A COMPARISON OF THE EFFECTIVENESS AND EFFICIENCY OF LEARNING FROM MULTI-MEDIA PROGRAMMED INSTRUCTION AT FIXED AND LEARNER SELECTED RATES OF COMPRESSED SPEECH

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ABSTRACT

A COMPARISON OF THE EFFECTIVENESS AND EFFICIENCY OF LEARNING FROM MULTI-MEDIA PROGRAMMED INSTRUCTION AT FIXED AND LEARNER-SELECTED RATES OF COMPRESSED SPEECH

By

Joseph G. Hagaman

Learner control over the presentation rate of recorded information may become a practical alternative in the near future with the advent of low-cost variable-speed speech compression recorders. The extent to which this additional control enables learners to learn more effectively and efficiently was of major concern to this study.

Purpose. The primary purpose of this study was to ascertain the effects on comprehension and learning efficiency when learners were given the opportunity to manipulate the presentation rates of programmed filmstrip/tape lessons using a variable-speed speech compressor. Specifically, this study compared comprehension and learning efficiency (cognitive scores divided by learning time) on two programmed filmstrip/tape lessons presented in an individual carrel setting under three different learning conditions: (1) original versions of the audio-tapes (150 wpm) played back on a normal tape recorder, (2) 25% compressed versions of the audio-tapes (200 wpm) played back on a normal tape recorder, and (3) original versions of the audio-tapes played back on a variable-speed speech compressor. The corresponding filmstrips

remained the same for all three conditions. This study was also concerned with ascertaining if attitudes toward the lessons' contents or the individualized programmed filmstrip/tape method of learning were differentially influenced by the learning conditions.

Procedures. Sixty-seven students from two sections of a basic audio-visual communications course were randomly assigned to one of the three treatments. Over a period of two weeks, all treatments took three commercially available filmstrip/tape lessons on the subject of behavioral objectives. Lesson One served as a practice lesson; data were collected on the cognitive tests and the amount of learning time for Lessons Two and Three and on a three-part attitude Post-test at the end of the experiment.

Thirteen specific hypotheses were formulated to examine mean differences and differences in variances among the three treatments. Mean differences were analyzed using ANOVA and Scheffé post-hoc techniques; differences in variances were analyzed using F-tests.

Findings. No significant differences were identified among the three treatments for cognitive learning and attitude. The findings did indicate, however, that for both learning time and learning efficiency, students in the normal, fixed-rate treatment took the most time to complete the lessons and were least efficient while those in the compressed, fixed-rate treatment took the least amount of time and were the most

efficient. The findings also suggested that students in the variable-rate treatment did, in fact, vary their learning time more than those in the two fixed-rate treatments.

Based on these findings, it was suggested that the individual use of variable-speed speech compression recorders to take programmed filmstrip/tape lessons offers little advantage, in terms of effectiveness and efficiency, over normal, fixed-rate audio-tapes or 25% compressed, fixed-rate audio-tapes.

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By

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To Marg, Danny and Brian

who shared my frustrations and joys

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CHAPTER I

RATIONALE OF THE STUDY

Introduction

Of the many ways that man communicates, probably the spoken word and the written word are the most important. Although both communicate verbal information, they are quite different in many respects.

> One of the major differences between communication by speech and communication by print is that in ordinary circumstances the former is externally-paced while the rate at which the latter is perceived is controlled by the individual recipient. (22:15)*

A reader is able to adjust his reading rate over a wide range to suit his ability and preferences of the moment. The listener, however, is confined to the rate at which the material is spoken and, in most cases, this rate rarely exceeds 175 words per minute (51). When compared to reading rates of 300 words per minute and more, listening at one-half that speed may be inefficient for many listeners.

Until 1954, investigators of rapid listening could only produce higher speaking rates by having the narrator speak faster, increasing the playback speed, or periodically cutting out small sections of the recorded tape and then splicing the remaining sections together. All of these

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*Numbers in parentheses refer to numbered references in the bibliography; those after the colon are page numbers.

methods were unsatisfactory. Speaking faster with acceptable intelligibility was physically impossible at the higher rates; speeding playback rate resulted in an undesirable pitch increase; and the "chop-splice" method was too cumbersome and time-consuming for any but research purposes.

The development of the first electromechanical speech compressor in 1954 made possible, for the first time, a convenient and effective way to compress or expand recorded speech. Since that time, researchers have consistently suggested that "The use of compressed audio-tape could make a considerable contribution towards achieving greater learning economy and educational economy by shortening information presentation time." (3:4)

Problem

There is no doubt that educational economy is of major concern to both educators and legislators today. But reducing the costs of instruction and, at the same time, improving its effectiveness is often difficult to achieve. One solution has been to place more of the responsibility for learning with the individual learner, the concept of individualized instruction. In fact, one of the most pervasive themes dominating American education today is the concept of individualized instruction. Both educational research and educational practice in recent years have emphasized the need to recognize individual differences in

learners and to accomodate these differences when possible. Although accomodating individual differences has been done primarily to improve the effectiveness of learning, increased learning efficiency has often been realized as a by-product.

One important variable on which learners differ significantly is the rate at which they learn. Individualized instruction attempts to accomodate these differences in rate by allowing individual pacing. In fact, as pointed out by Edling, "All individualized instruction requires, by definition, individual pacing." (14:2) Kemp also indicates the need to accomodate individual differences in rate.

> There is much evidence to support the theory that learning must be accomplished by the individual for himself and that it takes place best when the student works at his own rate, is actively involved in performing specified tasks, and has successful results. (28:56)

The movement to individualize instruction has generated a number of teaching-learning environments, each designed to accomodate, in varying degrees, individual differences. One typical arrangement is the learning laboratory where students interact with mediated programmed materials in an individual carrel setting. The materials, usually in the form of cassette tapes with corresponding slides or filmstrips, provide a structured learning experience to each individual student. A major advantage of this arrangement over group presentation of the same materials is that it allows the student to adjust the presentation rate to suit his individual abilities and preferences. However, in reality,

the learner has only limited control of the rate. Although he can adjust the rate downward by stopping and starting the presentation, he has no way of increasing the presentation rate; he cannot go faster than the narrator's speaking rate.

That there are considerable individual differences in reading rate has long been accepted. More recently, research in the area of compressed speech has shown that there are also significant differences in listening rate. Some listeners are able to comprehend speech presented at a rate of 300 words per minute, a rate well above normal speaking rates with little or no prior experience in listening to such speech. Other listeners show poor comprehension of compressed speech even after prolonged exposure to it (17:15).

In addition to the variation in student ability to learn by listening at various rates, there is also wide variation in the rates students prefer (31). And, this is further complicated by the fact that the preferred rate of listening, as with reading, may vary from day to day or minute to minute depending on the difficulty of the material and the mood of the listener (32).

Given that there are significant individual differences in listening rate and preferred listening rate, could not these be accomodated within an individualized, multi-media, carrel enviornment by allowing students to adjust the speaking rate of the narrator to be more in line with their unique listening abilities and preferences?

Would this manipulation result in more effective and efficient learning?

Purpose of the Study

The purpose of this study was to ascertain the effects on comprehension and learning efficiency (comprehension per unit of time) when learners are given the opportunity to manipulate the presentation rates of programmed filmstrip/tape lessons using a variable-speed speech compressor. Specifically, this study compares comprehension and learning efficiency on two programmed filmstrip/tape lessons under three different learning conditions: (a) original versions of the audio-tapes played back on a normal tape recorder, (b) 25% compressed versions of the audio-tapes played back on a normal tape recorder, and (c) original versions of the audio-tapes played back on a variable-speed speech compressor. The corresponding film strips remain the same for all three conditions. This study was also concerned with ascertaining if attitudes toward the lessons' contents or the individualized programmed filmstrip/tape method were differentially influenced by the learning conditions.

Need for the Study

Over the past twenty years, since the advent of the first speech compressor, a large volume of research has been

conducted in the area of compressed speech. This is most evident by a recently published bibliography on time-compressed speech which lists over 400 "selected" studies (11). A considerable amount of this research has been concerned with the effect of rate increase on listening comprehension; a relatively small portion of this research studied rate preferences, only one of which included tests for comprehension (22); an even smaller number investigated compressed speech and multi-media instruction; and, until very recently (47), there were no studies reported on the effect of student control of listening rate through a speech compression device during multi-media instruction.

The need for research in this area is even more pressing in light of recent technological advances in variable-speed speech compressors. In 1967, when Friedman, Orr, and Graae (22) reported on their study of the effect of self-pacing on comprehension, speech compressors were relatively expensive ($3000 to $5000). Although the authors found no differences between fixed and self-paced groups, they indicated that even if self-pacing were more effective, the educational implications would be limited:

> Given the state of the current technology, self-pacing is of limited practical value since it is not feasible to make available machines for extensive individual use. (22:27)

Over the past several years, development of more sophisticated electronic and and simpler electromechanical machines has

driven the price of speech compressors to less than $1000, still quite expensive for individual use.

One of the most recent advances in speech compressors has been the development of Variable Speech Control (VSC), a tiny solid-state module about the size of a sugar cube (44). The VSC module can be incorporated into normal tape recorders with only slight modification. Playback speeds from one-half to over three times normal rate are possible by means of a simple dial. The most significant feature of this new device is the anticipated low cost. It has been estimated that VSC equipped tape recorders will sell at first for less than $200 and ultimately for less than $50 (54).

Alvin Tofler, author of Future Shock, has made the following comments relative to the impact of VSC:

> Basically, I would look upon Variable Speech Control as a de-standardizing technology. It's a technology which makes it possible for the user to select from a greater repetoire of information and to play back at a speed he or she has chosen, an individualized speed. It makes it possible for the listener to custom-tailor what he or she is hearing. It strikes me, after some discussion of Variable Speech Control, that this is a new technology which has a very large-scale potential for changing the way we live. (54)

As student control over listening rate becomes a practical alternative in the near future, educators will be concerned with the potential of such control in bringing about improved learning effectiveness and efficiency. This study was designed to investigate those concerns.

Hypotheses to be Tested

Thirteen specific hypotheses were formulated for this study to test the effectiveness and efficiency of student learning of programmed filmstrip/tape lessons under three conditions: (1) original versions of the audio-tapes played back on a normal tape recorder, (2) 25% compressed versions of the audio-tapes played back on a normal tape recorder, and (3) original versions of the audio-tapes played back on a variable-speed speech compressor. These thirteen hypotheses are combined here into six general hypotheses dealing with cognitive learning (H_1 and H_2), learning time (H_3 and H_4), learning efficiency (H_5) and attitudes (H_6).

H_1: Students who are allowed to vary the presentation rates of programmed filmstrip/tape lessons using a variable-speed speech compressor will score significantly higher on cognitive tests for those lessons than students receiving those lessons at either the normal rate or the 25% compressed rate using standard tape recorders.

H_2: Students who are allowed to vary the presentation rates of programmed filmstrip/tape lessons using a variable-speed speech compressor will have significantly less variance of cognitive scores for those lessons than students receiving those lessons at either the normal rate or the 25% compressed rate using standard tape recorders.

H_3: Students who receive the programmed filmstrip/tape lessons at the normal rate using standard tape recorders will take a significantly greater amount of time to complete each lesson than students receiving those lessons at either the 25% compressed rate using standard tape recorders or the variable rate using a variable-speed speech compressor.

H_4: Students who are allowed to vary the presentation rates of programmed filmstrip/tape lessons using

a variable-speed speech compressor will have significantly greater variance in the times taken to complete each lesson than students receiving those lessons at either the normal rate or the 25% compressed rate using standard tape recorders.

H_5 Students who receive the programmed filmstrip/tape lessons at the normal rate using standard tape recorders will have significantly lower learning efficiency scores for those lessons than students receiving those lessons at either the 25% compressed rate using standard tape recorders or the variable rate using a variable-speed speech compressor.

H_6: Students who are allowed to vary the presentation rates of programmed filmstrip/tape lessons using a variable-speed speech compressor will score significantly higher on attitude measures of preference for behaviorally stated objectives, attitude toward content of lessons, and attitude toward method of learning than students receiving those lessons at either the normal rate or the 25% compressed rate using standard tape recorders.

Limitations

The following limitations are acknowledged as inherent in this study. Accordingly, the extent to which one generalizes from the findings should be restricted.

1. The population of this study is limited to students enrolled in Audio-Visual Communications 407-560 at the University of Wisconsin-Stout during the second semester of the academic year 1973-74. The sample drawn from this population was relatively small (N=67) resulting in treatment group sizes of 22, 21, and 24.

2. The stimulus materials used in this study were commercially produced programmed filmstrip/tape lessons used in an individual carrel setting. Generalizations from the results of this study to other types of materials in other settings should be done with caution.

3. Only fixed narration rates of 150 and 200 words per minute were included in this study. Other fixed rates were not included in the scope of this study.

4. Students in the variable rate group manipulated rate on a variable-speed speech compressor. Use of a variable-speed speech compressor-expander could produce different results.

5. The length of exposure to the experimental treatments totaled about one and one-half hours of learning for each student. Longer or shorter exposure could produce different results.

6. Time spent learning for each subject was measured by the time spent in the carrel for each lesson. The more accurate measure of time spent receiving the stimulus materials was not measured in this study.

Definitions

The following terms and phrases are used in the description of this study. A definition of each is provided to communicate to the reader the use of these terms in the restricted context of this study.

Compressed speech - Recorded speech that has been accelerated in rate of presentation with only negligible change in pitch. Usually accomplished through a "variable-speed speech compressor" that periodically deletes small samples of the recorded message (20 to 40 milliseconds) and abuts the remaining samples together electronically with negligible loss in intelligibility.

Expanded speech - The opposite of "compressed speech" where small pause segments are added periodically to the original message.

Variable-speed speech compressor - An electronic or electromechanical device used to play back original material at rates higher than the original recording. Playback rate can be adjusted by means of a simple dial.

Words per minute (wpm) - A unit of measure used to denote speaking rate of narrative passages. If 150 words were spoken in a one-minute passage, the speaking rate would be referred to as "150 wpm".

Individual carrel environment - A learning environment consisting of several booths isolated from each other where students work with stimulus materials independently and at their own rate.

Multi-media instruction - Used in a limited sense in this study to refer to instruction using stimulus materials that are combinations of aural and visual stimuli (i.e., slide/tapes, filmstrip/tapes, films, and television).

Programmed filmstrip/tape lessons - Stimulus materials in the form of a filmstrip with corresponding audio-tape. The taped narrative contains tones to signal the learner to change the filmstrip to the next frame. Lessons are programmed in the sense that: (1) they are designed from specifically stated instructional objectives, (2) they are validated, (3) they provide a structured sequence of stimulus items, (4) they require the learner to make specific responses during the lesson, (5) they provide feedback on these responses, and (6) learners are expected to perform at a relatively high level on a criterion test.

Learning efficiency - A computed measure used in this study to indicate the relative learning efficiency of the three treatments. Calculated for each student on Lessons #2 and #3 by dividing the number of correct responses on the criterion test by the time spent in the learning carrel for that lesson.

Overview

Chapter I has presented a rationale and frame of reference for this study. Chapter II reviews literature related to this study and provides a foundation for its design and interpretation of results. Procedures and methodology are included in Chapter III, and an examination of the data will be found in Chapter IV. Finally, Chapter V

presents a summary of the study, conclusions, implications, and recommendations for further research.

CHAPTER II

REVIEW OF RELATED LITERATURE

The primary purpose of this study is to ascertain the effects on comprehension and learning efficiency when learners are given the opportunity to manipulate the presentation rates of programmed filmstrip/tape lessons using a variable-speed speech compressor. In order to provide a foundation for designing the study and a basis for interpreting results, four areas of related research are presented in this chapter.

The first section on Comprehension and Listening Rate provides essential background information. Findings related to listening comprehension at various rates for different types of materials for different groups of subjects reveal some concensus regarding the most efficient rate of listening.

Research on Preferred Rate of Listening reported in the second section suggests that preferred rates may be considerably slower than the most efficient rate.

Because this research used filmstrip/tape materials, the third section on Compressed Speech and Multi-Media Instruction is included to establish the effect on comprehension when compressed speech is augmented with visual materials. Two of these studies (1;24) used the same filmstrip/tapes used in this research.

The fourth section of this chapter, Comprehension, Multi-Media Instruction, and Preferred Rate of Listening, reviews the only two studies known to the researcher (8;47) that included the same three major conditions employed in the present study.

The last section of this chapter summarizes those findings from previous research which influenced the design of this study.

Comprehension and Listening Rate

Research dealing with rate-altered speech typically begins by recording a passage of material at a "normal" speaking rate which is then altered by some type of rate-altering device that will provide duplicate recordings of the original passage at different rates. The wide variance of "normal" speaking rates reported in the literature has been noted by Wood (51) who notes that even though there is little agreement on what constitutes a normal speaking rate, a range of 125 to 175 wpm would include most reports. This is confirmed in a review of literature on time-compressed speech by Foulke and Sticht (21) who reported the same normal range of 125-175 wpm.

Although reports of research in compressed speech usually stipulate the words-per-minute rate of the original passage, references to other rates produced from the original

are sometimes expressed in other ways such as "30% compression" which means that 30 percent of the original time has been saved, or "compressed to 70%" which means that the compressed version takes 70 percent of the original time. Specification of rate can also be made in terms of the degree of acceleration of the original word rate, such as "compressed 1.5 times" meaning that the word rate after compression is one and one-half times the word rate before compression (21:482).

These differences in reporting makes it sometimes difficult for the reviewer of compressed speech research to compare findings from one study to another. For this reason, all reports of rates for research reviewed in this chapter will be converted to words-per-minutes (wpm) if the study has not already done so. Although words-per-minute may be considered an inaccurate and deceptive measure of rate because of varying length and complexity of words, it has become a standard that most researchers use (10:369).

One of the first, and most often quoted studies on listening rate and comprehension was done by Goldstein in 1940 (25), fifteen years prior to the invention of the first speech compressor. Goldstein was interested in comparing the efficacy of written and oral materials at various rates. A standardized reading test was reproduced visually on film and orally on records by a professional speaker. Adult

subjects (N=280) were randomly assigned to either visual-only, aural-only, or aural-visual treatments at seven different presentation rates ranging from 100 to 322 wpm in 37 wpm increments. Two difficulty levels of material at each rate were used. The author submitted the data to exhaustive analysis resulting in several conclusions, including the observations that listening comprehension was superior to reading for the less difficult material, and both reading and listening comprehension declined as rate increased.

Comprehension as a function of listening rate received little attention until the mid 1950's with the advent of the first speech compressor developed by Fairbanks, Everitt, and Jaeger (21:480). In addition to his engineering capability, Fairbanks was also interested in the practical application of this device. Several research investigations were conducted by Fairbanks and his colleagues, among which was a 1957 study that sought to determine comprehension at various listening rates (16). Two factual messages on meteorology were developed to represent typical expository lectures. Both eleven-minute passages were initially recorded at 141 wpm and then compressed 30% (201 wpm), 50% (282 wpm), 60% (353 wpm), and 70% (470 wpm). Adult male subjects were assigned to each treatment including a control group that received the test only. Mean comprehension scores on a 60 item post-test indicated the following results: 141 wpm ($\bar{x}$=38), 201 wpm ($\bar{x}$=36), 282 wpm ($\bar{x}$=35), 353 wpm ($\bar{x}$=27), 470 wpm ($\bar{x}$=16), and the test-only group

($\bar{x}$=12). A comparison of the means indicated that comprehension was affected only slightly up to a rate of 282 wpm and then dropped markedly for the higher rates. The authors also calculated an efficiency score for each subject by dividing the number of items correct by the presentation time in minutes. Mean efficiency scores for each rate clearly indicated that a maximum efficiency of 90% was obtained at the 50% compression level (282 wpm).

The findings of the Fairbank's study were significant in two respects: 1) it established a comprehension by rate relationship that was duplicated by many subsequent studies, and 2) the authors' use of an efficiency score as a measure of optimum learning in the shortest time. Based on their findings, the authors' concluded that:

> ...for learning of this type, the original message as recorded was relatively inefficient. If the original message is representative of expository lectures on factual topics, as it is believed to be both in content and delivery, then the implications for training procedures are direct, namely, that when message rate is slowed beyond a certain point the increment in learning becomes relatively costly in time, and that the cost should be weighed in terms of the objectives of the learning. (16:195)

During the 1960's increased interest in compressed speech and the availability of speech compression equipment generated a considerable number of research studies. In addition to the continuing research by Fairbanks and others at the University of Illinois, two other centers of research conducted numerous studies on many aspects of compressed speech (11:505).

One of these, the American Institutes for Research, was primarily concerned with various aspects of training students to comprehend high rates of speech. A study reported by Orr, Friedman, and Williams in 1965 (36) showed that practice in listening to compressed speech at relatively high rates (325 wpm) could improve comprehension. Subjects who had been exposed to several hours of compressed speech listening had significantly higher comprehension on test passages at 425 and 475 wpm than those subjects without practice. However, no significant differences were noted between the two groups at rates of 175, 325, and 375 wpm. It was also noted that comprehension only dropped 20% for those subjects with no training at the 325 wpm rate. The authors' findings led them to suggest that:

> ... where 80 per cent or better of normal speed comprehension is acceptable, even naive listeners can tolerate close to twice normal presentation speed (36:772).

The other center of compressed speech research active in the 1960's, and still quite active today, is the Center for Rate Controlled Recordings of the Perceptual Alternatives Laboratory at the University of Louisville. Under the direction of Dr. Emerson Foulke, the center has conducted a wide variety of studies, mostly concerning the comprehension of rapid speech by the blind. In one study, using 360 sighted college students, Foulke (18) investigated listening comprehension as a function of word rate. Twelve comparable groups heard a listening selection at rates ranging from 125

to 400 wpm in 25 wpm increments. Results supported the findings of Fairbanks (16) and Orr (36) in that comprehension declined as the rate increased but not significantly until the 275 wpm rate.

Some studies have examined comprehension of compressed speech and learner variables. Comprehension related to general ability level was the subject of a 1968 doctoral dissertation by Langford (29). Using a commercially available listening test, high school juniors and seniors from three ability groupings were assigned to word rates of 175, 225, 275, 325, and 375 wpm. An analysis of findings indicated that students with higher intelligence or better academic performance did consistently better than those of lesser ability. It was also determined that most students could listen, without significant loss of comprehension, to compressed material at rates between 275 and 325 wpm.

Another study by Parker (37) also included treatment groups for high and low aptitude students, however, results were somewhat different. A passage from the Nelson-Denny Reading Test was recorded at a normal rate and then compressed to two-thirds and one-half the normal recording time (no words-per-minute rates were given). Parker found no significant differences in comprehension related to aptitude level at any of the three rates. He also found that students assigned to the two-thirds rate did as well as those assigned to the normal rate.

Studies have also been conducted to determine the effect difficulty of material has on comprehension. Reid (40) constructed a grammatically simplified version of the Nelson-Denny Reading Test and recorded both versions at 175, 275, 325, and 375 wpm rates. Performance on a post-test by college students assigned to the treatments revealed a significant difference in comprehension in favor of the simplified version. Reid also found the 275 wpm rate for both versions of the material superior to the 175 wpm rate and noted that comprehension did not drop significantly until the 375 wpm rate.

In a duplication of Reid's experiment by George (23), retention was the primary concern, however, immediate comprehension was also measured. George did find that the rate of presentation affected comprehension, but unlike Reid's findings (40), the difficulty level did not. George also found that comprehension at the 175 wpm rate was significantly better than the other three rates. One possible reason for the differing results, suggested by George, was the use of headsets in Reid's study as compared to a speaker in his study.

All of the studies reviewed in this section so far, except for George (23), seem to indicate that somewhere around 275-300 wpm comprehension begins to drop significantly. However, George used no rates between the normal

version at 175 wpm and his lowest compressed version at 275 wpm.

A well designed experiment by Rossiter (41) compressed the 175 wpm normal rate of his materials to rates of 233 and 265 wpm. The author's primary concern in this study was to test the hypothesis that there was a significant interaction among scores on tests requiring recall of facts, recall of ideas, and generation of inferences about orally presented messages when the rate of presentation was varied. Fourteen 1-1/2 minute messages on various topics served as the stimulus materials administered to 271 college students. Six multiple-choice test items were constructed for each measure, two each for recall of facts, recall of ideas, and generation of inferences, thus resulting in an 84-item post-test for each group. Although Rossiter could not identify any significant interaction between speed of presentation and type of information, mean scores did show that comprehension declined significantly for all three types of information at the 233 wpm rate with a further significant decline at 265 wpm. Aware that previous researchers had noted the 275 wpm rate as the point of significantly declining comprehension, Rossiter suggested that his findings might be more reliable because of his larger sample-size and because he tested a control group that had not heard the messages.

This section on Comprehension and Listening Rate has attempted to provide a general background of information

relevant to the proposed study. The research studies reviewed indicate that listening to materials at rates higher than normal is possible for the untrained listener with little degradation in comprehension. Although the exact point where there is a significant decrease is debatable, 275 wpm is most often quoted. This review has also indicated the previous use of an efficiency measure (16), which was used in the present study.

There are, of course, many other stimulus and listener variables that may account for differences in comprehension in addition to the amount of compression. Foulke and Sticht (21) have reviewed research relevant to the effects on comprehension of method of compression, nature of material to be comprehended, reader's style and vocal quality, listener's sex, listener's age, intelligence, visual status, reading rate, and training methods to improve comprehension. The review of literature in this chapter, however, will only note these variables if they have been investigated as a significant part of studies related to the specific areas of interest to this study, namely, rate preference and multi-media instruction.

Preferred Rate of Listening

The research reported in the previous section concerned the possible upper limits of listening comprehension. Since this study allows one treatment group to

control their own rate, this section will review research relative to what rates listeners actually prefer.

Foulke (19) reported on the results of a survey conducted to assess the acceptability of rapid speech for purposes of reading by listening. A sample of 100 college students was drawn randomly from a list of patrons using the services of Recordings for the Blind. Each was sent a sample recording, containing several passages at various rates from 180 wpm to 350 wpm and a questionnaire. Analysis of questionnaire responses of the 51 replies, indicated that word rates within the range of 250-275 wpm could be understood without difficulty and that the preferred rate of 68 percent of the respondents was 275 to 300 wpm.

It should be noted that the relatively high preferred rate indicated by Foulke's survey might be partially a result of the subjects surveyed. Since blind students must rely heavily on listening to receive information, they may tend to prefer a rate that is closer to their most efficient rate.

Preferred listening rates of sighted college students were examined by Foulke and Sticht (20). A story at about the eighth grade reading level served as the stimulus material for each of 100 students tested individually. Each subject listened to 10 samples alternately started at a very high or a very low rate. On each trial, the subject directed the experimenter through an intercom to either raise or lower

the rate until the preferred rate was reached. The mean word rate for both ascending and descending trials was determined for each subject and an overall mean of 207 wpm was reported with a standard deviation of 24 wpm. The authors noted that this mean preferred listening rate of 207 wpm was well above normal speech rates typically reported in the literature. In conclusion, the authors felt that if sighted persons had experience in listening to accelerated speech, even faster word rates would be preferred.

Lovitt (35) investigated individual preferences for narrative rate among 10 normal and 10 retarded boys, ranging in age from 10 to 14. An award-winning book of interest to pre-adolescent boys was recorded by a professional narrator at 180 wpm. Using a compressor-expander, additional tapes were made at 90, 135, 225, and 360 wpm. To obtain each subject's most preferred rate of narration, five to nine individual sessions were administered. Each of these sessions involved the simultaneous presentation of two different narrative rates of the same story. Subjects could select one rate by pressing a microswitch at or beyond the preset rate of 45 responses per minute, or select the other rate by not responding at all. If the subject responded at rates of less than 45 per minute, he received both versions at minimal volumes. By pairing of all the rates over several sessions and by requiring subjects to sometimes respond and sometimes not respond to get the preferred rate, the

experimenter was able to determine preferred rates for 18 of the 20 subjects.

Results indicated that for the nine normal subjects, five preferred the normal 180 wpm rate, three chose the 225 wpm rate, and one selected the 135 wpm rate. Retardates selected rates that were both faster and slower than the normal subjects: three selected 90 wpm, two 135 wpm, three 225 wpm and one 360 wpm. No retardates preferred the normal 180 wpm rate.

It should be pointed out that any conclusions based on the results of Lovitt's study may be suspect because of the small sample size, the unnatural conditions of the treatment, and interference caused by constantly interrupting an interesting story.

As part of an extensive research program on the applicability of speeded speech in education Friedman, Graee, and Orr (22) investigated comprehension under fixed and self-paced conditions. Twelve male college students were paid to act as subjects. Seven historical passages taken from a college level text on English history were professionally recorded at 175 wpm and then compressed to 1.5 times the normal rate (262 wpm). Comprehension of each passage was measured by a 25-30-item multiple-choice test.

Under the experimental conditions, each subject listened to seven passages of about 23 minutes each. The first was a baseline at 175 wpm, followed by one externally-

paced passage at 262 wpm, then three self-paced passages, and finally two externally-paced passages again at 262 wpm. Comprehension tests were administered after each passage. During the self-paced passages, subjects could adjust the narration to their preferred rate by manipulating an unmarked remote control knob in front of them. The experimenters recorded rates at intervals of 30 seconds. Timings were also made with a stop watch.

Results indicated that the lowest mean rate for any one passage was 1.16 times normal (203 wpm), while the highest was 2.05 times normal (359 wpm). The overall mean rate on the self-paced passages was 1.45 times normal (254 wpm). No consistent trend was seen from the first to the third self-paced passages with means of 1.43, 1.45, and 1.48 respectively. There was, however, a tendency for subjects to manipulate the rate upward during the first quarter of each passage and then to slowly adjust the rate lower during the last three-quarters of the passage. An analysis of comprehension scores for both self-paced and externally-paced passages indicated no significant difference with respect to type of pacing.

In their discussion, the authors noted the closeness of the mean rates for self-paced (1.45) and externally-paced (1.5) passages. It was suggested that this may be due to a modeling effect since subjects first heard compressed speech at the 1.5 times normal rate. The experimenters

pointed out several factors that may have impeded an increase in comprehension on self-paced passages: (a) the order of the passages, (b) the lack of feedback on performance after each passage, and (c) the interference of manipulating the rate and comprehending at the same time.

It could also be pointed out that the small sample size and the use of paid subjects in an unnatural setting would limit any generalizations about these findings to a "real" educational setting.

Several master's theses, dealing with compressed speech have been sponsored by Professor Normal J. Lass, of the University of West Virginia. Among them are two published reports, relevant to this study, dealing with preferred listening rates. Cain and Lass (6) investigated listening rate preferences by means of a comparison paradigm. Subjects were 100 college students with a mean age of 19 years. The reading passage employed was the first paragraph of Fairbank's "The Rainbow Passage", altered by means of a speech compressor to yield nine different rates: 100, 125, 150, 175, 200, 225, 250, 275, and 300 wpm. Only 54 words of this passage were used in the experiment. Each master tape included 36 pairs of readings with each of the nine rates appearing eight times. For each pair, the subject's task was to select the most preferred rate.

Results indicated that 175 wpm was the most preferred rate while 100 wpm was the least preferred. Subjects also

displayed a very high level of agreement on the rankings of all nine rates. From rank one to rank nine, rates moved further away in both directions from the preferred 175 wpm rate. The authors noted that the preferred rate of 175 wpm was similar to the rate that is often considered "normal" in listening research. Although this was below the 207 wpm rate reported by Foulke and Sticht (20), the second most preferred rate of this study was 200 wpm.

A similar study by Lass and Prater (30) investigated listening rate preferences for both oral reading and impromptu speaking tasks. Subjects were 20 female college students with a mean age of 26 years. All procedures and materials used by Cain and Lass (6) were duplicated in this experiment with the addition of the sample material for the impromptu speech. Both reading and impromptu passages were recorded by the same announcer.

An analysis of preferences determined by the paired comparison procedure revealed a most preferred rate of 175 wpm for both tasks and a least preferred rate of 100 wpm. Rankings for both groups duplicated almost exactly those rankings determined by Cain and Lass (6).

Levine (31) examined rate altering behavior of 48 elementary school children while listening to a recorded short story taken from a third grade reading book. Four equal sections of the story were pre-compressed (or expanded) to rates of 100, 150, 200, and 275 wpm and combined in 12

different tape arrangements to overcome the modeling effect suggested by Friedman, et.al. (22). Four subjects were assigned to each of the 12 versions. During individual 20-minute listening sessions, each subject could manipulate the rate through a remote control knob. Continuous data on manipulation behavior was collected by the experimenter using a chart recorder controlled by the student's remote control knob.

An analysis of the data led the experimenter to conclude that: (a) students will manipulate rate, (b) students demonstrate a manifest preference for rate, and (c) the extent of manipulation of rate is based on the difference between the initial rate of presentation and a subject's manifest preference rate. The mean manifest preferred rate for all subjects was 208 wpm with a standard deviation of about 25 wpm. These results correspond closely with the results of Foulke and Sticht (20), who found a mean preferred rate of 207 wpm with a standard deviation of 24 wpm. Manifest preferences were highly divergent with a multimodal distribution for the entire group; the range of preference rates extended from a low of 167 wpm to a high of 275 wpm. Based on this data, Levine concluded that, ". . . preferred listening rate is an individual skill with considerable variance between subjects" (31:74). He further concluded that:

> Based on this finding it appears to be inappropriate to treat listeners in groups with pre-selected word rates used for presentation of recorded information. The most appropriate procedure would be the design of individual listening experiences with the word rate selected according to the individual listener's manifest preference for rate. (31:105)

Although comprehension was not assessed in this study, Levine recommended that further research be conducted to explore the relationship between manifest preference for rate and comprehension. In other words, to determine if comprehension of recorded information is improved when the rate of presentation of the information is close to a listener's preferred rate.

This section on preferred listening rates has suggested that there is a wide variance in rates preferred by listeners and that this rate is probably less than the highest rate listeners could comprehend, but greater than the normal rate. Whether the preferred rate is either the best rate or the most efficient rate, in terms of comprehension, is of primary concern to this study.

Compressed Speech and Multi-Media Instruction

The research reviewed so far has dealt with comprehension and preference for rate when listening to compressed speech. This section will review research on the comprehension of compressed speech when accompanied by visual material. Of major concern is whether visual augmentation

increases or decreases comprehension at various rates and whether the relationship of comprehension to rate established for aural-only material is similar for aural-visual materials.

One of the earliest studies dealing with visual material added to compressed speech was a doctoral dissertation done by Loper (34). Loper was concerned with investigating the efficiency of using time compressed speech in the presentation of factual messages over a television system. An 11-minute test message on meteorology previously used by Fairbanks (16) was recorded at a "normal" rate of 141 wpm and augmented by separate still-visuals approximately every 14 seconds. A degree of motion was added to some visuals through adjustment of a vari-focal lens. Two additional compressed presentations at 33 1/3 percent (210 wpm) and 50 percent (282 wpm) were produced. Seven experimental groups of about 15-20 were drawn from a basic college speech course. Three groups received an aural only presentation, three saw the aural-visual presentation, and one was tested, but saw no presentation. Results of the immediate comprehension test indicated that:

1) Comprehension was not significantly aided by visual augmentation.
2) Comprehension decreased as the rate of presentation increased.
3) There was a significant difference in favor of the aural-visual normal group when compared with the aural-

visual one-third compression group.
A reordered retention test two weeks later indicated that visual augmentation aided retention only at the highest rate of compression.

A similar slide/tape presentation through the television medium was used by Benz (4). College students in a basic geography course were assigned randomly to two versions of a geography lecture, aural-only and aural supplemented by maps. For each version, three rates were used; normal, one-third compression, and one-half compression (wpm rates were not noted). The author found that at all rates, the aural-visual presentation was superior to the aural-only presentation and that at one-third compression, comprehension was not seriously affected.

The superiority of the aural-visual presentation reported by Benz (4) as compared with the lack of any differences reported by Loper (34) could be explained by the types of stimulus materials each used. Benz used materials that were highly dependent on visual examples of the aural message (i.e., maps); Loper, on the other hand, visually supplemented an audio presentation originally designed to be a complete message in the audio form only.

Other studies have also sought to compare comprehension between aural-only and aural-visual presentations at various rates. Woodcock (52) conducted several studies, using historical passages supplemented with appropriate

slides. He found the listening-viewing condition to be more effective and efficient than listening only. Watts (50) found no significant differences when slides were used to accompany an aural message. He also found no differences in comprehension between rates of 160 and 240 wpm. These two studies are similar to Loper (34) in that visuals were added to an existing audio message, thus, their findings may not be generalizable to messages originally designed to be both aural and visual.

Compression of an aural-visual message involving motion was investigated by Dunathan, Masterson, Parks and Tharpe (12). A four-minute film demonstrating a psychomotor task at a normal word rate of 158 wpm was compressed to rates of 25 percent (211 wpm), 33-1/2 percent (236 wpm), and 50 percent (316 wpm). The visual material was compressed by rephotographing the original film on a rear projection screen and varying projection and camera speeds. Results of subjects' performances on the psychomotor task immediately after viewing the films indicated no differences in performance quality, however, there was some indication that subjects may have attempted to model the accelerated work rate shown in the film. This modeling effect was not apparent on a retention performance test 12 days later.

Although the authors concluded that sound motion pictures could be compressed to rates of 50 percent without significantly affecting performance quality in a psychomotor

task, it should be noted that the "old-time movie effect" resulting from this process may have limited educational applications. Selective editing of redundant visual material might be a better way to achieve the same compressions.

A study by Eckhardt (13) modified a 60-minute multi-media programmed instruction lesson on traffic accidents to achieve compressions of 25 percent (210 wpm) and 40 percent (275 wpm). Three-hundred high and low aptitude Air Force inductees were assigned randomly to each compressed version and to the original at 150 wpm. Visual materials consisted of slides and film segments; films were compressed by selective editing. During group presentations of the lesson, each subject was required to make responses to multiple choice questions periodically by pressing the appropriate button in front of him; a record of responses for the presentation at each rate was tabulated automatically.

Through analysis of these responses for each group and a final criterion test of factual information, Eckhardt concluded that high-aptitude men did better than low-aptitude men and that the high-aptitude men did equally as well at 40 percent compression as they did at the normal rate. Eckhardt also noted that for both aptitudes, the efficiency rating increased as rate increased.

The use of compressed multi-media materials in an individualized carrel setting has been explored by several researchers. Perry (38) used a slide/tape on "Teaching and

Teaching Tools" as the stimulus material to assess the effect of rate on a recall and application test. Students were assigned to one of two versions of the material, normal at 150 wpm and compressed at 250 wpm, in addition to a control group that was tested only. This lesson, along with others, was part of a self instruction lab on the uses and operation of audio-visual equipment. Perry found no significant differences in amount learned between the two treatment rates.

Similar results were also obtained by Sarenpa (42) in a more comprehensive study. The materials for Sarenpa's study consisted of 22 audio tapes used in a Plant Biology course patterned after the audio-tutorial methods developed by Postlethwaite (39). The tapes provided some factual information and also served to guide each student through a variety of learning activities and materials. Sixty-four students in two sections of the course were randomly assigned to either the normal version at 128 wpm or the 40 percent compressed version at 211 wpm. By comparing each student's score on the post-test at the end of the course to their pre-test score, Sarenpa calculated a modified gain score. No significant differences were found between the mean scores of both groups. There were also no significant differences in times taken to complete the lessons although the author noted a 12.3 percent savings in time for the compressed group. The author concluded that there appeared to be no significant advantage or disadvantage to using the

compressed tapes, however, he suggested that further research be done.

It is interesting to note that in a pilot study done prior to the above, Sarenpa assigned students to receive an extended exposure to both the normal and compressed versions for two-thirds of the course. When allowed to choose their preferred mode to complete the remaining one-third of the course, 80 percent of the students chose the compressed rate. Favorable student attitudes toward the use of moderately compressed tapes in an audio-tutorial setting have also been reported by Libby (33), Boyle (5), and Short (46).

Two studies investigating comprehension of compressed multi-media presentations are particularly relevant to this study since some of the same stimulus materials were used. Anderton (1) used the Vimcet filmstrip/tape "Educational Objectives"*, to determine if it would be as effective at higher rates of speed. In addition to the normal versions of the filmstrip/tape at 150 wpm, Anderton constructed three other versions at rates of 200, 250, and 300 wpm with the message repeated. For each rate, there was also the original cartoon embellished filmstrip and an unembellished version. Classes of students were assigned to watch one of the eight presentations in a group setting. An analysis of findings on a cognitive post-test and an attitude measure indicated

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*"Educational Objectives" is lesson number two of this study.

that the failure to identify any differences may have been due, in part, to unequal group sizes and possible lack of randomization.

In another study, using some of the Vimcet materials, Gleason, Callaway, and Lakota (24) found similar results. The purpose of their study was:

> . . . to assess the effects of rate compression of audio-tapes on the conceptual learning and attitudes towards the technique when used in an instructional setting with college students. Specifically, the project assessed the effects of 75 percent rate compression (225 vs 175 wpm) on learner comprehension and attitude and assessed the interactions between treatment, aptitude, sex, achievement, and attitude. (24:953)

Three Vimcet filmstrip/tapes were used: (a) "Educational Objectives"*, (b) "Selecting Appropriate Educational Objectives"*, and (c) "Establishing Performance Standards". Students were randomly assigned to one of the two treatments or a control group for all three presentations. A pre-test and post-test were given during each of three viewing-listening sessions. The primary data included; (a) pre- and post-test scores for each filmstrip (all groups), (b) Instructional Objectives Preference List (pre- and post-), (c) data on academic aptitude (G.P.A.), and (d) sex.

Results showed no significant differences in achievement between the normal and compressed group, however,

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*These two filmstrip/tapes were also used in this study.

the authors noted that mean post-test and gain scores for the normal group were slightly higher than those for the compressed group on all four tests. They suggested this might indicate a small decrement in comprehension among the compressed speech subjects. Results also confirmed no significant effects due to attitude, aptitude, or sex.

The authors concluded that the compressed version was just as effective and more efficient than the original version, however, they felt that

> . . . the optimal rate may well be idiosyncratic--some learners prefer faster rates, some slower. The rate obviously interacts with the type of material, the learning criterion measures, and the learning setting. (24:958)

It should be pointed out that the present researcher has determined a "normal" rate for the first two filmstrip/tapes used by Gleason and found them to be 151 and 155 wpm respectively and not 175 wpm as reported by Gleason.*

Most of the research related to the comprehension of compressed aural-visual materials has been consistent in showing only a slight decline in comprehension at moderate rates of compression. Two authors, Sarenpa (42) and Gleason (24) have suggested the possibility that comprehension may be improved if the learner could listen at his preferred rate.

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*The 151 wpm rate for "Educational Objectives" corresponds almost exactly with the 150 wpm rate reported by Anderton (1). A phone call to Gerald Gleason failed to resolve the differences or indicate how the 175 wpm rate was determined since the experiment was conducted three years prior and no records of rate estimation were kept.

Comprehension, Multi-Media Instruction, and Preferred Rate of Listening

Only two studies were identified that combined the three major variables of interest to this study.

Challis (8) randomly assigned 96 college students, enrolled in an audio-tutorial portion of a required course to one of four groups: normal (120 wpm), 30 percent compression (174 wpm), 40 percent compression (200 wpm), and choice of 20 percent, 30 percent, 40 percent, and 55 percent compressions. Sixteen recorded units with accompanying filmstrips contained the material to be learned. Subjects wore headsets, and listened to the filmstrip/tape lessons in individual carrels. Data was collected for each student for each lesson on achievement and time spent in the carrel. Grade point and an attitude questionnaire provided further data on each student.

An analysis of results determined that there was no significant difference in achievement for the four groups. There were also no significant differences in achievement related to time spent learning or to grade point average. Challis, however, did note the compressed versions saved time; subjects who used 30 percent compression realized a time savings of 17 percent, while those who used 40 percent compression saved 31 percent. Student responses to a Likert-type questionnaire indicated that 91 percent expressed a favorable attitude toward compressed speech as a primary mode

for learning subject matter, and 97 percent felt that learner control over the compression rate was necessary or desirable for a most satisfactory learning experience.

One reason that Challis may have found no significant advantage for those students who could choose their "preferred" rate may be the result of only allowing students to choose from four fixed rates of compression. Since a student's preferred rate may not only vary from lesson to lesson but also within the lesson, providing four fixed choices hardly allows students the opportunity to listen at their preferred rate.

In a recently completed doctoral dissertation by Short (47), the limitations of the Challis study were overcome by allowing students to freely control their rate through a speech compressor. Short has been interested in the potential of compressed speech in an audio-tutorial setting for several years.

In 1967, Short developed an audio-tutorial course to teach nutrition. As instructor for the course, she has been able to make improvements and assess their effects over a period of years. The first pilot studies, using compressed speech in the course were conducted in 1970-71 (46) by assigning students to three rates of presentation for a two-week period of the course (normal at 140-150 wpm, 25 percent compression at 187-200 wpm, and 55 percent compression at 311-333 wpm). An analysis of cognitive and affective tests

before and after the treatments indicated no significant differences in achievement. Sixty percent of the students indicated that they would like the entire course at a 25 percent compressed rate.

Subsequent research was reported by Short (45) where a wider variety of rates were used for the entire course (20, 25, 30, 40, and 55 percent compressions). The normal rate reported here of 110 wpm does not agree with that reported in the previous study because pause times were also considered. Results were similar; no significant differences in achievement, and when students were allowed to select their preferred rates, 69 percent listened to the 20 or 30 percent compressions. It was also found that students, using the uncompressed material spent about 100 percent more time listening to the tapes than the actual tape time, while those using compressed versions only spent 50 percent more time listening than the actual tape times.

Short's previous work led her to hypothesize that significant differences in achievement could result if learners were allowed complete control over listening rate. This hypothesis was of primary concern in her 1975 study (47). Ninety college students, enrolled in a nutrition and food course, were randomly assigned to use either variable-speed compressors or normal tape recorders for seven of the 22 modules in the course. The average speaking rate for all tapes was 150-160 wpm. All students used the same slides

and the same workbook and were tested on achievement after each module. To measure elapsed time for listening to a module, analog chart recorders were connected to both normal and variable speed tape recorders.

An analysis of variance with repeated measures was performed on mean time and post-test measures. The results indicated that the variable speed compressor group spent significantly less time listening and had significantly higher achievement than the normal speed group. Using variable-speed compressors resulted in a time savings of 32 percent.

From an analysis and evaluation of the data, Short concluded that:

1) Sighted college students enrolled in a basic course taught by self-instruction methods, achieve significantly higher achievement scores when variable speed compressors are used to listen to the taped modules than when normal speed tape recorders are used to listen to the same cognitive information.
2) Sighted college students enrolled in a basic course taught by self-instruction methods save significant amounts of time when variable speed compressors are used to listen to the tapes than when normal speed tape recorders are used. (47:88-89)

The implications of Short's results for educational practice are both convincing and timely. Education today

is faced with the problems of providing more individualized instruction while holding down costs at the same time. If student achievement in an individualized audio-tutorial course can be increased and, in addition, require the student to spend less time listening, the increase in efficiency is considerable. With the imminent arrival of low-cost variable-speed speech compressors, the value of this type of research is obvious.

One problem with Short's study, however, is that she failed to include a treatment group to receive the materials at a fixed pre-compressed rate. Based on her own findings in previous studies (45;46) and those of other researchers using pre-compressed rates in similar settings (42;38), it could be assumed that a moderate amount of compression, 20-30 percent, would not seriously affect achievement. It would have been interesting to compare the mean time spent listening and mean achievement of such a group to the normal and variable-speed groups of Short's study. If the pre-compressed group equaled the performance of the variable-speed group, the implications for educational practice would suggest an advantage to pre-compressing tapes since the cost would be much lower than purchasing special recorders to allow rate manipulation.

Summary

Based on the review of literature presented in this chapter, several observations seem warranted which influenced the design of this study and the interpretation of results:

1) Listening comprehension declines as the rate increases (25;34), however, a significant decrease in comprehension is not apparent until the 275 wpm rate is exceeded (16; 18;29;36).
2) A learning efficiency score may be computed by dividing the comprehension score by the time taken to complete the lesson (16).
3) Students prefer listening rates in the range of 175 to 200 wpm (6;20;30;31;35).
4) Students vary widely in the rates they prefer (20;24;31).
5) Augmenting compressed speech with visual materials does not significantly decrease comprehension (34;50), and may improve comprehension (4;52).
6) Comprehension of multi-media materials is not seriously affected by moderate compression rates (1;8;24;38;42).
7) Compressed multi-media materials can save learning time (8;24;42;47).
8) When students are allowed to adjust the compression rate of multi-media materials, comprehension may be improved (47).

CHAPTER III

METHODS AND PROCEDURES

The primary purpose of this study was to ascertain the effects on comprehension and learning efficiency when learners were given the opportunity to manipulate the presentation rates of programmed filmstrip/tape lessons using a variable-speed speech compressor. Specifically, this study compared comprehension and learning efficiency on two programmed filmstrip/tape lessons presented in an individual carrel setting under three different learning conditions: (1) original versions of the audio-tapes played back on a normal tape recorder, (2) 25% compressed versions of the audio-tapes played back on a normal tape recorder, and (3) original versions of the audio-tapes played back on a variable-speed speech compressor. The corresponding filmstrips remained the same for all three conditions. This study was also concerned with ascertaining if attitudes toward the lessons' contents or the individualized programmed filmstrip/tape method of learning were differentially influenced by the learning conditions.

This chapter describes the population and sample, the stimulus materials, and the instrumentation used in this study. The design of the study and the specific procedures used are outlined next followed by the section on hypotheses and analysis which lists the hypotheses that were tested and

the data analysis process for each hypothesis. A description of the supplementary data collected during the study is presented next, and finally a summary of the chapter.

Population and Sample

The population of this study consisted of students enrolled in Audio-Visual Communications 407-560 at the University of Wisconsin-Stout during the second semester of the 1973-74 academic year. Audio-Visual Communications is a basic media methods course required of students in most teacher education programs at Stout. Instructional procedures used in this course include lectures, class demonstrations, media presentations, student projects, and a self-instruction laboratory where students, in an individual carrel setting, learn to operate various types of audio-visual equipment using self-instruction manuals. The Audio-Visual Communications course was selected for this study because the individualized carrel environment is normally a part of the course, and the content of the stimulus materials used in this study (behavioral objectives) is normally included in two of the lectures.

Of the four sections of this course, two were randomly selected to comprise the sample used in this study. The instructor for these sections deleted his two lectures on behavioral objectives and replaced them with the

experimental treatments. The sample consisted of 30 percent freshmen, 33 percent sophomores, 22 percent juniors, 9 percent seniors and 6 percent graduate students.

During the second class meeting of the semester, students in both sections were given the experimental pre-test, then pooled and randomly assigned to one of the three treatments. Random assignment was done after the pre-test and not from the course enrollment list because at the beginning of a semester some students whose names appear on the course enrollment have already dropped the course.

Seventy students took the pre-test and were included in the study: T_1 (N=23), T_2 (N=23), and T_3 (N=24). Four students added this course during the four-week experimental period and were assigned to one of the treatments but were not considered part of the study. Three students dropped this course during the experimental period and were dropped from the study. Since it is normally expected that some students will drop courses at the beginning of the semester, there was no reason to believe that theses students were motivated to drop because of the experimental conditions. This resulted in a sample of sixty-seven (67) subjects distributed randomly among the treatments as follows: T_1 (N=22), T_2 (N=21), and T_3 (N=24).

Stimulus Materials

Three programmed filmstrip/tape lessons developed by Vimcet Associates (56;53;55) were used as Lessons #1, #2, and #3 of this experiment: (a) Systematic Instructional Decision-Making, (b) Educational Objectives, and (c) Selecting Appropriate Educational Objectives. Lesson #1 was included in this experiment to allow students to practice the methods and procedures for taking the lessons; no cognitive test was administered after this lesson.

Each of these lessons contained a filmstrip with a corresponding cassette audio-tape and an answer sheet (Study Guide) to allow students to make overt responses to various questions posed by the filmstrip/tape. These lessons, developed by James Popham of Vimcet Associates, were designed from carefully stated behavioral objectives and then revised through successive validation studies (48;15;43). Humorous cartoon illustrations throughout were designed to hold the learner's attention; pauses after each criterion question allowed the learner to make short responses on his answer sheet. For additional information about these materials the reader is directed to Appendix A for the objectives of each lesson; the Study Guides for each lesson are included in Appendix B; and several frames from the filmstrip, Educational Objectives, along with the corresponding written narration are included in Appendix C.

Three copies of each lesson were purchased for the experiment. Three cassette copies of each lesson were made on a Variable Speech Control Copycorder* at 0% compression and 25% compression. The resulting nine tapes at 0% compression were designated for use by the normal, fixed-rate group (T_1); the nine tapes compressed 25% were designated for use by the compressed, fixed-rate group (T_2); the original nine tapes were designated for use by the variable-rate group (T_3). Table 1 compares time, rate, and length factors of the stimulus materials used in this experiment.

Table 1

TIME, RATE, AND LENGTH FACTORS FOR THE EXPERIMENTAL LESSONS

Lesson #	Filmstrip Length (frames)	Tape Compression (%)	Tape Time (min.)	Mean Rate (wpm)
1	32	0	18.61	152
		25	13.96	203
2	37	0	23.81	155
		25	17.86	207
3	46	0	25.13	146
		25	18.85	195

*Model CC-103 produced by Magnetic Video Corporation, Farmington, Michigan 48024.

Word per minute rates for each lesson were determined by selecting a one-minute passage from the beginning, middle, and end of each tape. The number of words in each passage were counted and then a mean was calculated from the three samples. Samples selected for Lesson #1 were 151, 152, and 154 wpm; for Lesson #2 they were 153, 160, and 153 wpm; for Lesson #3 they were 140, 147, and 149 wpm. Word per minute rates for the compressed versions were calculated directly from the mean rates for the normal versions.

Instrumentation

The primary instruments used in this study were two cognitive tests for Lessons #2 and #3, and the Instructional Objectives Preference List (I.O.P.L.), all developed and validated by Vimcet Associates (48;15;43). The I.O.P.L. is a twenty-item instrument designed to assess student attitudes toward behaviorally stated objectives. These lessons and instruments have also been used by other researchers in group presentations to college students (49;24).

Additional attitudinal items were developed and added to I.O.P.L. on the post-test to gather further information about student attitudes toward both the content of the lessons and the method of instruction. The instruments used in this study, their contents, and their location in the Appendices are shown in Table 2.

Table 2

CONTENT AND LOCATION OF EVALUATION INSTRUMENTS USED IN THIS STUDY

Instrument Code	Content	Location
O_{Pre}	Pre-test, a combination of O_2, O_3 and the I.O.P.L.	Appendix D
O_2	A cognitive test for Lesson #2.	Appendix E
O_3	A cognitive test for Lesson #3.	Appendix F
O_{Post}	Post-test, the I.O.P.L. and additional attitude items to assess attitudes toward lesson content and instructional method.	Appendix G

Design

The design of this study over a four-week period is shown in Figure 1.

T_1	O_{Pre}	R	X_1	X_2	O_2	X_3	O_3	O_{Post}
T_2	O_{Pre}	R	X_1	X_2	O_2	X_3	O_3	O_{Post}
T_3	O_{Pre}	R	X_1	X_2	O_2	X_3	O_3	O_{Post}
			1 week		2 weeks		1 week	

Key:

T_1 - normal, fixed-rate treatment
T_2 - 25% compressed, fixed-rate treatment
T_3 - variable-rate treatment
R - random assignment
X_1 - Lesson #1 (practice)
X_2 - Lesson #2
X_3 - Lesson #3

O_{Pre} - combination of O_2, O_3 and the I.O.P.L.
O_2 - test on Lesson #2
O_3 - test on Lesson #3
O_{Post} - IOPL and attitude measure

Figure 1

DESIGN OF THE STUDY

As shown in Figure 1, students were randomly assigned to the three treatments (T) and then experienced the same lessons (X) and were administered the same measures (O). In addition to the data collected on the test instruments, time spent in the carrel for each student for each lesson was also determined.

Procedures

Three learning carrels were set up in the A-V Self-Instruction Lab specifically for this study. All three carrels were equipped with a Singer Graphlex Studymate filmstrip viewer and Mura Headphones. In the first two carrels Panasonic cassette tape recorders were used for playback of audio-tapes; in the third carrel, the Variable Speech Control Copycorder was used to playback audio-tapes. Numbers around the VSC dial of this machine were covered with masking tape to prevent subjects from knowing the rates they selected. Posted on the side of each carrel were equipment operating instructions. (These are included in Appendix H.)

One week prior to opening the carrels for the three lessons, a pre-test (O_{Pre}) and orientation were given to each of the two sections. During the orientation, students were told that these three lessons would replace the two lectures normally given on instructional objectives and that they could take the lessons any time they wished over a two-week period. They were also told that the Media Technology Department was interested in determining the effectiveness of these

materials and the effectiveness of variable-speed speech recorders, and that some of them would be using this machine. It was felt that providing all students with a brief, plausible explanation of the reasons behind the learning experiences they were about to undergo would have less reactive effect than saying nothing and having each student develop his own explanation. A complete outline of this orientation is provided in Appendix I.

Since A-V Self-Instruction Lab monitors would be dispensing the lessons to each student and collecting the data, care was taken to assure accurate and uniform methods among the five monitors. A meeting with all five prior to the experiment dealt with procedures for check-out and check-in of materials, recording of times for each subject, handling of lesson materials, and administration of quizzes. A written step-by-step procedure for monitors was also placed near the monitor's desk in the lab. These directions are included in Appendix J. To assure adherance to these procedures, the experimenter also worked with each lab monitor during the first two days students were taking lessons.

A typical break-down of the events that occurred from the time a student entered the lab to take a lesson until he left the lab is as follows:

Student - Enters the lab, identifies himself.

Monitor - Finds student's name on list, notes color code for treatment, gives student appropriate materials, directs student to appropriate

carrel, records check-out time beside student's name.

Student - Takes materials to carrel, reads equipment set-up instructions if necessary, sets up equipment, reads intro. paragraph of Study Guide if necessary, TAKES LESSON, removes tape and filmstrip from equipment, returns material to monitor.

Monitor - Records check-in time, files Study Guide, gives student quiz for Lesson #2 or #3.

Student - Takes quiz

Monitor - Rewinds filmstrip and tape.

Student - Returns quiz, leaves lab.

Monitor - Files quiz.

All materials were the same for each student in each treatment except for the cassette tapes which were color coded yellow for T_1, blue for T_2, and red for T_3. At the end of each day during the two-week period when students were taking lessons, all equipment and materials were checked for defects and cleaned if necessary.

The last step in the experimental procedure occurred about one week after the two-week instructional period when the post-test (O_{Post}) was given to each section.

Hypotheses and Analysis

Thirteen specific hypotheses were tested by this study. They included hypotheses relative to cognitive learning (H_1 and H_2), learning time (H_3 and H_4), learning efficiency (H_5), and attitude (H_6).

H_{1a}: Students in the variable-rate treatment (T_3) will score significantly higher on the cognitive test for Lesson #2 than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

H_{1b}: Students in the variable-rate treatment (T_3) will score significantly higher on the cognitive test for Lesson #3 than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

H_{2a}: Students in the variable-rate treatment (T_3) will have significantly less variance of scores on the cognitive test for Lesson #2 than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

H_{2b}: Students in the variable-rate treatment (T_3) will have significantly less variance of scores on the cognitive test for Lesson #3 than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

H_{3a}: Students in the normal, fixed-rate treatment (T_1) will take a significantly greater amount of time to complete Lesson #2 than those students in either the 25% compressed, fixed-rate treatment (T_2) or the variable-rate treatment (T_3).

H_{3b}: Students in the normal fixed-rate treatment (T_1) will take a significantly greater amount of time to complete Lesson #3 than those students in either the 25% compressed, fixed-rate treatment (T_2) or the variable-rate treatment (T_3).

H_{4a}: Students in the variable-rate treatment (T_3) will have significantly greater variance in the times taken to complete Lesson #2 than those students in either the normal fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

H_{4b}: Students in the variable-rate treatment (T_3) will have significantly greater variance in the times taken to complete Lesson #3 than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

H_{5a}: Students in the normal, fixed-rate treatment (T_1) will have significantly lower learning efficiency scores for Lesson #2 than those students in either

the 25% compressed fixed-rate treatment (T_2) or the variable-rate treatment (T_3).

H_{5b}: Students in the normal, fixed-rate treatment (T_1) will have significantly lower learning efficiency scores for Lesson #3 than those students in either the 25% compressed, fixed-rate treatment (T_2) or the variable-rate treatment (T_3).

H_{6a}: Students in the variable-rate treatment (T_3) will score significantly higher on an attitude measure of preferences for behaviorally stated objectives (I.O.P.L.) than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

H_{6b}: Students in the variable-rate treatment (T_3) will score significantly higher on a measure of attitude toward the content of the lessons than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

H_{6c}: Students in the variable-rate treatment (T_3) will score significantly higher on a measure of attitude toward the method of learning they were exposed to than those students in either the normal fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

Of the thirteen hypotheses, nine were concerned with differences in means among the three treatments. Each of these were analyzed using one-way analysis of variance procedures (2). In those cases where analysis of variance indicated differences among the means at or beyond the .05 level of significance, Scheffé's post-hoc comparisons of means (9) was employed to identify those treatments that were significantly different.

Four of the thirteen hypotheses were concerned with differences in variances among the three treatments. Each

of these were analyzed for significance at the .05 level using F-tests specified by Hays (26:351) and further detailed for unequal group sizes by Johnson (27·182).

Testing hypotheses about unequal means and variances on the same measure (i.e., H_{1a} and H_{2a}) was not considered a problem even though the assumption of equality of variances is often considered a prerequisite to tests for mean differences. Hays indicates that because the F-test is very sensitive to non-nomality, ". . . one can easily do himself a disservice if he interprets a significant result from a test of variances as a prohibition against the use of a test of means" (26:352).

Supplementary Data

In addition to the primary data used to test the stated hypotheses of this study, further data on each subject were collected to assist in analyzing the results of the statistical tests. These data included: (a) scores on the Pre-test (O_{Pre}), (b) scores on the Study Guides for Lessons 2 and 3, and (c) scores on three supplementary attitude items on the Post-test (O_{Post}). These data were analyzed using one-way analysis of variance procedures and Schéffe post-hoc comparisons when appropriate.

Summary

Sixty-seven students in a basic audio-visual methods course were randomly assigned to three learning conditions. Group one received three programmed filmstrip/tape lessons on behavioral objectives in an individual carrel setting using cassette tapes at the normal rate on a standard tape recorder; group two also used a standard tape recorder for playback, however, the audio-tape narrations were compressed 25%; group three used the same materials as group one but on a variable speed speech compressor that allowed them to speed the playback rate. Data were collected relative to cognitive learning, time spent in the carrel, and attitudes. These data were then analyzed using the appropriate statistical tests to determine any significant differences among the three learning conditions.

CHAPTER IV

ANALYSIS OF DATA

The purpose of this chapter is to summarize, analyze, and interpret the data collected in this study. Section one of this chapter summarizes the primary data of this study. Section two contains tests for the thirteen specific hypotheses of this study. Section three looks at supplementary data from the study. Section four interprets the data analysis and section five is a summary of the chapter.

Data Summary

A summary of the primary data collected in this study is shown in Table 3. Cognitive learning was measured by tests after Lessons 2 and 3. Learning times for Lessons 2 and 3 were calculated from check-out and check-in times of lesson materials for each student. Learning efficiency scores for Lessons 2 and 3 were computed as the number of cognitive test items correct per minute of learning time. Attitude was measured by the three major parts of the post-test. Of the thirteen specific hypotheses tested, seven indicated significant differences among scores for the three treatment groups.

Table 3

SUMMARY OF THE MEANS AND VARIANCES OF THE PRIMARY DATA COLLECTED FOR EACH TREATMENT GROUP FOR EACH HYPOTHESIS

Data Source	Treatment Group T_1(N=22)	T_2(N=21)	T_3(N=24)	Hypothesis
Cognitive Learning				
Lesson #2 $\bar{x}$	17.0454	16.2380	15.8750	H_{1a}
s^2	4.0433	5.6098	5.2757	H_{2a}
Lesson #3 $\bar{x}$	7.9545	8.0952	7.8750	H_{1b}
s^2	2.3159	2.4671	5.5258	H_{2b}*
Learning Time (min)				
Lesson #2 $\bar{x}$	30.6659	25.1276	27.8666	H_{3a}*
s^2	4.2717	5.4401	11.1736	H_{4a}*
Lesson #3 $\bar{x}$	31.5977	25.7690	27.9587	H_{3b}*
s^2	4.1771	4.9756	12.2654	H_{4b}*
Learning Efficiency**				
Lesson #2 $\bar{x}$	.5571	.6479	.5766	H_{5a}*
s^2	.0044	.0077	.0100	
Lesson #3 $\bar{x}$	.2521	.3118	.2845	H_{5b}*
s^2	.0023	.0033	.0089	
Attitude				
I.O.P.L. $\bar{x}$	81.2272	79.4285	80.7500	H_{6a}
s^2	76.9023	153.1010	96.0204	
Content $\bar{x}$	17.0454	17.2857	17.0833	H_{6b}
s^2	12.6792	12.7749	8.7427	
Method $\bar{x}$	17.6818	19.5714	18.0416	H_{6c}
s^2	16.2168	27.1014	12.6231	

*Analysis of these hypotheses revealed significant differences among scores for the three groups with $p<.05$.

**Since learning efficiency scores were computed as the number of correct cognitive test items per minute of learning time, comparisons cannot be made between Lessons #2 and #3.

Hypotheses and Data

Thirteen specific hypotheses were tested by this study. The written form of each hypothesis is presented in this section followed by a symbolic representation of each, a summary of the relevant data, and results of the data analysis.

Cognitive learning.

H_{1a}: Students in the variable-rate treatment (T_3) will score significantly higher on the cognitive test for Lesson #2 than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

$$H_{1a}: \bar{x}_{T_1} > \bar{x}_{T_2} \text{ and } \bar{x}_{T_3}$$

Data relevant to this hypothesis are presented in Table 4. The test for mean differences on the cognitive test for Lesson #2 produced an F-ratio of 1.56. Since this was less than the tabled F ($F_{(2,64)} = 3.14$, $p<.05$), it was concluded that the means for the three treatments were not significantly different.

Table 4

ANOVA FOR COGNITIVE LEARNING ON LESSON #2

Source	DF	MS	F
Between	2	8.1412	1.56
Within	64	5.2092	
Total	66	13.3504	

H_{1b}: Students in the variable-rate treatment (T_3) will score significantly higher on the cognitive test for Lesson #3 than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

$$H_{1b}: \bar{x}_{T_3} > \bar{x}_{T_1} \text{ and } \bar{x}_{T_2}$$

Data relevant to this hypothesis are presented in Table 5. The test for mean differences on the cognitive test for Lesson #3 produced an F-ratio of .07. Since this was less than the tabled F ($F_{2,64} = 3.14$, $p<.05$), it was concluded that the means for the three treatments were not significantly different.

Table 5

ANOVA FOR COGNITIVE LEARNING ON LESSON #3

Source	DF	MS	F
Between	2	.2756	.07
Within	64	3.6779	
Total	66	3.9535	

H_{2a}: Students in the variable-rate treatment (T_3) will have significantly less variance of scores on the cognitive test for Lesson #2 than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

$$H_{2a}: s^2_{T_3} < s^2_{T_1} \text{ and } s^2_{T_2}$$

Data relevant to this hypothesis are presented in Table 6. The F-tests for differences in variances on the cognitive test for Lesson #2 produced no F-ratios that equaled or exceeded corresponding required F-ratios. It was, therefore, concluded that the variances of scores for

the three treatments were not significantly different.

Table 6

F-TESTS FOR DIFFERENCES IN VARIANCES ON COGNITIVE TEST FOR LESSON #2

Hypothesis Tested	Calculated F	Required F
$s^2_{T_3} = s^2_{T_1}$	1.299	$F_{(23,21)}=2.05$
$s^2_{T_2} = s^2_{T_3}$	1.070	$F_{(20,23)}=2.04$

H_{2b}: Students in the variable-rate treatment (T_3) will have significantly less variance of scores on the cognitive test for Lesson #3 than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

$$H_{2b}: \quad s^2_{T_3} < s^2_{T_1} \text{ and } s^2_{T_2}$$

Data relevant to this hypothesis are presented in Table 7. The F-tests for differences in variances on the cognitive test for Lesson #3 produced two F-ratios that exceeded the corresponding required F-ratios.

Table 7

F-TESTS FOR DIFFERENCES IN VARIANCES ON COGNITIVE TEST FOR LESSON #3

Hypothesis Tested	Calculated F	Required F
$s^2_{T_3} = s^2_{T_1}$	2.377*	$F_{(23,21)}=2.05$
$s^2_{T_3} = s^2_{T_2}$	2.226*	$F_{(23,20)}=2.08$

*$p<.05$

Further examination of the data revealed that the variance of scores for T_3 was significantly greater than the variances for the other two treatments, therefore, the hypothesized relationship of variances ($s^2_{T_3} < s^2_{T_1}$ and $s^2_{T_2}$) was not supported by the data.

Learning time.

H_{3a}: Students in the normal, fixed-rate treatment (T_1) will take a significantly greater amount of time to complete Lesson #2 than those students in either the 25% compressed, fixed-rate treatment (T_2) or the variable-rate treatment (T_3).

$$H_{3a}: \quad \bar{x}_{T_1} > \bar{x}_{T_2} \text{ and } \bar{x}_{T_3}$$

Data relevant to this hypothesis are presented in Table 8. The test for mean differences of learning times taken to complete Lesson #2 produced an F-ratio of 22.14 which was greater than the tabled F ($F_{(2,64)} = 4.95$, $p<.01$).

Table 8

ANOVA FOR LEARNING TIME ON LESSON #2

Source	DF	MS	F
Between	2	164.8451	22.14*
Within	64	7.4437	
Total	66		

*p<.01

The significant F indicated that the means were not equal, therefore, Scheffé's post-hoc comparisons of means was employed to identify those means that were significantly

different. These data are presented in Table 9. All comparisons were shown to be significant and supported the hypothesized relationship fo the means ($\bar{x}_{T_1} > \bar{x}_{T_2}$ and $\bar{x}_{T_3}$).

Table 9

SCHEFFÉ'S POST-HOC COMPARISONS OF MEANS FOR LEARNING TIMES ON LESSON #2

	T_2 ($\bar{x}$=25.1276)	T_3 ($\bar{x}$=27.8666)
T_1($\bar{x}$=30.6659)	5.5383*	2.7993*
T_2($\bar{x}$=25.1276		-2.7390*

*p<.05

H_{3b}: Students in the normal, fixed-rate treatment (T_1) will take a significantly greater amount of time to complete Lesson #3 than those students in either the 25% compressed, fixed-rate treatment (T_2) or the variable-rate treatment (T_3).

$$H_{3b}: \bar{x}_{T_1} > \bar{x}_{T_2} \text{ and } \bar{x}_{T_3}$$

Data relevant to this hypothesis are presented in Table 10. The test for mean differences of learning times taken to complete Lesson #3 produced an F-ratio of 22.99 which was greater than the tabled F ($F_{(2,64)} = 4.95$, $p<.01$).

Table 10

ANOVA FOR LEARNING TIME ON LESSON #3

Source	DF	MS	F
Between	2	176.3003	22.99*
Within	64	7.6681	
Total	66	183.9684	

*p<.01

The significant F indicated that the means were not equal, therefore, Scheffé's post-hoc comparisons of means was employed to identify those means that were significantly different. These data are presented in Table 11. Two comparisons were shown to be significant and supported the hypothesized relationship of the means ($\bar{x}_{T_1} > \bar{x}_{T_2}$ and $\bar{x}_{T_3}$).

Table 11

SCHEFFÉ'S POST-HOC COMPARISONS OF MEANS FOR LEARNING TIMES ON LESSON #3

	T_2 ($\bar{x}$=25.9690)	T_3 ($\bar{x}$=27.9587)
T_1($\bar{x}$=31.5997	5.6287*	3.6390*
T_2($\bar{x}$=25.9690)		-1.9897

*p<.05

H_{4a}: Students in the variable-rate treatment (T_3) will have significantly greater variance in the times taken to complete Lesson #2 than those students in either the normal fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

$$H_{4a}: \quad s^2_{T_3} > s^2_{T_1} \text{ and } s^2_{T_2}$$

Data relevant to this hypothesis are presented in Table 12. The F-tests for equality of variances on the times taken to complete Lesson #2 produced one F-ratio that exceeded the corresponding required F-ratio.

Table 12

F-TESTS FOR DIFFERENCES IN VARIANCES ON TIMES TAKEN TO COMPLETE LESSON #2

Hypothesis Tested	Calculated F	Required F
$s^2_{T_3} = s^2_{T_1}$	2.605*	$F_{(23,21)}=2.05$
$s^2_{T_3} = s^2_{T_2}$	2.041	$F_{(23,20)}=2.08$

*$p<.05$

Further examination of the data revealed that while the variance of times taken to complete Lesson #2 for T_3 was significantly greater than the variance for T_1, it was not significantly greater than T_2. It was, therefore, concluded that the hypothesized relationship of variances ($s^2_{T_3} > s^2_{T_1}$ and $s^2_{T_2}$) was only partially supported by the data.

H_{4b}: Students in the variable-rate treatment (T_3) will have significantly greater variance in the times taken to complete Lesson #3 than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

$$H_{4b}: \quad s^2_{T_3} > s^2_{T_1} \text{ and } s^2_{T_2}$$

Data relevant to this hypothesis are presented in Table 13. The F-tests for equality of variances on the times taken to complete Lesson #3 produced two F-ratios that

exceeded the corresponding required F-ratios.

Table 13

F-TESTS FOR DIFFERENCES IN VARIANCES ON TIMES TAKEN TO COMPLETE LESSON #3

Hypothesis Tested	Calculated F	Required F
$s^2_{T_3} = s^2_{T_1}$	2.925*	$F_{(23,21)}=2.05$
$s^2_{T_3} = s^2_{T_2}$	2.450*	$F_{(23,20)}=2.08$

*p<.05

Further examination of the data revealed that the variance of times taken to complete Lesson #3 for T_3 was significantly greater than the variances for the other two treatments therefore the hypothesized relationship of variances ($s^2_{T_3} > s^2_{T_1}$ and $s^2_{T_2}$) was supported by the data.

Learning efficiency.

H_{5a}: Students in the normal, fixed-rate treatment (T_1) will have significantly lower learning efficiency scores for Lesson #2 than those students in either the 25% compressed fixed-rate treatment (T_2) or the variable-rate treatment (T_3).

$$H_{5a}: \quad \bar{x}_{T_1} < \bar{x}_{T_2} \text{ and } \bar{x}_{T_3}$$

Data relevant to this hypothesis are presented in Table 14. The test for mean differences of learning efficiency scores for Lesson #2 produced an F-ratio of 6.25 which was greater than the tabled F ($F_{(2,64)} = 4.95$, $p<.01$).

Table 14

ANOVA FOR LEARNING EFFICIENCY ON LESSON #2

Source	DF	MS	F
Between	2	.0490	6.25*
Within	64	.0078	
Total	66	.0568	

*p<.01

The significant F indicated that the means were not equal, therefore, Scheffé's post-hoc comparisons of means was employed to identify those means that were significantly different. These data are presented in Table 15. These comparisons show that while the mean of learning efficiency scores for T_1 was significantly less than the mean for T_2, it was not significantly less than the mean for T_3. It was, therefore, concluded that the hypothesized relationship of means ($\bar{x}_{T_1} < \bar{x}_{T_2}$ and $\bar{x}_{T_3}$) was only partially supported by the data.

Table 15

SCHEFFÉ'S POST-HOC COMPARISONS OF MEANS FOR LEARNING EFFICIENCY SCORES ON LESSON #2

	T_2 ($\bar{x}$=.6479)	T_3 ($\bar{x}$=.5766)
T_1($\bar{x}$=.5571)	-.0908*	-.0195
T_2($\bar{x}$=.6479)		.0713*

*p<.05

H_{5b}: Students in the normal, fixed-rate treatment (T_1) will have significantly lower learning efficiency scores for Lesson #3 than those students in either the 25% compressed, fixed-rate treatment (T_2) or the variable-rate treatment (T_3).

$$H_{5b}: \quad \bar{x}_{T_1} < \bar{x}_{T_2} \text{ and } \bar{x}_{T_3}$$

Data relevant to this hypothesis are presented in Table 16. The test for mean differences of learning efficiency scores for Lesson #3 produced an F-ratio of 3.68 which was greater than the tabled F ($F_{(2,64)} = 3.14$, $p<.05$).

Table 16

ANOVA FOR LEARNING EFFICIENCY ON LESSON #3

Source	DF	MS	F
Between	2	.0192	3.68*
Within	64	.0052	
Total	66	.0244	

*$p<.05$

The significant F indicated that the means were not equal, therefore, Scheffé's post-hoc comparisons of means was employed to identify those means that were significantly different. These data are presented in Table 17. These comparisons show that while the mean of learning efficiency scores for T_1 was significantly less than the mean for T_2, it was not significantly less than the mean for T_3. It was, therefore, concluded that the hypothesized relationship of means ($\bar{x}_{T_1} < \bar{x}_{T_2}$ and $\bar{x}_{T_3}$) was only partially supported by the data.

Table 17

SCHEFFÉ'S POST-HOC COMPARISONS OF MEANS FOR LEARNING EFFICIENCY SCORES ON LESSON #3

	T_2 ($\bar{x}$=.3118)	T_3 ($\bar{x}$=.2845)
T_1($\bar{x}$=.2521)	-.0597*	-.0324
T_2($\bar{x}$=.3118)		.0273

*p<.05

Attitude.

H_{6a}: Students in the variable-rate treatment (T_3) will score significantly higher on an attitude measure of preferences for behaviorally stated objectives (I.O.P.L.) than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

$$H_{6a}: \quad \bar{x}_{T_3} \; \bar{x}_{T_1} \text{ and } \bar{x}_{T_2}$$

Data relevant to this hypothesis are presented in Table 18. The test for mean differences on the I.O.P.L. produced an F-ratio of .16. Since this was less than the tabled F ($F_{(2,64)} = 3.14$, $p<.05$), it was concluded that the means for the three treatments were not significantly different.

Table 18

ANOVA FOR ATTITUDE TOWARD BEHAVIORALLY STATED OBJECTIVES (I.O.P.L.)

Source	DF	MS	F
Between	2	18.6198	.16
Within	64	112.6797	
Total	66	131.2995	

H_{6b}: Students in the variable-rate treatment (T_3) will score significantly higher on a measure of attitude toward the content of the lessons than those students in either the normal, fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

$$H_{6b}: \bar{x}_{T_3} > \bar{x}_{T_1} \text{ and } \bar{x}_{T_2}$$

Data relevant to this hypothesis are presented in Table 19. The test for mean differences on the attitude toward content measure produced an F-ratio of .03. Since this was less than the tabled F ($F_{)2,64)} = 3.14$, $p<.05$), it was concluded that the means for the three treatments were not significantly different.

Table 19

ANOVA FOR ATTITUDE TOWARD LESSONS' CONTENTS

Source	DF	MS	F
Between	2	.3587	.03
Within	64	11.8292	
Total	66	12.1879	

H_{6c}: Students in the variable-rate treatment (T_3) will score significantly higher on a measure of attitude toward the method of learning

they were exposed to than those students in either the normal fixed-rate treatment (T_1) or the 25% compressed, fixed-rate treatment (T_2).

$$H_{6b}: \quad \bar{x}_{T_3} > \bar{x}_{T_1} \text{ and } \bar{x}_{T_2}$$

Data relevant to this hypothesis are presented in Table 20. The test for mean differences on the attitude toward method measure produced an F-ratio of 1.12. Since this was less than the tabled F ($F_{(2,64)} = 3.14$, $p<.05$), it was concluded that the means for the three treatments were not significantly different.

Table 20

ANOVA FOR ATTITUDE TOWARD METHOD OF LEARNING

Source	DF	MS	F
Between	2	21.6227	1.12
Within	64	19.2011	
Total	66	40.8238	

Supplementary Data

In addition to the primary data collected in this study to test the specific hypotheses, supplementary data was collected and analyzed for the purpose of assisting in the interpretation of the primary data. The additional data collected included scores on the Pre-test, the Study Guides for Lessons #2 and #3, and the last three attitude items on the Post-test. Mean differences among the three treatment

groups for these measures were analyzed using analyses of variance. Table 21 summarizes the results of the separate ANOVAS on these measures.

Table 21

SUMMARY OF ANOVAS FOR PRE-TEST, STUDY GUIDES, AND THREE ATTITUDE ITEMS ON POST-TEST

Measure	Treatment Means			F
	$\bar{x}_{T_1}$	$\bar{x}_{T_2}$	$\bar{x}_{T_3}$	
Pre-Test				
O_2 Part	11.5909	11.8571	11.6250	.04
O_3 Part	3.3636	3.5238	3.5833	.04
IOPL Part	65.7272	66.1428	67.5000	.19
Study-Guides				
Lesson #2	15.8181	15.5714	15.7500	.19
Lesson #3	23.3181	23.1428	22.2500	.65
Attitude Items				
Lesson Difficulty	4.4545	5.3333	4.2083	.37
Lesson Pace	4.5909	2.8571	3.8750	11.77*
Lesson Length	3.2727	3.8571	3.7083	2.68

*$p < .01$

Only one significant F resulted from the ANOVAS summarized. This was the attitude item on the post-test asking students to rate the pace of the lessons they took on a seven-point scale from "too fast" to "too slow." The Scheffé post-hoc comparisons of means for this item are shown in Table 22.

Table 22

SCHEFFÉ'S POST-HOC COMPARISONS OF MEANS FOR RATINGS OF LESSONS' PACE

	T_2 ($\bar{x}$=2.8571)	T_3 ($\bar{x}$=3.8570)
T_1 ($\bar{x}$=4.5909)	1.7338*	.7159
T_2 ($\bar{x}$=2.8571)		-1.0179*

*p<.05

Results of these comparisons show that students who used the compressed, fixed-rate tapes (T_2) felt the pacing of the lessons to be significantly faster than those students who used either the normal, fixed-rate tapes (T_1) or those who could control the rate of tape playback (T_3).

Interpretation of the Data Analysis

The purpose of this study was to ascertain the effects on comprehension and learning efficiency when learners were given the opportunity to manipulate presentation rates of programmed filmstrip/tape lessons using a variable-speed speech compressor. This study was also concerned with the effects on attitude of rate manipulation.

Table 23 summarizes the major findings of this study by listing the hypothesized relationships of means and variances for the thirteen stated hypotheses in contrast to those relationships supported by the data analysis. Of the

Table 23

HYPOTHESIZED RELATIONSHIPS OF MEANS AND VARIANCES FOR THE THIRTEEN STATED HYPOTHESES IN CONTRAST TO RELATIONSHIPS SUPPORTED BY THE DATA ANALYSIS

Hypothesis	Hypothesized Relationships	Relationships Supported by the Data Analysis
Cognitive Learning		
H_{1a}	$\bar{x}_{T_3} > \bar{x}_{T_1}$ and $\bar{x}_{T_2}$	$\bar{x}_{T_3} = \bar{x}_{T_1} = \bar{x}_{T_2}$
H_{1b}	$\bar{x}_{T_3} > \bar{x}_{T_1}$ and $\bar{x}_{T_2}$	$\bar{x}_{T_3} = \bar{x}_{T_1} = \bar{x}_{T_2}$
H_{2a}	$s^2_{T_3} < s^2_{T_1}$ and $s^2_{T_2}$	$s^2_{T_3} = s^2_{T_1} = s^2_{T_2}$
H_{2b}	$s^2_{T_3} < s^2_{T_1}$ and $s^2_{T_2}$	$s^2_{T_2} > s^2_{T_1} = s^2_{T_2}$
Learning Time		
H_{3a}*	$\bar{x}_{T_1} > \bar{x}_{T_2}$ and $\bar{x}_{T_3}$	$\bar{x}_{T_1} > \bar{x}_{T_2}$ and $\bar{x}_{T_3}$
H_{3b}*	$\bar{x}_{T_1} > \bar{x}_{T_2}$ and $\bar{x}_{T_3}$	$\bar{x}_{T_1} > \bar{x}_{T_2}$ and $\bar{x}_{T_3}$
H_{4a}**	$s^2_{T_3} > s^2_{T_1}$ and $s^2_{T_2}$	$s^2_{T_3} > s^2_{T_1}$ $s^2_{T_3} = s^2_{T_2}$
H_{4b}*	$s^2_{T_3} > s^2_{T_1}$ and $s^2_{T_2}$	$s^2_{T_3} > s^2_{T_1}$ and $s^2_{T_2}$
Learning Efficiency		
H_{5a}**	$\bar{x}_{T_1} < \bar{x}_{T_2}$ and $\bar{x}_{T_3}$	$\bar{x}_{T_1} = \bar{x}_{T_3} < \bar{x}_{T_2}$
H_{5b}**	$\bar{x}_{T_1} < \bar{x}_{T_2}$ and $\bar{x}_{T_3}$	$\bar{x}_{T_1} < \bar{x}_{T_2}$ $\bar{x}_{T_1} = \bar{x}_{T_3}$ $\bar{x}_{T_2} = \bar{x}_{T_3}$
Attitude		
H_{6a}	$\bar{x}_{T_3} > \bar{x}_{T_1}$ and $\bar{x}_{T_2}$	$\bar{x}_{T_3} = \bar{x}_{T_1} = \bar{x}_{T_2}$
H_{6b}	$\bar{x}_{T_3} > \bar{x}_{T_1}$ and $\bar{x}_{T_2}$	$\bar{x}_{T_3} = \bar{x}_{T_1} = \bar{x}_{T_2}$
H_{6c}	$\bar{x}_{T_3} > \bar{x}_{T_1}$ and $\bar{x}_{T_2}$	$\bar{x}_{T_3} = \bar{x}_{T_1} = \bar{x}_{T_2}$

*Hypotheses supported by the data analyses.

**Hypotheses partially supported by the data analyses.

thirteen hypotheses tests, three were supported by the data analysis and three were partially supported. Interpretation of the data analysis for hypotheses relating to cognitive learning, learning time, learning efficiency, and attitude are presented here along with some factors that may have affected the results.

Cognitive learning. It was hypothesized that students who were allowed to adjust presentation rates using a variable-speed speech compressor would manipulate playback rates in a manner that would maximize their cognitive learning (H_{1a} and H_{1b}). It was further hypothesized that the variance of their cognitive learning scores would be significantly less than those of the two fixed-rate treatments (H_{2a} and H_{2b}). These four hypotheses were not supported by the data analysis (see Table 23), and suggest that, under the conditions of this study, cognitive learning was not affected by the experimental conditions. Students in the variable-rate treatment performed no better on cognitive post-tests than did students in the two fixed-rate treatments.

Short (47), in a similar study done concurrent to the present research, did find significant differences in learning in favor of a variable-rate treatment over a normal fixed-rate treatment. However, Short's comparisons were made for the last seven lessons of a twenty-two lesson course, thereby overcoming two limitations of the present study: 1) the novelty effect, and 2) the brief exposure to learning

materials. Although an attempt was made to counteract this novelty effect in the present study by including Lesson #1 as a "practice" lesson, this may have been insufficient, especially for those students using the variable-speed speech compression recorder. It is possible that these students were uncomfortable with this new technique of rate control and, consequently, did not manipulate rate in a manner that would maximize their learning. In fact, rate manipulation may have had a negative effect. Although not significant, mean scores for the variable-rate treatment were lower on both tests than mean scores for the two fixed-rate treatments (see Table 3). The variable-rate treatment also had significantly greater variance of scores on the test after Lesson #3 further suggesting a possible negative effect.

The second factor that may have influenced results on the cognitive learning tests and possibly all the results of this study is the relatively brief length of exposure to the learning materials. When the study was being planned, consideration of this factor suggested that one exposure to the experimental conditions would not be enough, therefore, the final design included three lessons. However, both the length of each lesson and the length of the total learning experience (see Table 1) may not have given students in the three treatments enough time to exhibit significant differences on the dependent variables.

Comparing the results of the present research to those of Short (47) might suggest that significant increases in cognitive learning for students using variable-speed speech compression recorders will result only after students become well-accustomed to the self-instruction method and the use of variable-speed speech compression equipment.

Learning time. It was hypothesized that students in the normal fixed-rate treatment would take significantly longer to complete each lesson than students in the other two treatments (H_{3a} and H_{3b}); these hypotheses were supported by the data analysis (see Table 23). In addition, mean times of the three treatments for both lessons fell into the same rank order from the normal fixed-rate treatment taking the most time to the compressed fixed-rate treatment taking the least (see Table 3). Although not directly measured by the study, this might suggest that the mean listening rate of students in the variable-rate treatment was between the 150 wpm rate of the normal, fixed-rate treatment and the 200 wpm rate of the compressed, fixed-rate treatment.

It was further hypothesized that students in the variable-rate treatment would have significantly greater variance of times taken to complete each lesson than those students in the two fixed-rate treatments (H_{4a} and H_{4b}); H_{4b} was supported by the data analysis and H_{4a} was partially supported (see Table 23). These results could indicate that the variable-rate students individualized the presentation

rate more than those students in the two fixed-rate treatments.

Learning efficiency. It was hypothesized that students in the normal, fixed-rate treatment would have the lowest learning efficiency scores of the three treatments (H_{5a} and H_{5b}); these hypotheses were partially supported by the data analysis (see Table 23). In addition, the data analysis partially supported the fixed-rate compressed treatment as the most efficient.

Since learning efficiency was defined as a ratio calculated by dividing the cognitive score by the learning time, either measure could have influenced an individual's learning efficiency score. The findings of this study indicate that differences in learning efficiency scores were primarily the result of differences in learning time and not differences in cognitive learning.

Attitude. It was hypothesized that students in the variable-rate treatment would have significantly more positive attitudes toward behavioral objectives (H_{6a}), content of the lessons (H_{6b}), and method of instruction (H_{6c}) than those students in the two fixed-rate treatments; these hypotheses were not supported by the data analysis (see Table 23). As was the case with cognitive learning, the lack of significant differences may have been the result of the relatively brief length of exposure to the experimental materials.

Analysis of supplementary data showed that students in the compressed fixed-rate treatment felt the pacing of lessons

was significantly faster than those students in the other two treatments (see Table 22). This did not, however, seem to affect their performance on the cognitive tests nor did it influence their attitudes.

Summary

Thirteen hypotheses dealing with cognitive learning, learning time, learning efficiency, and attitude were analyzed in this chapter; three were found to be tenable and three were partially tenable. No significant differences among the three treatments were identified for cognitive learning and attitude. The data analysis did suggest that for both learning time and learning efficiency the normal, fixed-rate treatment took the most time to complete the lessons and was least efficient while the compressed, fixed-rate treatment took the least amount of time and was the most efficient. Data analysis also suggested that the variable-speed treatment did, in fact, vary their learning time more than the two fixed-rate treatments.

Two factors that might have influenced the results of this study were discussed including: (a) the brief exposure to the experimental materials, and (b) the novelty effect.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

The first section of this chapter summarizes the purpose of this study, the procedures, and the method of data analysis. Section two will present the major conclusions of this study. Implications resulting from the study for those who might plan to use compressed speech are presented in section three. And finally, recommendations for further research are suggested in the last section.

Summary

The primary purpose of this study was to ascertain the effects on comprehension and learning efficiency when learners were given the opportunity to manipulate the presentation rates of programmed filmstrip/tape lessons using a variable-speed speech compressor. Of additional interest were the effects on attitudes of rate manipulation.

Sixty-seven students from two sections of a basic audio-visual methods course were randomly assigned to three treatments: (a) group one received three programmed filmstrip/tape lessons on behavioral objectives using cassette tapes at the normal rate on a standard tape recorder, (b) group two also used a standard tape recorder for playback, however, the audio-tape narrations were compressed 25%, and

(c) group three used the same materials as group one but on a variable-speed speech compressor that allowed them to adjust the playback rate faster if they desired. All lessons were taken in an individual carrel environment over a two-week period.

Primary data were collected on the cognitive tests and the amount of learning time for Lessons #2 and #3 and a three-part attitude Post-test at the end of the experiment. Supplementary data were collected on the Pre-test, Study Guides, and three additional items on the Post-test.

Thirteen specific hypotheses were formulated to examine mean differences and differences in variances among the three treatments. Mean differences were analyzed using ANOVA and Scheffé post-hoc techniques; differences in variances were analyzed using F-tests.

Conclusions

Based on the analysis of the data five major conclusions can be drawn from this study:

1. Learners who are allowed to vary the presentation rates of programmed filmstrip/tape lessons using a variable-speed speech compressor perform no better on cognitive tests for those lessons than learners who use normal tape recorders and audio-tapes pre-recorded at either 150 or 200 wpm.

2. Learners who use a normal tape recorder to take programmed filmstrip/tape lessons pre-recorded at 150 wpm spend more time with those lessons than learners who use pre-recorded lessons at 200 wpm or learners who are allowed to vary presentation rates using a variable-speed speech compressor.
3. Learners who are allowed to vary the presentation rates of programmed filmstrip/tape lessons using a variable-speed speech compressor vary the amount of time spent with those lessons more than learners who use normal tape recorders and audio-tapes pre-recorded at either 150 or 200 wpm.
4. Learners who use a normal tape recorder to take programmed filmstrip/tape lessons pre-recorded at 150 wpm are less efficient in their learning (cognitive score divided by learning time) than learners who use pre-recorded lessons at 200 wpm. These learners are not, however, less efficient than learners who are allowed to vary presentation rates using a variable-speed speech compressor.
5. Learners who are allowed to vary the presentation rates of programmed filmstrip/tape lessons using a variable-speed speech compressor do not have more favorable attitudes toward either the lessons' contents or the instructional method than learners who use normal tape recorders and audio-tapes pre-recorded at either 150 or 200 wpm.

Implications

Learner control over presentation rate of recorded information may become a practical alternative in the near future with the advent of low-cost variable-speed speech compression recorders. The extent to which this additional control enables learners to learn more effectively and efficiently was of major concern to this study. The findings of this study suggest several implications for those considering the use of compressed speech in an individualized multi-media learning environment.

Under the conditions of this study, there were no apparent differences in cognitive learning or attitude among normal, 25% compressed, and variable-rate treatments suggesting that where effectiveness is of prime concern, unaltered tapes and normal tape recorders would be the most convenient and least costly alternative. This may be especially true where only part of a course is presented in this format. If an entire course utilizes the individualized multi-media format then the use of variable-speed speech compressors may result in greater learning effectiveness as suggested by Short (47). However, until additional research can further substantiate Short's findings and until the cost of variable-speed speech compressors is reduced considerably, one should be cautious about investing four times the cost of a good cassette recorder to obtain one with variable-speed control.

If the reduction of learning time with consequent increase in learning efficiency is of prime concern, then the use of moderately compressed tapes (about 200 wpm) on normal tape recorders would be a viable alternative. Under the conditions of this study, students in the 25% compressed treatment did take the shortest time to complete the lessons. The difference was significant but possibly not meaningful since it amounted to a savings of five minutes for a thirty minute lesson. However, this could be meaningful over a large number of lessons for a large number of students. It should be noted that Short (47) found that students using a variable-speed speech compressor averaged a 32 percent savings of time over normal-rate students.

Recommendations

This study has generated a number of questions which suggest further directions for research dealing with variable-speed speech compressors and learning. It is suggested that further research be conducted to:

1. Investigate the performance of learners using variable-speed speech compressors for different types of materials, both aural only and aural-visual, at different levels, elementary through adult. It is possible that the difficulty level of the material and the age of the learner would affect the results.

2. Examine more precisely the rate manipulation behavior of learners using variable-speed speech compressors. Does the learner manipulate in a manner that will maximize learning effectiveness and efficiency? Can learners be taught to manipulate in this way?
3. Compare performance of learners using variable-speed speech compressors with several alternate fixed rates ranging from 125 wpm to over 300 wpm. Relatively high pre-compressed rates may be as effective and more efficient than the variable-rate treatment. There may, however, be a serious decline in attitudes toward content and method for the high fixed-rate treatments.
4. Investigate the performance of learners using variable-speed speech compressors for lessons of different length and for learning experiences of a few lessons compared to extensive learning experiences of many lessons. It is possible that longer lessons and longer total learning experiences would favor the individual use of compression recorders.

APPENDICES

Appendix A

Objectives for Lessons #1, #2, and #3

Appendix A

Objectives for Lessons #1, #2, and #3

Objective for Lesson #1 - Systematic Instructional Decision Making (48:2)

The specific objective for the program is that the learner's post-instruction responses will reflect a position more consonant with the position taken in the program.

Objectives for Lesson #2 - Educational Objectives (15:1)

More specifically, after viewing the program the learner should be able to:

1. Accurately distinguish between written objevtives which are stated in terms of student behavior and those which are not so stated.

2. Convert non-behavioral objectives to objectives which adequately describe post-instruction pupil behavior.

3. Obtain a score on an attitude inventory which reflects a more favorable disposition toward behaviorally stated instructional objectives.

Objectives for Lesson #3 - Selecting Appropriate Educational Objectives (43:1)

Specifically, the objectives for the program are presented below:

1. The learner will be able to distinguish correctly between written objectives representing the cognitive, affective, and psychomotor domains of pupil behavior.

2. Having properly identified cognitive objectives, the learner will be able to classify them as (a) the lowest or (b) higher than the lowest level of the cognitive domain.

3. Given a relatively unstructured task of writing objectives for a single class period, the learner will tend to write cognitive objectives at a higher level than would be the case prior to viewing the program.

4. Learners will achieve pre- to post-instruction scores on an attitude inventory which reflect a positive attitude toward objectives which are both behavioral and important.

Appendix B

Study Guides for Lessons #1, #2, and #3

INSTRUCTIONAL OBJECTIVES

Lesson 1 - STUDY GUIDE

Name_____

Directions

Since the filmstrip is coordinated with the audio tape, it is important to present the proper frame at the right time. Once the tape has been placed in the tape recorder and rewound to the beginning, set the filmstrip on the second title frame which is located after the focus frame. Then at the first tone advance the filmstrip to the next frame. Thereafter, advance the filmstrip one frame each time a tone signal is heard. The taped narrative commences as follows: "Of the almost innumerable ways to conceptualize the teaching act..."

During the program you will be instructed by the narrator to use the answer sheet provided below.

When you have completed this lesson, return this STUDY GUIDE and the filmstrip/tape materials to the desk monitor.

Answer Sheet

1. A B

2. A B

3. A B

4. A B C D

5. _____

_____

_____

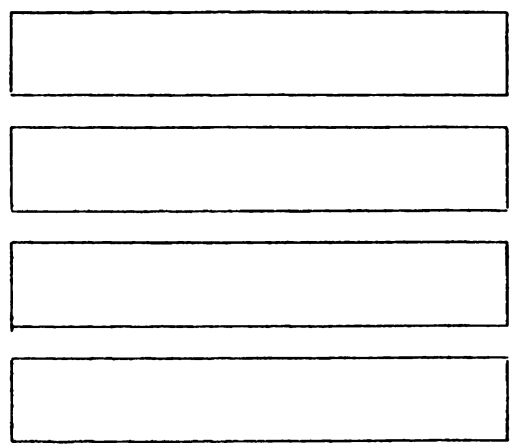
7. A B

8. A B C

9. A B

10. A B

11.



INSTRUCTIONAL OBJECTIVES

Lesson 2 - STUDY GUIDE

Name_____

Directions

Since the filmstrip is coordinated with the audio tape, it is important to present the proper frame at the right time. Once the tape has been placed in the tape recorder and rewound to the beginning, set the filmstrip on the second title frame which is located after the focus frame. Then at the first tone advance the filmstrip to the next frame. Thereafter, advance the filmstrip one frame each time a tone signal is heard. The audio tape commences with the following words: "Pupils go to school to get an education...."

During the program you will be instructed by the narrator to use the answer sheet provided below.

When you have completed this lesson, return this STUDY GUIDE and the filmstrip/tape materials to the desk monitor and ask for the QUIZ for Lesson 2.

ANSWER SHEET

1. Yes No
2. Yes No
3. Yes No
4. A B
5. A B C D
6. A B C D
7. A B
8. A B
9. A B
10. A B
11. A B
12. Yes No

Modified Objective (one)_____

_____

_____

_____

Modified Objective (two)_____

_____

_____

Modified Objective (three)____

_____

_____

_____

INSTRUCTIONAL OBJECTIVES

Lesson 3 - STUDY GUIDE

Name_____

Directions

Since the filmstrip is coordinated with the audio tape, it is important to present the proper frame at the right time. Once the tape has been placed in the tape recorder and rewound to the beginning, set the filmstrip on the second title frame which is located after the focus frame. Then at the first tone advance the filmstrip one frame each time a tone signal is heard. The taped narrative commences as follows: "Which of these two semester objectives more clearly communicates..."

During the program you will be instructed by the narrator to use the answer sheet provided below.

When you have completed this lesson, return this STUDY GUIDE and the filmstrip/tape materials to the desk monitor and ask for the QUIZ for LESSON 3.

ANSWER SHEET

1.	A	B	Neither	11.	C	A	P
2.	A	B		12.	C	A	P
3.	A	B	Neither	13.	C	A	P
4.	A	B		14.	C	A	P
5.	A	B	Neither	15.	L	H	(L=Lowest - H=Higher)
6.	A	B		16	L	H	
7.	A	B	Neither	17.	L	H	
8.	A	B	Neither	18.	L	H	
9.	A	B		19.	C	(L or H) A	P
10.	C=Cognitive			20.	C	(L or H) A	P
	A=Affective			21.	C	(L or H) A	P
	P=Psychomotor			22.	C	(L or H) A	P

__(a) __(c)

__(b) __(d)

Appendix C

Excerpt from Educational Objectives

Frame 10

Good instructional objectives must be stated in terms of student behavior. Yes, meaningful and valuable instructional objectives must be described by stating how the student behaves or will be able to behave after instruction. The more specifically the pupil behavior can be defined, the better. For when the teacher's goal is to change the student's observable behavior, a way of judging whether the objective has been achieved is provided, namely, to observe whether the behavior change has occurred.

But what kind of behavior?

How should we describe the way a pupil will behave after instruction?

Is this a satisfactory description?

Frame 11

When a teacher syas that a student will understand, precisely, what does he mean? For instance, think about the kind of evidence you could use to demonstrate that this next objective had been achieved.

Frame 12

(8 SECOND PAUSE)

Or this one.

(7 SECOND PAUSE)

Frame 13

It is true that most people have a somewhat similar conception of what the word "understand" means. But if you ask them to be more specific, for example, to describe the kind of student behavior, even test behavior that reflects understanding, you'll find tremendous differences in their interpretation of this term.

For instance, some would think the student understood the meaning of the Monroe Doctrine when he could write out a description of it from memory--or maybe when he could answer a series of true-false questions about its background--or, perhaps, only when he could properly identify instances where the Doctrine was violated.

Frame 14

It is clear that terms such as "understanding", "knowledge", and "insight" allow considerable lattitude with respect to their interpretation. Even though terms such as "understanding" refer to the student, it is next to impossible to tell what they mean unless one further specifies what type of student behavior signifies understanding.

In the next frame, does phrase A or phrase B allow for fewer interpretations?

Frame 15

Circle the correct answer on your sheet along side number four.

(10 SECOND PAUSE)

Phrase A allows fewer interpretations because it describes an observable form of behavior. Phrase B describes a rather vague internal type of response, which because it is unobservable, might be interpreted in many ways.

In the next frame. . .

Appendix D

Pre-test

PRE-TEST

(Use the IBM answer sheet provided)

For each of the following instructional objectives, mark "A" on your answer sheet if the objective is properly stated or mark "B" if the objective is not properly stated.

1. The student will grasp the significance of the Treaty of Versailles.

2. The student will have an attitude favorable to English grammar indicated by his response to a questionnaire.

3. The student will know six verbs.

4. The student will learn the names of the common tools in wood shop.

5. The teacher will list three major causes of the Civil War on the chalkboard.

6. The student will know the important battles of World War I.

7. The student will prefer cooking to sewing.

8. The student will be able to correctly thread a sewing machine.

9. The student will pay attention as the teacher demonstrates the use of the lathe.

10. The student will be able to develop a sense of the cultural unity of man.

11. The student will list and describe the themes of four of Shelley's poems.

12. The child will develop interest in leisure sports.

13. The student will give indications of a desire to learn more history by volunteering to present an extra oral report.

14. The teacher will describe with understanding five concepts treated in the text.

15. The student will correctly solve all of the story problems presented.

16. The student will accurately learn the best known works of Voltaire.

17. The teacher will help the class to solve algebra problems correctly.

18. The student will appreciate the key importance of algebraic approaches.

19. The student will include 10 supporting facts in a written persuasive paragraph.

20. The student will become familiar with how to write an essay using no reference but personal experience.

Classify each of the following objectives according to the following scheme:

A. psychomotor

B. affective

C. cognitive - higher than lowest level

D. cognitive - lowest level

The learner:

21. is able to choose the best of two solutions to a geometry problem using standards given by the teacher.

22. exhibits tolerance for others by displaying good manners toward those of minority groups.

23. lists the names and contributions of the five key curriculum workers as described in class.

24. properly knits a baby blanket.

25. scores well on the Minnesota Teacher Attitude Inventory.

26. uses instructional principles properly in planning daily lessons.

27. plays table tennis according to rules well enough to beat three inexperienced girls 100% of the time.

28. correctly recites Gettysburg Address from memory.

29. scores 80% or better on a spelling quiz.

30. displays interest in higher mathematics by volitionally attending lectures on this topic.

Rate each of the following instructional objectives according to the following scheme:

A. Excellent

B. Good

C. Average

D. Fair

E. Poor

There are no "right" or "wrong" answers for this list, so please express your preferences candidly.

31. The student will be able to comprehend thoroughly the ways in which our constitution permeates our everyday life.

32. When presented with a list of nouns and pronouns, the student will be able to label each word correctly.

33. Student will be able to see the value of reading the "classics" in his leisure time.

34. The student will be able to write an essay employing one of three logical organizations given in class which exhibits no grammatical errors.

35. The student will be able to learn the number of voters in his precinct.

36. The student will be able to list those articles in the constitution which relate to "due process of law."

37. Students will realize the importance of knowing the approximate date at which a given literary work was produced.

38. The teacher will cover the key tools of the chemistry lab, that is, the Bunsen burner and various types of test tubes.

39. Given a list of 10 actual municipal court decisions, the student will be able to select the six which violate key tenents of the constitution and subsequently write an essay briefly explaining the nature of these violations.

40. The student will orally recite the names of six chemical compounds containing three or more elements.

41. The student will be able to cite some of the literary "classics" and briefly describe in an essay those features which give them universal appeal.

42. The student will grasp the significance of civic responsibility.

43. The student will be able to name the date when women were first permitted to vote.

44. The teacher will discuss the grammatical form of the amendments to the constitution.

45. The student will be cognizant of the important role scientific investigation has played in the field of chemistry and will become conversant with the relationship between scientific inquiry and the everyday life of the individual.

46. The teacher will help the class to become proficient communicators in written English.

47. Give the names of well-known novels and the names of contemporary authors, the student will be able to correctly match them in a test.

48. The student will be able to write an essay in which he contrasts the arguments for having a democracy or totalitarian state.

49. The student will learn the parts of speech.

50. The student will be capable of setting up an experimental hypothesis test in the field of quantitative chemical analysis so that presented with an unknown chemical compound he can thereafter correctly identify its constituent elements.

Appendix E

Lesson 2 - QUIZ

INSTRUCTIONAL OBJECTIVES

Lesson 2 - QUIZ

Directions (Use a #2 pencil)

On the IBM answer sheet provided, write your name and date at the top. In the space provided for NAME OF TEST, write "2". Write your student identification number under the red arrow and code it in the spaces provided to the right.

For each of the following instructional objectives, mark "A" on your answer sheet if the objective is properly stated or mark "B" if the objective is not properly stated.

1. The student will grasp the significance of the Treaty of Versailles.

2. The student will have an attitude favorable to English grammer indicated by his response to a questionnaire.

3. The student will know six verbs.

4. The student will learn the names of the common tools in wood shop.

5. The teacher will list three major causes of the Civil War on the chalkboard.

6. The student will know the important battles of World War I.

7. The student will prefer cooking to sewing.

8. The student will be able to correctly thread a sewing machine.

9. The student will pay attention as the teacher demonstrates the use of the lathe.

10. The student will be able to develop a sense of the cultural unity of man.

11. The student will list and describe the themes of four of Shelley's poems.

12. The child will develop interest in leisure sports.

13. The student will give indications of a desire to learn more history by volunteering to present an extra oral report.

14. The teacher will describe with understanding five concepts treated in the text.

15. The student will correctly solve all of the story problems presented.

16. The student will accurately learn the best known works of Voltaire.

17. The teacher will help the class to solve algebra problems correctly.

18. The student will appreciate the key importance of algebraic approaches.

19. The student will include 10 supporting facts in a written persuasive paragraph.

20. The student will become familiar with how to write an essay using no reference but personal experience.

Return this quiz and answer sheet to the desk monitor when completed.

Appendix F

Lesson 3 - QUIZ

INSTRUCTIONAL OBJECTIVES

Lesson 3 - QUIZ

Directions (Use a #2 pencil)

On the IBM answer sheet provided, write your name and date at the top. In the space provided for NAME OF TEST, write "3". Write your student identification number under the red arrow and code it in the spaces provided to the right.

Classify each objective below according to the following scheme:

A. psychomotor

B. affective

C. cognitive - higher than lowest level

D. cognitive - lowest level

The learner:

1. is able to choose the best of two solutions to a geometry problem using standards given by the teacher.
2. exhibits tolerance for others by displaying good manners toward those of minority groups.
3. lists the names and contributions of the five key curriculum workers as described in class.
4. properly knits a baby blanket.
5. scores well on the Minnesota Teacher Attitude Inventory.
6. uses instructional principles properly in planning daily lessons.
7. plays table tennis according to rules well enough to best three inexperienced girls 100% of the time.
8. correctly recites Gettysburg Address from memory.
9. scores 80% or better on spelling quiz.

10. displays interest in higher mathematics by volitionally attending lectures on this topic.

Return this quiz and answer sheet to the desk monitor when completed.

Appendix G

Post-test

NAME_____

Use the IBM answer sheet for items 1 through 20.

Directions: Rate each of the following instructional objectives according to the following scheme:

A. Excellent
B. Good
C. Average
D. Fair
E. Poor

There are no "right" or "wrong" answers for this list, so please express your preferences candidly.

1. The student will be able to comprehend thoroughly the ways in which our constitution permeates our everyday life.

2. When presented with a list of nouns and pronouns, the student will be able to label each word correctly.

3. The student will be able to see the value of reading the "classics" in his leisure time.

4. The student will be able to write an essay employing one of the three logical organizations given in class which exhibits no grammatical errors.

5. The student will be able to learn the number of voters in his precinct.

6. The student will be able to list those articles in the constitution which relate to "due process of law".

7. Students will realize the importance of knowing the approximate date at which a given literary work was produced.

8. The teacher will cover the key tools of the chemistry lab, that is, the Bunsen burner and the various types of test tubes.

9. Given a list of 10 actual municipal court decisions, the student will be able to select the six which violate key tenents of the constitution and subsequently write an essay briefly explaining the nature of these violations.

10. The student will orally recite the names of six chemical compounds containing three or more elements.

11. The student will be able to cite some of the literary "classics" and briefly describe in an essay those features which give them universal appeal.

12. The student will grasp the significance of civic responsibility.

13. The student will be able to name the date when women were first permitted to vote.

14. The teacher will discuss the grammatical form of the amendments to the constitution.

15. The student will be cognizant of the important role scientific investigation has played in the field of chemistry and will become conversant with the relationship between scientific inquiry and the everyday life of the individual.

16. The teacher will help the class to become proficient communicators in written English.

17. Given the names of well-known authors and the names of novels, the student will be able to correctly match them in a test.

18. The student will be able to write an essay in which he contrasts the arguments for having a democracy or totalitarian state.

19. The student will learn the parts of speech.

20. The student will be capable of setting up an experimental hypothesis test in the field of quantitative chemical analysis so that presented with an unknown chemical compound he can thereafter correctly identify its constituent elements.

Appendix H

Equipment Operating Instructions

For this part of the examination, mark your answers directly on this page.

Directions: For the following three questions, express your opinions using the seven-place scales that follow each question. The strength of your opinion will be indicated by where you place an "X" on the scale. For example, if you feel that for the first one instructional objectives are extremely important you would respond:

important X : __ : __ : __ : __ : __ : __ unimportant

If you felt that they are neither unimportant nor important or you have a neutral opinion you would respond:

important __ : __ : __ : X : __ : __ : __ unimportant

What is your opinion of instructional objectives?

important __ : __ : __ : __ : __ : __ : __ unimportant

worthless __ : __ : __ : __ : __ : __ : __ valuable

useful __ : __ : __ : __ : __ : __ : __ useless

What is your opinion of the self-instructional method you experienced?

pleasant __ : __ : __ : __ : __ : __ : __ unpleasant

passive __ : __ : __ : __ : __ : __ : __ active

interesting __ : __ : __ : __ : __ : __ : __ uninteresting

de-humanizing __ : __ : __ : __ : __ : __ : __ humanizing

What is your opinion of the lessons you took?

too difficult __ : __ : __ : __ : __ : __ : __ too easy

too fast __ : __ : __ : __ : __ : __ : __ too slow

too long __ : __ : __ : __ : __ : __ : __ too short

EQUIPMENT OPERATION*

SET-UP

Filmstrip Viewer

1. Turn on viewer.
2. Take filmstrip out of container and check to see that end labeled START is out.
3. Place filmstrip roll into holder in front of viewer with START end pointing down.
4. Feed end into slot while turning FRAME knob on left side until filmstrip is pulled through viewer. Keep turning until you get to the FOCUS frame.
5. Push FRAME knob and turn to adjust image up or down until perfectly framed, then release knob.
6. Advance filmstrip to the title frame using the FILM ADVANCE on front of viewer.
7. Once the lesson has started, push the FILM ADVANCE every time you hear a tone.

Tape Recorder

1. Push EJECT.
2. Insert lesson tape with number up into machine.
3. Press REWIND to assure tape is at beginning.

TO BEGIN

1. Read STUDY GUIDE.
2. To start tape, press PLAY.
3. Advance filmstrip on each tone.
4. Adjust VOLUME control on left side.

AT END

1. STOP tape recorder.
2. Return all materials to the desk monitor.
3. Take QUIZ if this is LESSON 2 or 3.

---

*Instructions in carrels equipped with normal tape recorders.

EQUIPMENT OPERATION*

SET UP

Filmstrip Viewer

1. Turn on viewer.
2. Take filmstrip out of container and check to see that the end labeled START is out.
3. Place filmstrip roll into holder in front of viewer with start end pointing down.
4. Feed end of filmstrip into slot while turning FRAME knob on left side until filmstrip is pulled through viewer. Keep turning until you get to the FOCUS frame.
5. Push FRAME knob and turn to adjust image up or down until perfectly framed, then release knob.
6. Advance filmstrip to the title frame using the FILM ADVANCE on the front of the viewer.
7. Once the lesson has started, push the FILM ADVANCE every time you hear a tone.

Tape Recorder

1. Insert lesson tape into right compartment marked ORIG.
2. Press REWIND to assure tape is at the beginning.
3. Notice on the right front of the recorder there is a dial labeled VARIABLE SPEECH CONTROL. Once you begin the lesson, use this dial to adjust the speed of the lesson to fit your individual abilities and preferences. Turn clock-wise to increase speed; counter clock-wise to decrease speed.

TO BEGIN

1. Read STUDY GUIDE.
2. To start tape press the PLAY button.
3. Advance filmstrip on each tone.

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*Instructions in carrel equipped with speech compression tape recorder.

4. Adjust volume control as needed.

5. Adjust VARIABLE SPEECH CONTROL as needed throughout the lesson.

AT END

1. STOP tape recorder.

2. Return all materials to the desk monitor.

3. Take QUIZ if this is LESSON 2 or 3.

Appendix I

Outline of Class Orientation

ORIENTATION

I. Introduction

A. My name and position

B. Purpose of my being here

1. To introduce three self-instruction lessons

2. To determine how much you know about content already

II. Pre-test

A. Pass out answer sheets and pencils

B. Instructions to fill in heading

1. Name

2. Name of test ' "1"

3. Student number

4. Grade or class - 1, 2, 3, 4, or 5

5. Major

C. Try to do as well as you can; if you don't know answer, guess.

D. Students take test (20 minutes)

E. Collect tests, answer sheets, and pencils

III. Describe procedures

A. You will take these during next 2 weeks

B. Subject of Instructional Objectives normally covered in class

C. Format is coordinated filmstrip, tape, and study guide

D. Equipment and lessons available in Self-Instruction Lab

E. Brief quiz after Lessons #2 and #3

F. Each lesson will take about 1/2 hour

G. You may take lessons any time during open hours but be aware that certain times may be busy

IV. Rationale

A. Media Technology Department is interested in effectiveness of new methods and materials

B. Some of you will use a tape recorder that allows you to control the rate of tape playback

V. Any questions?

Appendix J

Instructions for Lab Monitors

PROCEDURES FOR SELF-INSTRUCTION

FILMSTRIP/TAPE LESSONS

Students taking Mr. Hartz's AV Communications course in Sections 1 and 2 will be going through 3 self-instruction lessons using the materials located on the shelves under the counter and the 3 carrel stations equipped with filmstrip viewers, tape recorders, and headsets.

Your job will be to hand out lessons, collect lessons when completed, hand out quizes and collect quizes.

Procedure

1. Student will come in and request a lesson.

2. Ask student for name, section number, and lesson number that he wants.

3. Check class list posted on cabinet door for student's name. Under column headed CODE, note the color beside that student's name.

4. If the CODE color is either BLUE or YELLOW

   a. Give the student the following materials for that lesson:

      -- filmstrip
      -- STUDY GUIDE
      -- pencil
      -- cassette tape that is coded in the same color as the mark beside his name.

   b. Direct the student to one of the first two carrels; the last carrel is to be used exclusively by students coded RED.

   c. Record exact check-out time in the space provided on the class list to the right of the student's name for that lesson.

5. If the CODE color is RED

   a. Give the student the following materials for that lesson:

      -- filmstrip
      -- STUDY GUIDE
      -- pencil
      -- cassette tape that is coded RED

b. Direct the student to the last carrel only.

c. Record exact check-out time in the space provided on the class list to the right of the student's name for that lesson.

6. When students return lesson materials to the desk:

a. RECORD EXACT CHECK-IN TIME in the space provided on the class list to the right of the student's name for that lesson.

b. Give student QUIZ for Lesson 2 or 3, an answer sheet, and a pencil.

c. Rewind tape and filmstrip if necessary; return to correct box.

d. Put used STUDY GUIDES in place provided.

e. When students return QUIZ, put in place provided.

NOTE: Provide help to students if they need it. Students coming in for the first lesson may need help with equipment operation even though instructions are listed in each carrel. This may be especially true of students using the carrel with the special recorder. Become familiar with the operation of all the equipment.

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