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ABSTRACT

Two studies were conducted in an effort to better understand the role of digitized speech as feedback in computer assisted instruction (CAI). The first study examined the use of familiar and unfamiliar voice feedback in two CAI lessons designed to teach advertising techniques to fifth graders. Subjects were 100 fifth graders from suburban Minneapolis (Minnesota). No differences were found between responses to the familiar and unfamiliar voices. In the second study, 145 sixth graders and a subset of 41 high and 49 low reading ability students from suburban Minneapolis (Minnesota) listened to feedback that was spoken audio only, printed and spoken, and spoken by an animated character. Analysis indicates that the type of feedback makes no significant difference, although there is a consistent tendency for students receiving the voice only feedback to score higher on the posttest, possibly because supplementing with text or graphics divides learners' attention. Overall results suggest that whose voice is used seems to be of little importance, although the gender of the speaker can influence performance. Females outperformed males when a female voice was used. When the agent was male, no effect for gender was found. Students appeared to enjoy the animated characters and to talk back to the computer more than did students in other treatments. Nine figures and four tables illustrate the findings. (Contains 18 references.) (SLD)

Title:

Digitized Speech as Feedback in Computer-Based Instruction

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Digitized Speech as Feedback in Computer-Based Instruction

We should not be surprised by the flood of educational products utilizing digitized speech currently moving through the home and school markets. From the time of Socrates, speech has been an important part of instruction. For most of history speech has been the primary mean of communicating content to the learner. Only recently has text in the form of books and other technologies been effectively utilized to increase the number of learners that can be reached and to provide a consistent delivery of information. Naturally then, the integration of speech into instructional software has great intuitive appeal, especially if it can be linked to text, graphics and animation.

While the phenomenon of talking software may now be upon us in full, it has been evolving for years. Several techniques for generating computer speech have existed since the 1970s. However, these early techniques were seldom utilized because of cost, equipment requirements or quality issues. Recent advances in hardware and software have made the use of digitized speech a practical option for many instructional applications.

Software designers and developers appear to believe that speech will make computer-based instruction (CBI) more attractive, more effective, and ultimately more marketable. They are rushing to integrate speech into a variety of products. Their motives for applying this technology, however, may be based purely on consumers' demonstrated eagerness to see, use and own the latest innovations.

There is little empirical research to indicate that educational gains can be achieved by simply incorporating speech in computer software. Decades of empirical research on the use of sound, music and speech in instruction (Brophy, 1981; Chiang, 1983; Cumming & McCorriston, 1981; Fleming, 1980; Haugh, 1952; Rulon & Others, 1943; Rysavy & Sales, 1991; Sanders, Benbasset & Smith, 1976) provide only limited guidance on how these features might be used in computer-based instruction. This guidance falls well short of identifying when speech is an appropriate component of CBI, the role it should perform, or the interface and operational support that a program should provide to ensure optimal learning.

Many questions that may inform decision about the utilization of speech in software remain unanswered. This paper reports on two studies conducted in an effort to help use better understand the role of digitized speech as feedback in CBI. (A third study in this line of research is being reported at this meeting by Michael D. Johnston.)

Study 1. The first study examined the use of familiar and unfamiliar voice feedback in two computer-based lessons designed to teach advertising techniques (propaganda techniques) to fifth graders. The role of the voice feedback was to provide knowledge of response, guidance and motivation during the practice portion of the instruction. (See figures 1-6 for examples of the screen displays from the computer-based lesson, the feedback types, and content of the feedback messages.)

The primary research questions addressed in this study were:

- Will the use of a feedback provider whom learners know influence their performance in the instruction, as measured by the posttest?

- Will the use of (1) voice with text or (2) voice with a speaker's image influence the learners' performance in computer-based instruction?

- Are there differences (e.g., use of optional buttons, achievement, time to complete) in performance that can be attributed to gender?

Study 2. The second study examined the effects of three types of feedback (1) spoken audio only, (2) printed and read (spoken), and (3) spoken by an animated character. These feedback types were substituted in the propaganda software used for the first study. (See figures 7-9 for examples of the screen displays from the computer-based lesson, the feedback types, and content of the feedback messages.)

The primary research questions were:

- Will the type of feedback (i.e., form of presentation - (1) spoken audio only, (2) printed and read (spoken), and (3) spoken by an animated character) effect performance?

- Will reading ability interact with performance as measured by posttest scores?

Literature Review

What is the role of speech in instruction? It would be difficult to deny that speech can play a central role in the delivery of instruction. Most modern models of instruction assume the extensive use of spoken or written words. For example, each of the events of instruction (Gagne, Briggs & Wager,1992), from informing the learner of the objectives to enhancing retention and transfer, can be accomplished at some level through spoken words.

The power and influence of the spoken word is equally difficult to deny. The effectiveness and impact of speech in such roles as the delivery of content, feedback and motivation in classroom instruction are well documented (e.g., Brophy, 1981, 1986).

Salomon (1979, 1985) argues that research on the effectiveness of media must look at the most essential characteristics of symbol systems being utilized. In software that utilizes digitized speech, Brophy's work on the impact of teachers' comments indicates that these essential characteristics are the familiarity of the source, the nature of the learners relationship with the source, and the attitude communicated through tones and inflections in feedback to the learner.

What do we know about the effects of speech (and other audio) in computer software? Researchers have expressed concern over techniques and strategies for the use of speech in CBI. Sanders, Benbasset and Smith (1976), for example, argue that for speech to add significantly to learning, it must not "merely take the place of a hard-copy manual or of printed text on a computer terminal." For example, one method of adding value to the use of audio might be to personalize the software. Personalization strategies have been shown to increase the effectiveness of CBI (Ross, 1983, Ross & Anand, 1987).

Research on the use of speech in CBI has had mixed results. Research conducted with young children learning phonics and vocabulary (Sales & Johnson, 1991) found no achievement or attitude differences for students in several treatments involving different levels of speech and "motivational" sound. The authors suggest several explanations including the low level of students' metacognitive skills, and the redundant presentation of critical information through text.

Two research studies examining the different uses of audio in computer-based instruction were conducted with special needs students (Chiang, 1983, Wiener, 1991). These studies had dramatically different findings. Chiang found audio designed to reward and motivate students was actually detrimental to learning. He argued that audio served as a distractor, causing students to require more study time to achieve the same level of learning. Wiener, however, found significant achievement effects when using computer generated speech to teach word recognition to mentally handicapped junior high school students.

In summary, speech can be a critical component of instruction. It appears to be particularly valuable as a means of communication between the teacher and the learner. Much of the communication results from when and how the message is delivered. These characteristics of the discourse may be essential to the learning outcomes.

Speech and other auditory elements of CBI have had mixed success in a number of research studies. Our limited understanding of these findings is in part due to the small amount of research that has been conducted. This, in turn, can be traced to the rapid changes technologies and the fact that the commercial application of speech in CBI has only recently become practical.

Study One

Participants. The subjects who voluntarily participated in this study were 100 fifth grade students from a suburban Minneapolis elementary school. All of the students had regular contact with computer-based instruction prior to the study.

Instructional materials. The software, which provided instruction on propaganda techniques used in advertising, is based on the software used by Carrier and associates (see Carrier &Williams 1988; Carrier, Davidson and Williams, 1985). The new version, was designed to take advantage of the graphic and sound capabilities of Macintosh computers with monochrome monitors. It was created using HyperCard 2.1 and for this study it was run on Macintosh LC computers in a thirty station lab.

During the data collection, all of the participants were required to wear headphones. The software and individual student records were stored at each workstation on the hard drive. At the end of each day of data collection, the student records were collected and aggregated for analyses.

Design. A 2x2 design was used (Figure 10) in this research. Variable one, degree of familiarity with the feedback provider, has two levels - familiar and unfamiliar. The second variable, type of feedback, has two levels - *Voice Only* and *Voice with Animated Character.* The treatments in the familiar condition used a person of authority (the school's media center teacher/librarian) that was known to the subjects as the vehicle for delivering feedback . In the treatments in the unfamiliar condition a fictitious character unknown to the

subjects was used. In addition to the voice feedback, two groups received a visual of the speaker's face. Animation techniques were used to create the appearance that the speaker was actually talking as the feedback was delivered.

Procedures. Subjects participated in the research in intact classroom groups but individuals within groups were randomly assigned to one of four treatments. Classroom teachers did not play a role in the delivery of the instruction.

Over a period of three days, each subject completed two computer-based lessons on techniques used in advertising. The first lesson, which lasted approximately 20 minutes introduced students to four techniques and their defining attributes. Students were given an opportunity to practice identifying examples and non-examples of two of the techniques introduced. The second lesson, which lasted approximately 30 minutes, provided practice on the remaining two techniques and allowed for a brief review. Following the second lesson the students completed an on-line test consisting of 25 items (Cronbach's alpha, r=.87), five representing each of the four techniques studied and five non-examples. Finally, students responded on paper to seven questions focusing on effort, attitude and learning.

Data Analysis and Results. Analyses of variance were conducted to determine the effects of the treatment variables on the posttest scores. Neither the familiarity of the voice nor the presence of a feedback provider influenced overall performance ($F=.54$, $p=.462$ and $F=.99$, $p=.321$, see Table 1). No interactions of the treatment variables were found. Gender was found to be significant with girls outscoring boys by an average of 2 1/2 points. Means for the two groups are shown in Table 2.

Discussion. Analysis of the data related to the primary research questions, which addressed the issues of familiar versus unfamiliar and voice versus animated speaker, found no differences. This may indicate that the attribution of authority does not transfer to a computer representation of a teacher. Or, it may mean that a student's sense of accountability in a computer-based lesson is not influenced by the attribution of feedback to a specific source. Regardless of the source of the feedback as represented in the software, students may simple associate the feedback with the inanimate, non-judgmental delivery technology.

Some issues of secondary interest were identified and are deserving of discussion. Use of the "Say it again." option, which allowed students to have the verbal feedback repeated, appeared to be related to gender and treatment. Boys tended to use this option more in the familiar/voice with text treatment. Girls tended to use this option more in the unfamiliar/voice with face treatment.

Another, and perhaps related, secondary finding is that in spite of the pattern of option button use, girls spent more time working through treatments in which the feedback provider was known. Boys spent more time in treatments where the feedback provider was unknown. These findings might indicate that girls were willing to work harder at studying the information on the screen when they knew the feedback provider. When the provider was unknown, they may not have tried as hard. The feedback

provider in the software studied was a female. This may also account for the differences in the ways in which the boys and girls used the material.

As a result of these findings a second study was designed and conducted to further explore the use of speech as feedback. It was determined that for the second study we would use a male speaker was unknown to the learners. Two new treatments, voice only and text that was read, were added to isolate any effect attributed to the voice variable.

Study Two

Participants. Subjects volunteering to participate in this study were 145 sixth grade students in a suburban Minneapolis middle school that served only fifth and sixth grades. Subset of volunteers with high (N=41) or low (N=49) reading abilities were identified. Only the scores from these individuals were used for this study although all 145 participated in the instruction. All of the participants had had regular contact with computer-based instruction prior to this study.

Instructional Materials. The instructional materials used in this lesson were the same as those describe in Study 1 except for the delivery of feedback which was specific to the treatment condition. The feedback in this study differed in that the audio was a male voice and the animated figure was of an unfamiliar male cartoon character.

The computers used in this study were in two labs of approximately 15 Macintoshes each. One lab was equipped with SE30 computers, the other was equipped with LC computers.

Design. A 2x3 research design was used. Variable one, type of feedback, has three levels - (1) spoken audio only, (2) printed and read (spoken), and (3) spoken by an animated character. The second variable, reading ability, has two levels - high and low.

Procedures. Subjects' classroom groups were divided in half and each half was required to report to one of two Macintosh computer labs where the studies were conducted. In each lab the subjects were randomly assigned to one of the treatments. Classroom teachers did not play a role in the delivery of the instruction.

Data Analysis and Results. Analyses of variance were conducted to determine the effects of the treatment variables on the posttest scores. Type of feedback was not found to have a significant effect on students' performance in this study (Table 3). However, ANOVA results do indicate that reading was significant (Table 4).

Discussion. Analysis of the data related to the primary research question (type of feedback) found no difference. However, there was a consistent tendency for students receiving only voice feedback to score higher on the posttest. This may indicate that supplementing the audio with text or graphics divides the learners' attention resulting in decreased comprehension.

The findings related to reading ability appear to reflect the participants' ability to read and learn from the text in the lesson. These findings indicate that the audio feedback component does not compensate for the text presentation of the content.

Conclusions and Recommendations

Following are a number of conclusions and recommendations based on the results of these studies and the observations of the researchers. While they

may be tentative, they none-the-less provide food for thought and direction for future work.

1. Whose voice is used in the delivery of feedback in CBI seems to be of little importance. Perhaps of more importance is the gender of the speaker. In our first study, where a female agent was used, female students outperformed male students. In our second study, where the agent was a male, no performance difference based on gender was found. Whether this indicates that (1) girls work harder for a female agent, or (2) boys don't work as hard for a female agent, is worthy of further investigation.

2. The image associated with the speaker is of little importance. The students in our study did not appear to associate an agent on the screen with the person being represented. A possible topic for further investigation is whether younger learners would attribute more authority to the computer agent that represented a person they know.

3. It is reasonable to assume that if speech is going to effect a change in learning outcomes, then the amount and positioning of the speech within a lesson are of critical importance. In the studies we conducted speech was used only to deliver feedback. Much of the content was delivered through text. In our second study students' reading ability was found to have a significant effect on their learning. Therefore, it is reasonable to assume that an effective use of speech technology would be to help students overcome reading limitations that influence their processing of content.

4. During the research teachers and school staff repeatedly commented on the effect headphones had on student behavior. Once the headphones were on, student focused their attention on the computer lesson. Normal computer lab behavior appears to involve talking with others and looking around the room. Whether this auditory isolation produces better concentration, and thus improved performance, is uncertain.

5. Another observation made during the studies was that students in the animated character treatments were more demonstrative. They showed more facial expressions and talked back to the computers more than students in other treatments. The observers felt these students seemed to be more involved and to enjoy the lessons more. This may indicate a particular value to this method of integrating speech.

6. Regardless of what our research finds,we may not have a choice but to use speech and agents in instructional software. The use of these techniques is similar to the use of color. Increasingly our clients expect products to contain certain features. When they are not present, questions are raised and instructional products are devalued. Perhaps the most we can hope to do at this time is to moderate what we believe we can accomplish through the use of speech technology and proceed cautiously with its use.

7. In multimedia environments identification of primary symbol systems and the "most essential characteristics" of each is no small task. For spoken words, the list of characteristics includes, but is not limited to: gender of the speaker, tone, mode, pacing, cultural cues, and message. Furthermore, these characteristics may have varying degrees of importance to different learners.

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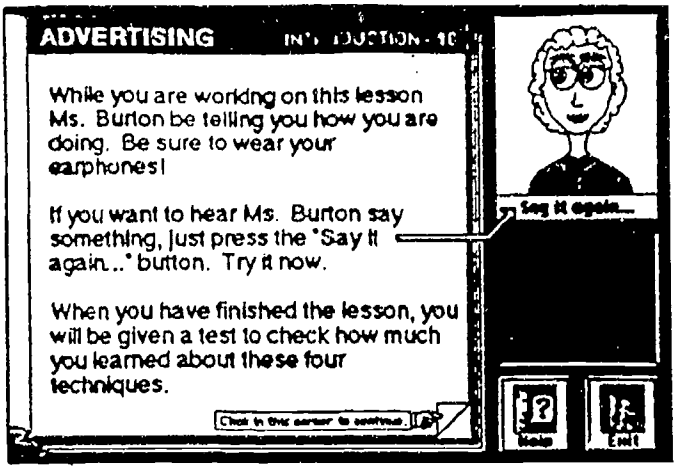

Figure 1. Introduction from *Propaganda Techniques in Advertising* lesson describing audio controls.

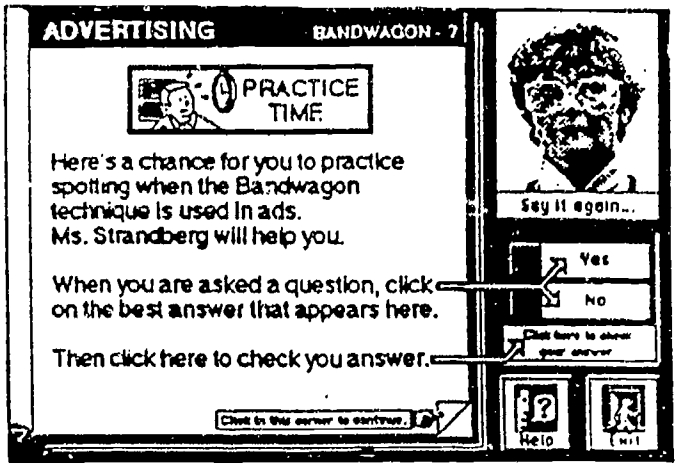

Figure 2. Beginning of practice section explaining response options.

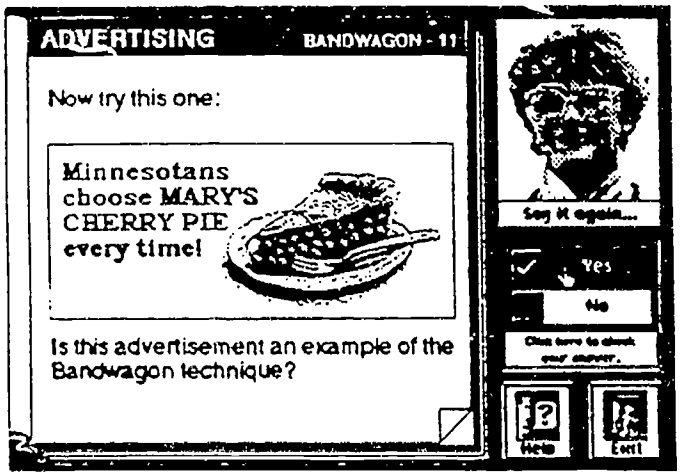

Figure 3. Typical practice item from the "familiar" voice and actor treatment just prior to response checking.

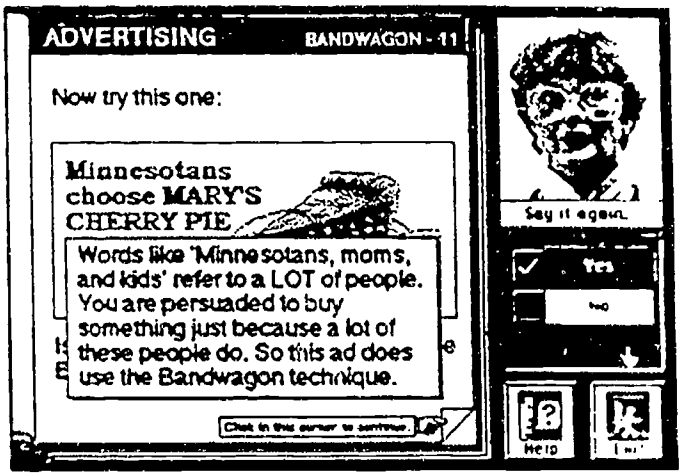

Figure 4. Additional feedback appearing in answer window after audio feedback is delivered.

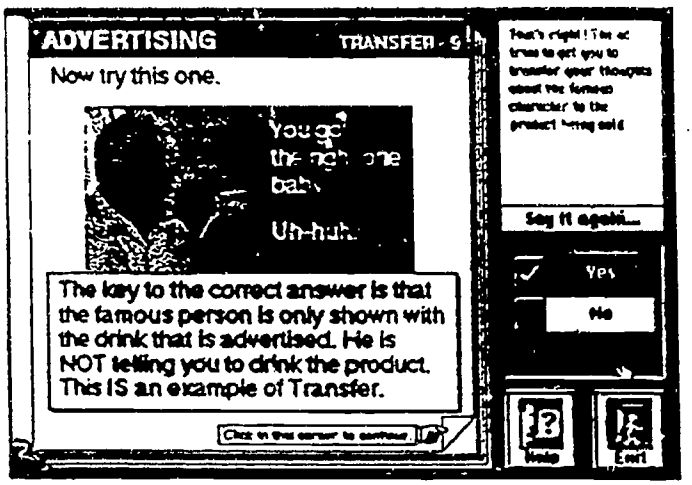

Figure 5. Feedback as displayed to the voice only treatments (both "familiar" and "unfamiliar" voice).

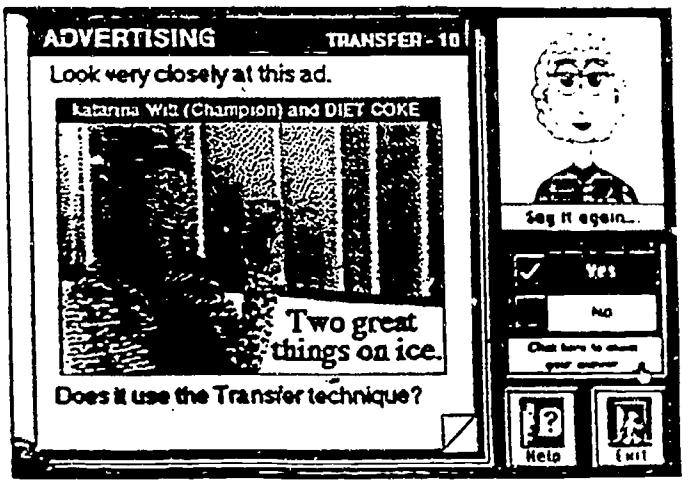

Figure 6. Practice item using the "unfamiliar" voice and actor.

Figure 7: Spoken only.

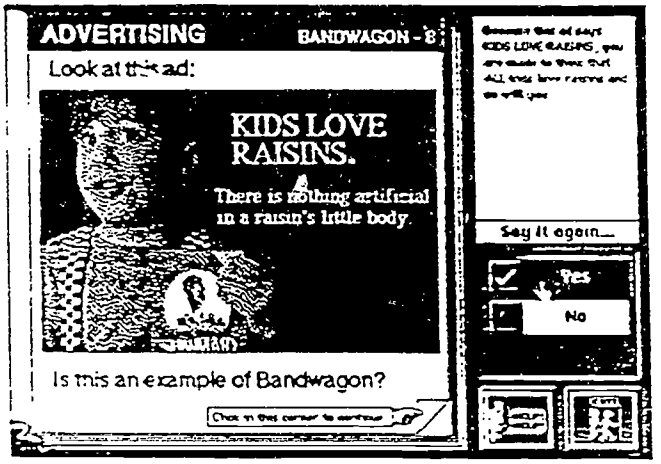

Figure 8: Printed and read (spoken).

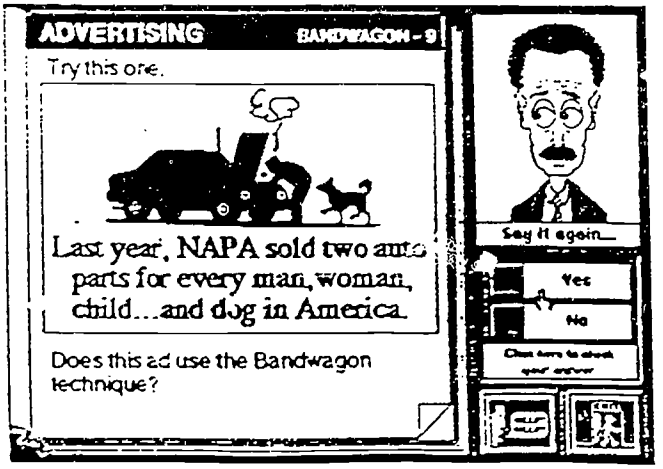

Figure 9: Spoken by an animated character.

Table 1

Analysis of Variance - Tests of Significance for Posttest Scores

Source of Variation	MS	F	Sig of F
within cells	25.88		
covariate	785.20	30.34	.00
familiar/unfamiliar	14.10	.54	.46
voice/image	25.71	.99	.32
gender	176.72	6.83	**.01**
familiar/unfamiliar by voice/image	.64	.02	.87
familiar/unfamiliar by gender	18.88	.73	.39
voice/image by gender	1.35	.05	.82
familiar/unfamiliar by voice/image by gender	3.34	.13	.72

Table 2

Summary of Posttest Scores by Gender

Gender	Mean Count Standard Deviation
Boys	1
	12.68 47 5.56
Girls	2
	15.26 53 5.89
	14.05 100 5.85

Figure 10

2x2 Research Design, Cell Size and Gender

	Familiar	Unfamiliar
Voice (with text)	**22** (14 girls, 8 boys)	**24** (17 girls, 7 boys)
Voice with Animated Character	**29** (11 girls, 18 boys)	**25** (11 girls, 14 boys)

Table 3. Means and Standard Deviations for Posttest Scores (Treatment by Ability)

Ability		Treatments 1	2	3	Total
High					
	Mean:	21.87	22.11	21.59	21.80
	SD:	3.83	2.57	4.00	3.59
	N:	15	9	17	41
Low					
	Mean:	16.07	13.95	15.13	14.94
	SD:	4.53	6.73	5.57	5.74
	N:	14	19	16	49
Combined					
	Mean:	19.07	16.57	18.45	18.07
	SD:	5.06	6.87	5.77	5.95
	N:	29	28	33	90

Table 4. Two-way ANOVA Results for Posttest Scores (Treatment by Reading Ability)

Source	df	SS	MS	F	p
Treatment	2	12.38	6.19	0.25	.778
Ability	1	985.60	985.60	40.14	.000
Interaction	2	19.47	9.73	0.40	.674
Error	84	2062.37	24.55		