Immediate Learner Achievement as an Effect of Aesthetic Embellishment in Educational Art

Roger D. Markham
University of Central Florida
IMMEDIATE LEARNER ACHIEVEMENT AS AN EFFECT OF AESTHETIC EMBELLISHMENT IN EDUCATIONAL ART

BY

ROGER D. MARKHAM
B.A., Florida State University, 1974

THESIS

Submitted in partial fulfillment of the requirements for the degree of Master of Arts: Communication in the Graduate Studies Program of the College of Social Sciences of Florida Technological University

Orlando, Florida
1978
ABSTRACT

This study was designed to test the null hypothesis that there would be no significant difference in the achievement of subjects who are taught the same concepts using two sets of visuals which differ in detail, complexity, accuracy of scale and use of background. A 20-item comprehension test produced non-significant differences between the simple and complex artwork treatments within both the Army Reserve and FTU samples. Subjects in both target audiences achieved approximately the same comprehension level even though they perceived the complex art to be significantly more adequate to teach. The major implication of this study is the possibility for dramatic savings in costs as well as time contributed to the development process of TEC lessons without a corresponding drop in teaching effectiveness. It was recommended that educators consider this and other related research when planning, designing, purchasing and using audio-visual instructional materials and training aids.
TO ELAINE AND BANKS...

...THESE ARE MY LIFE.
ACKNOWLEDGMENTS

I would like to express my appreciation to my Committee Chairman, Dr. Giles Hoglin, to my Committee Member, Dr. Edgar Wycoff, and especially to Dr. Albert Pryor, my Committee Member and mentor.

My thanks also go to Mr. Donald Johnson and all my friends at the Naval Training and Equipment Center, Orlando, for their assistance, support and confidence.
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CHAPTER I

INTRODUCTION

The purpose of this study is to determine the effects of levels of artwork in audio-visual sound-slide teaching devices on message comprehension. More specifically, the experiment was undertaken to determine whether a student can obtain as much information from simple art (line drawings, stick figures, geometric patterns, etc.) as he can from a more complex rendition of the same subject, including full human figures, extremely detailed subject matter, use of color and more embellishment for the purpose of intensifying the aesthetic quality of the visual.

THE PROBLEM

The U.S. Army Combat Arms Training Board initiated an audio-visual TEC (Training Extension Course) program in 1972. The first TEC lesson was ready for field use in 1974. The typical TEC lesson includes a filmstrip cartridge and an audio cassette that are designed for synchronous use in the Beseler Cue/See projector. The filmstrip is produced by photographing commercially developed artwork. A TEC lesson normally contains approximately 150 pieces of art. The current cost of one frame of art may vary from as little as 15 dollars for a simple piece to as much as 75 dollars for a complex piece. If a simple drawing
could achieve the same results as a complicated embellished art frame, the Government would realize substantial savings in money as well as in time invested in developing and producing TEC lessons for this program.

SIGNIFICANCE

This study is significant in that the results can be applied to any teaching organization that uses audio-visual training devices. With the continued advancements in the field of educational technology, the number of agencies using or considering audio-visual training in as well as outside the education field is rapidly increasing. This study could suggest a way of cutting the high cost of developing training material if the same learning objectives can be accomplished with simpler, lower-priced artwork. The investigation could determine whether the degree of aesthetic embellishment increases or hinders the retention rate of a student. This research is of particular importance since previous studies have been more concerned with the student's preference of simple or complex art rather than with its training effectiveness.

CONTRIBUTORY STUDIES

The justification for using large amounts of realistic detail in visual illustration is found in the theoretical work of Morris (1946) Carpenter (1953) and Dale (1954). Although differing considerably in detail, these various theoretical orientations can all be classified as realism theories (Dwyer, 1972). The basic assumption underlying all of these theories is that learning will be more complete as the number of cues in the learning situation increases. There-
fore, an increase in realism in the visual portion of the lessons would increase the number of cues in the learning situation, thereby facilitating learning.

Bullough (1974) discovered that most media designers have been content to forget about the problem and to use embellishments in a rather random or accidental fashion. Aesthetics in media design are often thought of as additional effects that actually may not assure greater increments of learning. However, Bullough suggests that the student’s innate sensitivity to appealing displays be considered.

Ball (1960) suggested it is entirely possible that both too much or too little aesthetic embellishment in educational art could detract from the student’s capability to comprehend the subject matter.

Few studies have been conducted which investigate the relative effectiveness of visual illustrations that employ different amounts of realistic detail to complement oral instruction. Two important early studies (Carpenter, 1954; Lumsdaine, 1958) employed filmographs to study simple versus complex motion picture film presentations. A filmograph is a simplified version of a motion picture film which is produced by using a motion picture camera to film either a series of still frames taken from the original motion picture or the storyboard from which the original motion picture was produced.

Carpenter (1954) prepared two filmographs from a sound motion picture film concerned with riot control for military police trainees. One filmograph was based upon frames of the original motion picture while the other was shorter and was based on stock photographs which were substituted for complex mob
scenes. Achievement gains and attitudes of subjects seeing the motion picture and the two filmographs were not significantly different. Carpenter concluded that simplified visual presentations in the motion picture format compared with more complex ones did not differ significantly in effectiveness.

Lumsdaine (1958) replicated the filmograph experiment using a motion picture entitled "The Cowboys" and still photographs taken from the original film. His subjects were fourth and fifth graders. Lumsdaine concluded there was no significant difference in achievement gains between the two treatment groups.

Gorman (1973) employed two black-and-white slide presentations to study the effects of pictorial detail on concept formation. One set of slides employed simple line drawings while the other set employed detailed drawings. He selected 150 fifth, ninth, and 12th-grade students for subjects in his study. There were no significant differences in the final performance of any of his groups.

Spaulding (1956) studied the performance of poorly educated adults in several countries and found that they had difficulty in interpreting complex illustrations. He concluded that pictorial complexity may reduce the "readability" of a picture in much the same way that idea density reduces the readability of printed material.

Wicker's (1970) research on paired-associate learning and the work of Paivio, Rogers, and Smythe (1968) on free recall showed that detailed pictures did not significantly improve learning as compared with simple line drawings.

Perhaps the most significant work in this area is a series of studies carried out by Dwyer (1970). On the subject of rising costs for visualized instruction
which seem to pace the rising use of visualized instruction, Dwyer (1972) comments:

This use of visualization increases the cost of education. Consequently, from time to time it is necessary that we critically re-examine those aspects of the instructional program that contribute significantly to increased cost in order to verify that their presence is justified in terms of increased student achievement (p.v).

It is important to realize that not all visual material lends itself to all teaching situations. Dwyer (1972) points out that the effectiveness of visualized instruction relative to student achievement is primarily dependent upon the type of visualization, the method or mode of presentation, the learning objectives, characteristics of the target audience and attention-focusing techniques.

Davies (1973) concurred with Dwyer’s (1972) observations on the relativity of student achievement to other variables by stating the teacher’s difficulty lies not in being convinced that simple aids work, but in deciding when visual rather than audio aids are optimal and when pictures should be used rather than diagrams.

The series of studies carried out by Dwyer (1972) illustrates two points under consideration here. One is the visual effectiveness relative to the degree of detail; the other is the notion that visual effectiveness may be a function of the specific learning objectives.

Dwyer (1972) developed a 2000-word instructional unit describing the human heart, its parts and the internal processes occurring during the systolic and diastolic phases. He then developed illustrations at different levels of complexity ranging from simple line drawings in black-and-white to realistic heart
photographs in full color. The 2000-word instructional unit was analyzed to locate critical information that could be illustrated in a visual treatment. A total of 39 critical areas were identified, and visuals were designed to specifically illustrate the information in each critical area. The end result was eight complete visual sequences reproduced on 2 X 2 slides. Four of these sequences were in black-and-white and four were in color. All sequences employed the same 2000-word instructional content recorded on audio tapes. Care was taken to insure that the same format and size relationships that appeared in the original heart photographs were conveyed in the drawings. The same set of printed symbols was used in all experimental treatments and these were positioned in identical locations on each slide. A control treatment employed the audio tape with no visuals.

In order to determine which treatment was most effective in facilitating student achievement of specific educational objectives, four criterion measures were developed. These involved drawing, identification, terminology, and comprehension. Students were permitted to take as much time as was required to complete one criterion measure before proceeding to the next. The measures contained 18 to 20 items each and had reliability coefficients ranging from .76 for the comprehension test to .81 for the drawing test. The total criterion test consisting of the four individual tests contained 78 items and had a reliability coefficient of .91.

In Dwyer's initial study, the control treatment plus three black-and-white presentations were used. One hundred eight college freshmen were randomly
assigned to four treatment groups. In comparing the performance of the four groups on the criterion measures, it was found that the simple line drawing presentation was most effective for the drawing test, the identification test, and the total criterion score. The oral presentation (no visuals) was most effective for the terminology test and the comprehension test. Dwyer found that the more realistic illustrations which contained shaded drawings and realistic photographs were the least effective in complementing the oral instruction. In fact, they were no more effective than the oral instruction alone. Dwyer suggests that an undue amount of emphasis has been placed on the desirability of more realistic illustrations for instructional purposes.

In Dwyer's next study, the nine treatments were administered to 1054 students in grades nine, 10, 11, and 12. At each grade level, each of nine classes was assigned at random to one of the treatment groups. A total of 20 comparisons were made to identify the most effective treatment for each criterion measure at each level. The oral presentation with no visuals was most effective in four of the 20 comparisons. In contrast, the simple line drawing presentation was most effective in nine comparisons, while the simple line drawings in color proved superior in only one case. Detailed black-and-white shaded drawings were most effective in two comparisons. Treatments using black-and-white photos of a heart model, color photos of a heart model, black-and white photos of an actual heart and color photos of an actual heart were not the most effective in any of the 20 comparisons.

In Dwyer's third study, 261 college students were randomly assigned to the
nine treatment groups. The control group (Group I) received no illustrations of the heart but viewed slides containing the names of parts and processes of the heart as they were mentioned in the instructional script. Group II received simple black-and-white line illustrations depicting the form and relative locations of the heart parts. Group III viewed simple line illustrations in color (blue lines on pink background). Group IV viewed detailed black-and-white shaded drawings. Group V received detailed color shaded drawings. Group VI viewed black-and-white photographs of a heart model, while Group VII received color photographs of the heart model. Finally, Group VIII viewed black-and-white photographs of an actual heart specimen and Group IX viewed color photographs of an actual heart specimen.

The results were that on two test criteria (terminology and comprehension), there was no significant difference between the oral presentation and any other visual reinforcement. However, on the drawing test, the simple black-and-white line drawing was most effective. The simple color line drawing and the detailed color shaded drawing were equally more effective on the total criterial and identification tests than any other group.

This tends to support the statement that not all visual material lends itself to all teaching situations. Another interesting "aside" found in this study is that subjects' perceptions regarding the most effective visuals do not always match those found to be most effective in the research.

This finding is important, although it would be difficult to generalize it to all applications. It would seem that each learning objective would have to be
validated using a series of varying degrees of detail or realism.

The overall results of Dwyer's three studies indicated that the simple line drawings were the most effective on the total criterion measure. The four most complex treatments which consisted of black-and-white and color photographs of heart models and of actual hearts were the least effective.

An important observation resulting from Dwyer's (1970) studies is that where the use of visuals did make a difference in increasing student achievement, those illustrations containing relatively small amounts of realistic detail were most effective. These results were attributed to the fact that students viewed their respective types of visuals for equal amounts of time. In contrast, results of the self-paced studies indicated that where the use of visuals did make a difference in increasing student achievement, the more realistic illustrations were most effective. These results were explained by the fact that students were permitted to interact with the more realistic illustrations for as long as they felt necessary to complete their understanding of the information being processed.

Dwyer seems to suggest that as long as the student was utilizing the self-paced mode and proceeding at his own pace, he would have plenty of time to absorb the information presented no matter how complex it may be rendered. However, Dwyer (1967) had previously stated that a programmer prior to writing a program, would have to define his teaching objectives and select the most appropriate visuals because all visuals were not equally effective in complementing programmed instruction.
The most recent study conducted regarding amount of realism in instructional visuals was carried out by Borg (1977). The experiment was conducted for the U.S. Army Research Institute at Fort Eustis, Virginia and was directly related to the U. S. Army's Training Extension Course (TEC) program. These audio-visual lessons have been designed to eventually cover every MOS (military occupational skill) offered by the Army. Most TEC lessons are self-paced and require an occasional immediate decisive response from the student.

Other TEC lessons are designed to teach the soldier a task or tasks with a continuous flow of information. These are scored by a post-test. TEC is generally used as supplemental or support training but in some cases it is used for primary training. The programs are mainly designed for use with enlisted soldiers whose average education approaches the ninth-grade level.

The target population for Borg's research was Armor Crewmen. A total of 80 subjects with this primary MOS were randomly assigned to four groups. Two of these groups were administered the complex version of the selected TEC lesson while the other two groups were administered the simple version. The TEC lesson selected for the test was entitled, Bore Sighting the Machine-guns, M60/M60A1 Tank. The lesson had been developed and produced by the U. S. Army Armor School at Fort Knox, Kentucky and was already in use in the field. It consists of an audio tape plus a filmstrip containing 119 visual frames. These visuals included nine which were classified as simple artwork, 34 classified as standard artwork and 70 classified as complex artwork. In order to develop a simpler version of the lesson, the investigators analyzed
each frame in the complex lesson and prepared specifications for simplifying most of the frames. This process resulted in 38 simple frames, 59 standard frames and 16 complex frames. Much of the simplification involved removing superfluous items such as foliage in the foreground and mountains, trees, etc. in the background, removing hands from the equipment, removing uniform details from soldiers depicted in the frames and sketching equipment rather than drawing it to scale. Both lessons employed the same audio tape which was inaudibly pulsed to advance the filmstrip automatically and required the same amount of time to complete, approximately 35 minutes.

Each treatment was carried out with two groups of 20 subjects. One group in each treatment was given the lesson in the morning and the other in the afternoon. This permitted the investigators to check the effects of time of day in addition to the effects of the two treatments.

Test measures employed for the study included a 36-item pre-test which dealt with the specific content covered in the selected TEC lesson. Afterwards, a 36 item post-test was administered which closely paralleled the pre-test in terms of item content although the specific items used in the two forms were different. A visual achievement test and an attitude measurement questionnaire were also administered.

Analysis of covariance was employed to analyze the results of this study. For all four of the dependent variables, the differences between the adjusted final mean scores for subjects in the simple versus complex treatments were extremely small and rendered insignificant. These results prompted Borg to
conclude that the complex art contributed nothing to either learning or soldiers' attitudes. Further, he expressed doubts that the complex format would be superior for any content covered in TEC lessons.

In light of his findings, as well as the Army Research Institute's calculation that the simple version of the lesson saved one third of the total cost, Borg recommended that as high a percentage of simple art as possible be employed in the development of future TEC lessons.

PURPOSE AND HYPOTHESIS

It is the author's intention and the purpose of this thesis to take Borg's recommendation concerning further research and produce an even further simplified version of the TEC lesson which was used in his study. The experiment is designed to test the null hypothesis that there will be no significant difference in the achievement of subjects who are taught the same concepts using two sets of visuals which differ in detail, complexity, accuracy of scale and use of background.
CHAPTER II

METHODOLOGY

MATERIALS

It was the author's desire to duplicate the Army Research Institute's study of TEC art as closely as possible. Therefore, the materials used were two Beseler Cue/See projectors, an original complex version of the TEC lesson, Boresighting the Machineguns: M60/M60Al Tank, a simplified version of the same lesson created by the author (see Appendix A), plus 20 questions selected from the post-test questionnaire which had been used in the Army Research Institute study. These questions were indicative of the original 36 questions, so 20 questions were selected due to time constraints. In addition to the questionnaire, two opinion items were included (see Appendix B). In the Florida Technological University portion of the study, six semantic differential scales were substituted for the two opinion-measurement scales.

This particular TEC lesson is not self-paced in the traditional sense that the student proceeds at his own pace. This lesson is one in which the information is provided in a continuous flow and learner achievement is usually measured by a post-test.

The simple version of the filmstrip was created by projecting the original lesson on the Beseler Cue/See and free-hand drawing each frame of art onto a
plain white 8 1/2" by 11" sheet of paper using black felt tip pens. An average of five minutes was spent executing each frame of simple art. Some color was arbitrarily added to certain frames that obviously contained so many black lines that they were confusing. Some color was necessary to portray some sense of depth or perspective. Colors were selected on a random basis and were purposefully used inconsistently. For example, if blue were used for a background or to highlight an area of a visual, then red may have been used the next time that same visual came up in the lesson. In all cases, color was limited to light shading.

After the 119 simple frames of art were accomplished, they were photographed on super 8mm film using a single frame super 8mm camera, tripod, and two photo-flood lamps. The lesson was photographed three times on the same roll of film and exposure was bracketed to insure at least one projectable copy. After having the film processed, a suitable copy was selected and loaded into a super-8mm Technicolor Magi-cartridge. In order to minimize the danger of film scratches and other deterioration, the film was projected only once to see if it maintained synchronization with the original inaudibly pulsed audio tape.

SUBJECTS AND PROCEDURES

In order to maintain integrity with the Army Research Institute's study, the target audience for this experiment was selected from a U. S. Army Reserve unit in Orlando, Florida. The soldiers in the unit held primarily transportation MOS's.
Thirty-one subjects participated on a voluntary basis. These soldiers were randomly assigned to two groups designated simple and complex.

The testing took place at the Reserve unit's headquarters on a Saturday afternoon during the regularly scheduled monthly drill. The test was administered in the small-group mode (rear screen projection). The two treatments were administered simultaneously in the same room, thus controlling for possible biasing effects of intrasession history. Due to a shortage of space at the unit, the only available testing area was a long narrow room which served both as a dining hall and an indoor pistol target range.

The two Beseler Cue/See projectors were set up back to back in the center of the room where the group on either side could not see the other screen. The subjects were told that due to the small size of the Beseler Cue/See screen, it would be necessary to split the groups and use two projectors for a better viewing atmosphere. Since the same audio tape was used to advance both visuals, the subjects thought they were viewing the same film. After viewing the 35-minute lesson, the subjects completed the 20-item comprehension test and the opinion questions. Finally, the subjects in both groups were briefed as to the real reason for the test. Two participants, one from each condition, dropped out during the treatment. Thus, 29 subjects completed the dependent measures.

All tests were administered by the author and one assistant. The tests were graded by a second assistant who was not present at any of the treatment sessions.

To further enhance the validity of this study, it was decided to repeat the ex-
periment at Florida Technological University using three freshman speech classes. In this experiment, a control group was added. Twenty-four students in one class took the complex treatment. Eighteen students in another class were given the simple treatment and 20 students in the third class were utilized as a control group which received only the 20-question questionnaire. All treatments were administered on the same day during regularly scheduled class periods.

The same independent variable, degree of realism, was used for the FTU experiment. However, in order to further determine subjects' perceptions of the two levels of art, six semantic differential scales replaced the opinion questions used in the Army sample. These included evaluations of the degree to which the lesson was sophisticated, complex, adequate, appealing, effective and interesting.

Testing of the complex group was accomplished in the Humanities and Fine Arts building in a classroom which had all outside light opaqued out. The subjects were told that some students would not find the lesson as interesting as others but that they should pay close attention anyway in order to complete the questionnaire which would be administered immediately following the treatment. Then, using the Beseler Cue/See in the large group mode (projected image), the complex version of the TEC lesson was projected to a two-by-three-foot image on a standard classroom screen located in the corner of the room. After viewing the lesson, the questionnaire containing the 20 questions and six semantic differential scales was completed by each subject. The students were then
briefed as to the nature of the study and the test they had just completed.

In the following class period, the simple treatment was administered in another classroom. This room was virtually identical to the first and again, all outside light was opaqued out during the treatment. The subjects were given the same instructions as the complex group and the lesson was projected the same as before in the large group mode. The subjects were then administered the questionnaire and six semantic differential scales.

The control-group session followed in the next class period. Since no treatment was administered, the semantic differential scales were not used. The only task required of the control group was to complete the 20-item comprehension test. The students were allowed ten minutes to answer the questions, after which the purpose of the study was explained. As in the Army sample, all treatments in the FTU sample were administered by the author.
CHAPTER III

RESULTS

A two-tailed t-test was employed to compare the comprehension means obtained in the Army Reserve simple and complex treatments. Results of this test are shown in Table 1.

TABLE I

Comparison of Army Reserve Comprehension Means

<table>
<thead>
<tr>
<th></th>
<th>( \bar{X} ) incorrect</th>
<th>df</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>simple</td>
<td>13.3</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>complex</td>
<td>10.9</td>
<td>28</td>
<td>1.48</td>
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</tbody>
</table>

Results show the simple group averaged 13.3 incorrect answers out of 20 questions while the complex group averaged 10.9 incorrect answers out of the 20 questions. While the t-test revealed no significant difference, there is an observable trend in favor of the complex treatment \( p < .20 \). The data very tentatively supports the null hypothesis of no significant difference in achievement gains of subjects who are taught the same concepts using visuals which vary in amount of detail, complexity, realism and use of background.

A two-tailed t-test was also employed to compare the comprehension
means obtained in the Florida Technological University experiment. The results of this test are shown in Table 2.

TABLE 2
Comparison of FTU Comprehension Means

<table>
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<tr>
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<th>X</th>
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<tr>
<td>simple</td>
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<td></td>
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<tr>
<td>complex</td>
<td>11.4</td>
<td>41</td>
<td>1.03</td>
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<tr>
<td>simple</td>
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<td>37</td>
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<tr>
<td>control</td>
<td>16.7</td>
<td>37</td>
<td>7.28*</td>
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<tr>
<td>complex</td>
<td>11.4</td>
<td>43</td>
<td></td>
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<tr>
<td>control</td>
<td>16.7</td>
<td>43</td>
<td>6.36*</td>
</tr>
</tbody>
</table>

* p < .01

The Florida Technological University experiment revealed the simple group averaged 10.1 incorrect answers out of 20 questions and the complex group averaged 11.4 incorrect answers. Again, the t-test did not yield significance (p > .30).

The means between the control group and both the simple and complex groups were measured. The control group averaged 16.7 incorrect answers out of 20 while the simple group averaged 10.1 incorrect. The t-test reveals significance of p < .01. The t-test between the means of the control group and the complex group also produced significance at the .01 level.
Two-tailed t-tests were also used to examine differences in the comprehension levels between the Army Reserve and the FTU subjects. Table 3 contains a summary of this analysis.

**TABLE 3**

A Comparison of Army Reserve with FTU Comprehension Means

<table>
<thead>
<tr>
<th></th>
<th>( \bar{X} )</th>
<th>incorrect</th>
<th>df</th>
<th>( t ) value</th>
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<tr>
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<tr>
<td>Army simple</td>
<td>13.3</td>
<td></td>
<td>32</td>
<td>1.83*</td>
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<td>FTU complex</td>
<td>11.4</td>
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<tr>
<td>Army complex</td>
<td>10.9</td>
<td></td>
<td>38</td>
<td></td>
</tr>
</tbody>
</table>

* \( p < .025 \)

The FTU group scored significantly higher than the Army Reserve group in the "simple" condition \( (p < .025) \). However, there was no significant difference between the means of the Army Reserve complex and the FTU complex groups.

A question designed to measure the Army Reserve subjects' opinions of the sufficiency of the visuals required a "yes" or "no" answer. Ten out of 14 in the simple group thought the visuals supported the lesson while 13 out of 15 in the complex group thought the visuals supported the lesson. Chi-square results revealed no significant difference of opinions between the simple and the complex groups as to whether the visuals were sufficient to support the
lesson ($\chi^2=2.19$).

An additional opinion question was included on the Army Reserve questionnaire to determine the subjects' perceptions of the quality of the artwork, regardless of whether or not it supported the lesson. Results of the test are presented in Table 4.

**TABLE 4**

<table>
<thead>
<tr>
<th>Army Reserve's Opinion of the Quality of the Artwork</th>
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<th>t value</th>
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<tr>
<td>complex</td>
<td>7.7</td>
<td>28</td>
<td>2.92*</td>
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</tbody>
</table>

*p < .01

The simple group mean was 5.3 on the 10-point scale. The complex mean was 7.7 on the 10-point scale. A one-tailed t-test revealed significance of $p < .01$.

The semantic differential scales administered to the FTU groups solicited information concerning six different points in the artwork as well as in the overall lessons used in this experiment. The opinion data is shown in Table 5.

The one-tailed t-tests revealed no significant difference on four of the measures. The complex art received significantly higher ratings on the sophistication ($p < .01$) and adequacy ($p < .05$) scales.
<table>
<thead>
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<th>FTU Opinions on Artwork</th>
<th>X</th>
<th>df</th>
<th>t value</th>
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<td><strong>Sophistication</strong></td>
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<td>4.13</td>
<td>41</td>
<td>2.45**</td>
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<td>simple</td>
<td>3.70</td>
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<tr>
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* p < .05

** p < .01
CHAPTER IV

DISCUSSION

The null hypothesis which stated there would be no significant difference between the achievement gains of subjects who are taught the same concepts using two sets of visuals which differ in detail, complexity, accuracy of scale, and use of background was supported in two separate experiments.

The same treatment was administered to two distinctly different target audiences. The Army Reserve group was used to approximate the constituency of the groups used in the Borg (1977) study. The FTU group was included to collect supplementary data, particularly regarding opinions toward the artwork.

Two additional dependent measures were employed in the Army Reserve experiment. The simple "yes" or "no" question asked the subjects their perceptions of whether the visuals were sufficient to support the lesson while the 10-point attitude scale asked the subjects to rate the quality of the artwork regardless of whether it supported the lesson or not. Interestingly, both the simple and the complex groups thought the visuals were sufficient to teach the lesson, although the attitude scale results revealed a significant difference in opinion of the overall appearance of the artwork. In other words, both groups agreed they could learn from the simple artwork even if they did not like it as
well as the complex artwork.

In the FTU experiment, only two of the six additional dependent measures reached levels of significant difference. These two were the subjects' perceptions of whether the artwork was sophisticated and whether it was adequate to teach the lesson. The results of the question of adequacy were similar to those received from the Army Reserve. Even though the FTU subjects achieved approximately the same measure of immediate retention on the treatments, they differed significantly in their perceptions pertaining to quality or adequacy of the visuals. Regarding these findings, one must consider Bullough's (1974) statement concerning the subject's innate sensitivity to appealing displays even though this research may indicate that appeal is not absolutely necessary. In support of this, Dwyer (1972) states that the type of visuals that subjects themselves perceive as being most effective are not always the ones found to be most effective in facilitating achievement.

This is certainly an area which requires further investigation. Recall that Ball (1960) stated the source cannot expect to be successful in communication if the receiver is not paying attention to the message.

Although there was no significant difference between the simple and complex groups concerning their opinions on complexity, appeal, effectiveness and interest, it must be pointed out that both FTU groups rated these items in the lower to neutral categories. This means that the FTU groups found neither the simple nor the complex TEC lessons very captivating. Since the
lesson was originally designed and intended for the use of U. S. Army Armor Crewmen, this result is not surprising. This lesson was number three in a five-part series and probably contains little interest value for anyone except a professional soldier whose job is to drive and maintain a tank. In sum, the comprehension data suggest that when the student has low to moderate interest in learning the material, the complex artwork does not significantly improve learning. It seems unlikely that the results would be different with soldiers who are assigned to Armor, and are highly motivated to learn the material regardless of the level of art embellishment.

It must be pointed out that the simple visuals created by the author were very loosely drawn; almost to the point of being extremely crude. It is not expected that the Government, nor any other institution, would opt to use artwork drawn to this extreme. However, if the simple artwork were more tightly rendered by a professional artist, it is expected that there would be even less significant difference in teaching effectiveness and learner achievement between the simple and complex artwork.

In the comparison of Army Reserve and FTU comprehension means shown in Table 3, the two simple treatments reflect a t value of 1.83 which results in a significant difference of \( p < .025 \). This finding may be explained by the assumption that college students have attained more of a learned sensitivity to abstract forms and representations than have enlisted Army Reserve soldiers. There is also the fact that college students have more "practice" at attentiveness since they spend a greater percentage of their time in an aca-
ademic or learning environment. College students may also be able to use the audio stimulus to a greater advantage than Army Reserve soldiers because of the academic environment. This would assist the students in interpreting the associated visual cues of the lesser defined art. There was no significant difference in comprehension between the Army and FTU students who received the complex treatment. In the complex treatment, there were no abstract forms to contend with. The art was very graphic and realistic and left little doubt as to how it should have been interpreted.

The fact that the Army sample rated the complex artwork higher in quality than the simple artwork was not surprising. It is likely that the complex art earned a higher rating because it appears more professional and more symmetrically pleasing to the viewer's eye. This also explains the differences obtained from the FTU subjects' opinions regarding the questions of sophistication ($p < .01$) and adequacy ($p < .05$). Here, the complex art was rated significantly higher than the simple art. Neither of these results were surprising for these two questions closely approximated the question of quality discussed in the Army Reserve study. The lack of significant difference regarding four of the six opinion factors in the FTU data is consistent with the null findings in the comprehension data.

An implication of the study was that such a finding could considerably reduce the costs of producing audio-visual materials. As will be explained, the cost savings found in this study were quite dramatic.

The original complex artwork for the TEC lesson used in this experiment
cost the Government $6,661. The simplified version of the same lesson used by Borg (1977) cost $3,949. This appears to represent a 40 per-cent savings.

It must be explained, however, that before a lesson gets to the stage of development where it actually goes into the artwork process, there must be a considerable amount of "front-end" analysis in order for the artist to plan what to draw. Front-end analysis consists of reviewing and analyzing Government-furnished material to determine if it is sufficient to work from. Government-furnished material is all available information in the form of training manuals, field manuals, photographs, films, pieces of equipment and subject matter experts' notes on the particular subject. Front-end analysis continues after it has been ascertained that all information is available to begin development of a lesson. From this information, a writer must design a lesson strategy which includes developing the tasks to be learned, preparing the lesson design approach, preparing pre- and post-tests and, in short, envisioning everything that will go into the lesson in the form of written, audible and visual cues to insure teaching effectiveness. Only after all this has been accomplished does the artist actually start to draw. The cost for the front-end analysis of the TEC lesson used in this study was approximately $2,000. This means the actual cost of the art used in the original complex lesson was around $4,661. The Borg (1977) artwork cost $1,949 over the cost of the front-end work. This is a savings of $2,712 from the original complex artwork.

The entire set of simple art frames created by the author cost approximately ten dollars. As this research has shown, the lesson taught approx-
imately as well as the original $6,661 complex version. Adding the $2,000 front-end analysis cost, one still realizes a savings of $4,651 over the original lesson and $1,939 over the Borg simplified version.

Concerning the question of time, it took the artists who constructed the original lesson approximately three to four months to create the artwork. Borg's version took about two months to create, but the artists were working from already prepared material. His artists did not actually have to conjure up a drawing. They merely reduced the complexity of actual frames of art by removing details from the integral scenes.

It took the author four hours to construct the simple lesson used in this study. However, the author was also working from the previously prepared material. Using personal experience in this field as a guide, the author estimates that a lesson could be produced in a minimum of from two to three weeks as compared to the current three to four months. In view of the potential for major cost savings, at little or no decrease in the teaching effectiveness of the lessons, it is important that TEC program officials consider relevant research findings when planning for audio-visual instructional materials and training aids.

In any experiment, it is possible to identify potential threats to the validity of the findings. For example, the evidence presented here is probably not generalizable to all TEC subject matter that may be taught. For example, in certain mechanical procedures, it is necessary that one knows exactly what the parts and pieces of equipment look like. One must know widths, thick-
nesses, diameters, etc. in order to determine ratios, proportions and other sensitive measures. As Dwyer (1972) points out, the effectiveness of visuals relative to student achievement is dependent upon the type of visualization, mode of presentation, learning objectives, target audience and attention-focusing techniques. If any of these variables are altered, new tests would be required in order to generalize to that target audience's population. Future experiments are needed to investigate the main and interaction effects of such factors. In addition, further research on the relationship between lesson complexity, artwork complexity, and comprehension would be beneficial to the TEC program.

The current findings suggest, however, that educators, especially those in the U.S. Army TEC program, would be well-advised to consider this and other related research when planning, designing, purchasing and using audio-visual instructional materials and training aids.

SUMMARY

This study was designed to test the null hypothesis that there would be no significant difference in the achievement of subjects who are taught the same concepts using two sets of visuals which differ in detail, complexity, accuracy of scale and use of background. A 20-item comprehension test produced non-significant differences between the simple and complex artwork treatments within both the Army Reserve and FTU samples. Subjects in both target audiences achieved approximately the same comprehension level even though they perceived the complex art to be significantly more adequate to teach.
The major implication of this study is the possibility for dramatic savings in costs as well as time contributed to the development process of TEC lessons without a corresponding drop in teaching effectiveness. It was recommended that educators consider this and other related research when planning, designing, purchasing and using audio-visual instructional materials and training aids.
APPENDIX A

EXAMPLES OF SIMPLE AND COMPLEX ART
Example of Simple Art used in this study.
Example of Complex Art as defined by the U.S. Army TEC Program.
APPENDIX B

INSTRUMENTATION
1. Which of the following statements is correct?
   ___ a. Machineguns and main guns have the same target aiming point.
   ___ b. Machinegun target aiming point is lower than the main gun aiming point.
   ___ c. Machinegun target aiming point is higher than the main gun aiming point.
   ___ d. There is no relationship between the two targets.

2. Identify what must be done before you can remove the receiver assembly by checking the appropriate letters.
   ___ a. Barrel extension assembly in forward position.
   ___ b. Unsnap cover shield.
   ___ c. Remove super elevation from computer.
   ___ d. Loosen gun mount collar.
   ___ e. Remove left disconnector ring.
   ___ f. Remove barrel assembly.
   ___ g. Disconnect electrical lead wire.
   ___ h. Pull right disconnector ring to the rear.

3. The collar of the gun mount cover shield contains setscrews in the:
   ___ a. M60A1 tank.
   ___ b. M48 tank.
   ___ c. M60 tank.
   ___ d. M48A1 tank.
   ___ e. All of the above.
4. What must be done to the setscrews in the collar of the gun mount cover shield for boresighting purposes?
   a. Remove from the collar until after gun is boresighted, then replace them.
   b. Loosened after gun is boresighted.
   c. Loosened three complete turns prior to boresighting.
   d. Loosened one and a half turns prior to boresighting.

5. If the boresight cross has already been removed from the main gun tube, what else can be done to align the main gun?
   a. Adjust using elevation and deflection knobs.
   b. Use gunner's periscope and align daylight reticle on aiming point.
   c. Adjust slip scales to the reading they were first set on.
   d. None of the above.

6. Binoculars are used in boresighting the machinegun because:
   a. It is necessary to make the targets look bigger to find right angles for aiming.
   b. We need to insure that all sightings have the same perspective.
   c. Long range targets need to be identified.
   d. They allow for more accuracy in boresighting.
7. A boresighting cross is not used on the coax machinegun because:
   ____a. Machineguns aren't made to be that accurate.
   ____b. You can't see through the bore.
   ____c. The barrel is too small to use one accurately.
   ____d. It could damage the gun by blocking in gases.

8. Why are the bracket assembly mounting screws loosened?
   ____a. To make vertical adjustments to the gun.
   ____b. To make horizontal adjustments to the gun.
   ____c. To make both vertical and horizontal adjustments to the gun.
   ____d. None of the above.

9. Where is the infinity sight body located?
   ____a. Right of the main gun tube.
   ____b. Between bracket assembly mounting screws.
   ____c. In back of the gunner's periscope.
   ____d. Right of the receiver assembly.

10. What is the unity power window used for?
    ____a. To align machinegun on right angle targets.
    ____b. To fire at "area targets" like troops.
    ____c. To sight moving vehicles.
    ____d. To check and see that main gun and machineguns are on the same target.
11. How is the infinity sight reticle aligned?
   ___a. Using elevation and deflection knobs.
   ___b. By setting the slip scales.
   ___c. By adjusting the horizontal and vertical setscrews.
   ___d. None of the above.

12. After boresighting, what must be done to the setscrews in the collar of the gun mount cover shield?
   ___a. Tightened until they touch the flash suppressor.
   ___b. Backed off two full turns from the flash suppressor body.
   ___c. Backed off one turn from the flash suppressor body.
   ___d. Backed off 1/4 to 1/2 turn from the flash suppressor body.

13. The primary objective in the process for boresighting the M-85 machinegun is: ______________________________________________
   ______________________________________________
   ______________________________________________

14. In order to expose the M-85 gun parts which are to be removed during boresighting, three items must be opened. What are the items?
   ___b. Bolt assembly.
   ___c. Bolt buffer group.
   ___d. Cradle doors.
   ___e. Machinegun cover assembly.
   ___f. Ammunition belt removed.
   ___g. Access doors.
15. Which of the following statements correctly describes the position of the "Fire/Safety" switch when boresighting the M-85 machinegun?

a. The switch is in the "Safe" position for all boresighting procedures.

b. The switch is in the "Fire" position for all boresighting procedures.

c. The switch is in the "Safe" position when moving the bolt assembly to the forward position and in "Fire" position during other boresighting procedures.

d. The switch is in "Fire" position to move bolt assembly forward and in "Safe" position for other boresighting procedures.

16. Prior to boresighting the M-85 machinegun, why must the ammunition belt be removed?

a. To prevent possible misfiring of the gun.

b. To clear the cover assembly.

c. To see through the bore of the gun.

d. To allow access to the bolt assembly.

e. All of the above.

17. In order to move the M-85 bolt assembly to the full forward position, what five main steps must be taken?

a. ________________________________

b. ________________________________

c. ________________________________

d. ________________________________

e. ________________________________
18. Number in order of removal the four parts which must be removed before you can see through the barrel of the M-85 machinegun.

   ___ a. Back plate assembly.
   ___ b. Hand charger assembly.
   ___ c. Sear assembly.
   ___ d. Bolt assembly.
   ___ e. Receiver assembly.
   ___ f. Bolt buffer group.
   ___ g. Ammunition belt.
   ___ h. Solenoid lead connector assembly.

19. In order to remove the driving spring guide rod from the bolt buffer group, what must be done?

   ___ a. Turn guide rod 1/4 turn counter-clockwise (left) and push forward.
   ___ b. Turn guide rod 1/8 turn counter-clockwise (left) and pull back.
   ___ c. Turn guide rod 1/8 turn clockwise (right) and push forward.
   ___ d. Turn guide rod 1/4 turn clockwise (right) and pull back.

20. What should be the position of the "Fire/Safety" switch when removing the sear assembly from the M-85?

   ___ a. Switch must be in "Safe" position for all boresighting procedures.
   ___ b. Switch must be in "Fire" position for all boresighting procedures.
   ___ c. Switch must be in "Fire" position during removal and "Safe" after removal.
   ___ d. Switch must be in "Safe" position during removal and "Fire" after removal.
Opinion Survey

1. Did you think the visuals were sufficient to support this lesson?
   yes_________    no_________

2. On the scale from one to ten, indicate your perception of the quality of artwork used in this lesson.
   1  2  3  4  5  6  7  8  9  10
   lousy   fair   excellent
Semantic Differential Scales

Opinion Survey

Please rate the following scales according to your opinion in each area.

Example:

- Good: extremely, moderately, slightly, neutral, slightly, moderately, extremely
- Bad: extremely, moderately, slightly, neutral, slightly, moderately, extremely

1. In my opinion, the artwork in this lesson was:

Sophisticated: ________ Unsophisticated

Complex: ________ Simple

Adequate: ________ Inadequate

Appealing: ________ Unappealing

2. In terms of focusing my attention on the subject matter, the artwork was:

Effective: ________ Ineffective

3. In my opinion, the lesson was:

Interesting: ________ Uninteresting
REFERENCES


