. Even when instructional illustrations are presented thoroughly, learners using educational software tend to ignore or forget to read important instructions presented in textual or other visual display (16-18). Good instructional design should invite students to observe and associate from different dimensions, such as temporal sound or audio (17).

The recent literature (16, 17 ,19, 20) suggests adding audio to enhance educational software. In many dual-media presentations, such as computer-based learning (CBL), speech is used on the sound track to describe or explain the visual image (21).

Audio elements can gain and maintain attention throughout a multimedia program (22, 23). Audio is also preferred when it is necessary to direct the viewers attention to details of the visual. Audio also influences the pace of visual presentation. Auditory instruction can establish a fast pace or a slow pace to compliment the visual (23).

The combination of audio-visual information has produced mixed results. Some research has shown increased learning (18, 24-26). Other studies have

reported no significant difference (2, 20). There is a lack of guidelines for the proper use of auditory and visual presentation in computer based instruction (27, 28). Designers must decide if audio should be accompanied with text, static, or dynamic illustration on a CBL screen.

METHODOLOGY

Subject

A total of 169 college students participated in this research. The sample included four classes of college students. Students' experience with the content area (computer programming languages) was investigated on the survey questionnaire. Most of the students were novice learners. Students were randomly assigned to one of three treatment conditions with a balanced ratio of males and females.

Learning Material

The computer-based learning (CBL) program was designed by the investigator. The CBL lesson differed in the way that the instructional presentation was displayed on the screen to teach the abstract concept. Version 1 contained text with audio instruction to explain the abstract programming concept. Version 2 contained text with audio instruction supplemented by static graphics to highlight the abstract concept. Version 3 contained text with audio instruction supplemented by dynamic illustration that demonstrated the process that occurs in the computer for the programming statement. The CBL courseware was developed using Macromedia Director, version 6, on Pentium 586 personal computers. The research was conducted in one computer lab with 60 computers. Students' time spent to completing the courseware was recorded.

Assessment Measure

Two assessment measures were used in this study: scores on the posttest and attitude toward the CBL program. The questions on the posttest consisted of 20 multiple-choice questions. The test item measured students' understanding of the programming concept and function. The subjects were awarded one point if they answered a question correctly resulting in a total of 20 points possible on the test. The attitude questionnaire contained 20 items with responses for each based on the five point Likert scale. The posttest and attitude questionnaire were administered immediately after the CBL courseware.

The content validity of the posttest and attitude was checked through experts in the domain area. The modified Kuder-Richardson Formula 20 Reliability Coefficient (KR-20) was used to measure the inter-item consistency for posttest (Alpha = 0.7) and attitude (Alpha = 0.8).

Procedures

Students were given a pretest one week before the treatment. The pretest was exactly the same as the posttest. Students were then administered the treatment in the computer lab. All subjects were instructed how to operate the computer-based program properly There was no time limitation for viewers to complete the lesson. Subjects were administered the posttest after finishing the lesson.

RESULTS

Results of the pretest and posttest indicated that all three treatments were instructionally very effective. Data showed that learning for all three treatments increased significantly between the pretest and the posttest. The result of repeated measure ANOVA is presented in Table 1.

TABLE 1. REPEATED MEASURE ANOVA FOR PRETEST AND POSTTEST

Dependent Variables	N	Mean	S.D.	DF	F
Text					
Post	57	6.27	4.58	55	93.04*
Pre		9.16	2.73		
Static					
Post	57	3.73	3.42	55	
Pre		7.95	2.20		
Dynamic					
Post	55	5.31	4.60	53	
Pre		10.15	2.82		

*p<.05

The group mean, standard deviations and sample size of the achievement posttest, attitude, and time for each group are summarized in table 2.

TABLE 2. MEAN SCORE COMPARISON OF THE DEPENDENT VARIABLES

Dependent Variables	Text	Static	Dynamic
Achievement			
Mean	9.16	7.95	10.15
S.D.	2.73	2.20	2.82
Attitude			
Mean	3.49	3.50	3.58
S.D.	0.36	0.42	0.54
Time			
Mean	33.10	30.07	30.49
S.D.	6.09	5.12	7.32
N	57	57	55

Since a significant differnece of pretest results was found among groups, the pretest was used at the covariate for achievement test. An analysis of covariance (ANCOVA) conducted on the posttest indicated that significant differences existed among the three treatments on the achievement test ($F(2,166) = 11.32$, $P < 0.000$). The follow up posthoc comparison with Tukey's HDS test was examined and found that the dynamic group was more effective than the text and static groups. The result is presented in Table 3.

TABLE 3. ANCOVA ON ACHIEVEMENT WITH PRETEST AS COVARIATE

Source of Variance	Analysis of Variance				
	SS	DF	MS	F	P
Cov.	18.52	1	18.52	2.78	0.097
Main	150.64	2	75.32	11.32	0.000*
Exp.	155.55	3	51.85	7.79	0.000
Resi.	1104.73	166	6.66	7.79	
Total	1260.29				

No significant difference was found for the attitude measure ($F(2,166) = 0.63$, $p < 0.59$). The question pertaining to the effect of treatment on time was tested using a one-way analysis of variance with three treatments. The criterion variable used to assess completion time was the number of seconds each student required to complete all portions of the computer tutorial. Significant differences ($F(2,166) = 34.06$, $p < 0.000$) existed among the three treatments on time for completion. A follow up posthoc comparison was conducted and found that the text group took a significantly longer time than the static and dynamic illustration groups. The result is presented in table 4.

TABLE 4. ANOVA ON TIME

Source	SS	df	MS	F	P
Between	284.93	2	142.47	3.68	0.027*
Within	6119.48	158	38.73		
Total	6404.41	160	40.03		

DISCUSSION AND CONCLUSIONS

The low pretest result convinced the researcher that the learners were novices in the subject matter. The significant difference between pretest and posttest supported the use of multimedia based programs in teaching abstract concepts. Previous research supported the effect of static graphics that serves as one analogy to understand the abstract concept. When redundant audio was added to the static graphics, students in the group of dynamic graphics performed better than

the other two groups (control and static graphics). A possible explanation is that when the visual was further elaborated with dynamic illustration, the audio not only drew students' attention toward the dynamic illustration, but also explained step by step the visual image that helped to build connections between the abstract concept and the concrete illustration.

These findings corroborated those of past research (7) that effective illustration should step by step show the state of the operation in the system that constituted dynamic representation (9). It also supported the notion that dynamic representation could lead to deeper processing of the underlying steps that happen during the program execution to help the learner build a runnable mental model of the system (8). Research results also support previous research (12,23) that when using sound effects in multimedia, many authors overlook the importance of matching the aural and visual characteristics of space and location. When one narration states the change of conditions (visual) without revealing the synchronous process or results, this can cause confusion in the viewer. This is especially important when cognitive information is being supplied by the audio track. The finding also supports the dual-coding theory of Paivio (6) in that concepts can consist of elements arising from different media, for example, linguistic and pictorial. When a complementary understanding of the concept is created, it will be connected to the already existing mental image.

Previous research found that students took a longer time on animation when audio was not provided. In this research, it was interesting to note that, with audio, students in the control group took a significantly longer time than the other two groups to complete the CBL lesson. Without audio, students' attention might be drawn to the animation and could not proceed to the next page. However, when the audio was provided with the dynamic illustration, students could go through the program easily and get the point easily from the step by step explanation of the animation. Auditory illustration alone might give students more chance to create their own visual image. When linguistic material (audio) was used as one analogy to explain the abstract concept, the visual images were created automatically by the learner. Visualization, like perception, is not like a camera that can capture images on film quickly. Interpretation and understanding are continually and gradually filtered through learner's entire knowledge (14). This might explain why they, control group, which developed their own mental imagery, took a longer time to complete the program.

Although the research results showed a positive attitude toward the program, no significant difference was obtained between groups. If the study time is extended in the future, a different result will probably be obtained. The present findings reinforced a cautionary note in terms of embracing different formats of multimedia (audio and visual illustration) as a general way to promote learning, though, audio and visual by themselves, might be effective in some bounded cases. Additional questions related to student achievement might include (a) whether or not different degrees of interactivity of illustration would produce different results, (b) the effects of audio with various degrees of redundancy in computer-based learning, and (c) the relationship between students' learning style and the delivery mode.

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