INFLUENCE ON STUDENT ACHIEVEMENT OF REDUNDANCY IN SELF-INSTRUCTIONAL MATERIALS

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Foreword

This research represents a portion of the exploratory development program of the Technical Training Branch, Training Research Division of the Behavioral Sciences Laboratory. The research is documented under Project 1710, "Human Factors in the Design of Training Systems." Task 17107, "Automated Training and Programmed Instruction." Dr. Gordon A. Eckstrand was the Project Scientist. Dr. James J. Morgan was Task Scientist. The research was initiated in August 1967 and was completed in February 1968.

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This technical report has been reviewed and is approved.

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Commander
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Abstract

Five versions of an instructional program on medical terminology were experimentally evaluated to determine the effect of redundancy or repetition on learning. The subjects (N = 440) were assigned to five groups (N = 88 for each group). A different instructional mode was administered to the subjects in each group as follows:

Group 1 - 274-frame linear program
Group II - 100-frame linear program
Group III - 88-frame linear program
Group IV - Narrative, typographically cued, text
Group V - 4 by 6-inch summary card

The modes contained identical terminal behaviors and a 79-item multiple-choice test, which exhausted the population of behaviors, served as the achievement criterion. All groups studied the materials for an equal amount of time (3 hours). Groups I and II did not differ in achievement. Groups III, IV, and V also did not differ in achievement. Groups III, IV, and V all were significantly superior in achievement to Groups I and II. Therefore, for certain learning outcomes, i.e., terminology and procedure following, programmed practice and review may detract from the effectiveness of self-instructional program.
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SECTION 1.

Introduction

The purpose of this study was to investigate the effect of redundancy on the learning from self-instructional materials. Redundancy, as considered in this paper, refers to the use of mere words, instructional frames, or support materials that are necessary to teach desired behaviors. Five instructional modes differing in degree of internal redundancy were compared in the experiment.

Many programmed texts are used to teach blocks of instruction in Air Force training programs. End-of-course critiques of these programs have indicated that some students resent the boring and "spoon feeding" aspects of small-step constructed response programs. They are especially critical of programmed materials that are not compatible with the students' threshold knowledge of the subject matter.

Of course, multiple tracks are used in linear and intrinsic programs in an effort to provide for individual differences among students. However, there is some evidence that the use of multitracks does not increase learning efficiency. Glaser et al. (1964) conducted two experiments to evaluate multitracking in a linear program. Although branching seems to be a logical way to provide for individual differences, the authors found no significant differences in learning efficiency between regular linear programs and multitrack programs.

In another study, by Senter et al. (1965), records were kept of the number of "wrong answer" branches taken by 65 subjects receiving branched programmed instruction. Of the total possible "wrong" branches, only about 6% were taken by the subjects. The authors suggested that intrinsic programs may be wasteful since much of the material is never studied.

There seems to be a tendency to increase the number of small-step frames in linear programmed instruction for students of low reading ability. However, it is doubtful that the addition of more frames will result in greater learning efficiency. Instead, the programmer should give more attention to the readability of the programmed text. As Hershberger (1963) indicated, it appears to be both unnecessary and uneconomical to use the low-error rate linear programming technique just to insure readability. A better estimate of the difficulty level of programmed materials can be obtained by the use of readability formulas (Flesch, 1948; Chall, 1958; Kincaid, et al., 1967; Smith and Senter, 1967).

Studies by Hershberger (1963) and Hershberger and Terry (1965) present evidence that terse self-testing programmed instructional materials have a facilitative effect on learning. Thus, for some desired instructional outcomes, learning through the use of redundant programs may be less efficient than terse programs which provide self-test events.

It is economically sound to develop a redundant ("fat") program if a "lean" one will suffice. An effort should be made, in the early stages of program development, to determine the number of teaching frames or operational span required to enable students of the target population to attain the desired terminal behaviors. If the instructional materials are initially programmed lean, the steps that are too large should be easily identified during the initial and group testing phases. If, however, a fat program is developed initially, the redundant material may not be noticed by the subjects of the target population nor by the programmer during the testing of the materials.
Concerning the economics of lean programming, Rummler (1985) cautioned:

"However, as I mentioned earlier, there is a problem with maintaining lean programming behavior. Often a manager will not accept a lean, well-designed pamphlet as a program. "Where are the small steps?" Likewise, there are the trainers who buy one program over another because it has more frames. Just remember you are buying a change in behavior, not frames."

SECTION II.
Problem

The problem was to compare student achievement on five programmed instructional modes to determine if a reduction in programmed redundancy would adversely affect learning of desired terminal behaviors. It was hypothesized that learning which involves terminology, nomenclature, or procedure following is not facilitated by redundant verbal or other support materials.

SECTION III.
Method

INSTRUCTIONAL MATERIAL: The prefixes, roots, and suffixes of medical terminology considered to be useful in all airman medical specialties, are taught by programmed instructions in the Medical Service School (MSS) at Sheppard Air Force Base, Texas. The students take the programmed medical terminology test in the Medical Helper Course, AQB0010. The class time allotted for completion of the program is three hours. All airmen selected for the medical services career field attend the Medical Helper Course. Upon graduation from this course, they are either enrolled in a specialized course, or they are sent to the field as Directed Duty Assignees (DDAs) where they are given on-the-job training in a given medical services specialty.

For comparison purposes in this experiment four additional modes of instruction in descending order of redundancy were prepared and each contained the same terminal behaviors, as the programmed text used in the regular course of instruction. In the experiment, the five instructional modes were evaluated in terms of achievement on a test designed to measure achievement of the instructional objectives. The Medical Service School (MSS) modes of instruction were identified as follows:

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a. **MSS-1**: A linear programmed test, consisting of 274 instructional frames. The program is used to teach the regular medical terminology block of instruction in the Medical Helper Course. A sample of the program is contained in Appendix I.

b. **MSS-2**: An experimental linear programmed test similar to MSS-1, except that the number of instructional frames are reduced to 160. The reduction in frames was accomplished by eliminating from MSS-1 any review 10 or more frames from the introduction of a term. A sample of the program is contained in Appendix II.

c. **MSS-3**: An experimental programmed test similar to MSS-1 and MSS-2 except that the instructional frames are further reduced to 83. With the exception of 3 introductory frames, each criterion item is the subject of only one instructional frame. Redundancy in this program was figuratively "cut to the bone."

d. **MSS-4**: An experimental tense narrative test using a typographically cued response mode (underlined important words). A sample of the narrative test is contained in Appendix III.

e. **MSS-5**: All regular course medical terminology information is presented on a 4 by 6-inch summary card. Both sides of the card are used for this purpose. A sample card is shown in Appendix IV.

**SUBJECTS.** The subjects (N = 440) were airmen (E-4) enrolled in the Medical Helper Course, Medical Service School, Sheppard Air Force Base, Texas. They were recent graduates of the Basic Military Training Program, Lackland Air Force Base, Texas and their average age was 19. They were assigned to five groups as shown below:

<table>
<thead>
<tr>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
<th>Group IV</th>
<th>Group V</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSS-1</td>
<td>MSS-2</td>
<td>MSS-3</td>
<td>MSS-4</td>
<td>MSS-5</td>
</tr>
<tr>
<td>N = 88</td>
<td>N = 88</td>
<td>N = 88</td>
<td>N = 88</td>
<td>N = 88</td>
</tr>
</tbody>
</table>

The groups were equated to the lowest N (88) by random selection.

The subjects were not matched prior to assignment to the various groups. However, an analysis of variance was made to determine if any significant differences existed among the groups as measured by the Otis Self-Administering Tests of Mental Ability (Higher Examination). The time limit used for the test was 90 minutes.
SECTION IV. Procedure

A 79-item multiple-choice (4 alternative) master validation examination designed to measure achievement of each expected terminal behavior of the medical terminology block of instruction served as the criterion test for all five instructional modes. The average time required to complete the test was one hour. Since the class schedules for the medical terminology block of instruction was based upon the average completion times which did not include a total two hours for pre- and post-testing, it was decided only to measure achievement by the post-test. However, an estimate of the familiarity of the subjects with the content of the block of instruction was obtained by administering the criterion test to 113 comparable subjects prior to their exposure to the instructional material. The obtained mean of 20 indicates little, if any, familiarity with the content of the subject matter.

The various modes of instruction were administered by the course instructors during the scheduled class period. Group I, Group II, and Group III subjects were instructed to make overt responses to the program stimuli and to complete the self-test at the end of the test. Group IV subjects were instructed to read the textural material and to pay particular attention to the underlined information. They were also instructed to complete the self-test at the end of the test. Group V subjects were issued the 4 by 6-inch cards and they were informed that the cards contained all of the information needed to successfully complete the block of instruction. They were instructed to study the information presented on both sides of the cards and to complete the separate self-test when they were sure they had mastered the information.

The self-test contained all the medical terminology studied by the students. A matching format was used in which the student matched the medical terminology in Column A with the lay terminology in Column B. A sample of the self-test is shown in Appendix V. All subjects taking the five instructional modes were permitted to review the material if desired.
SECTION V. Results and Discussion

RESULTS. Bartlett’s test for homogeneity of the treatment \((k)\) variances was made to determine if the separate variance estimates of the treatment \((k)\) samples were all estimates of the same population variance. The test results, as shown in Table I, indicated that the five treatment variances were homogeneous.

![Table I](https://example.com/table1.png)

Table I: Bartlett's Test of Homogeneity of Variance for \((k)\) Variances With Equal Degrees of Freedom

<table>
<thead>
<tr>
<th>Treatment</th>
<th>d.f.</th>
<th>(s_k)</th>
<th>(s_k)</th>
<th>log (s_k)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>87</td>
<td>8790.44</td>
<td>101.04</td>
<td>2.00448</td>
</tr>
<tr>
<td>2</td>
<td>87</td>
<td>9842.99</td>
<td>113.14</td>
<td>2.05361</td>
</tr>
<tr>
<td>3</td>
<td>87</td>
<td>8417.72</td>
<td>96.75</td>
<td>1.98565</td>
</tr>
<tr>
<td>4</td>
<td>87</td>
<td>6363.62</td>
<td>72.45</td>
<td>1.90004</td>
</tr>
<tr>
<td>5</td>
<td>87</td>
<td>8057.44</td>
<td>92.61</td>
<td>1.99666</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>475.99</td>
</tr>
</tbody>
</table>

\[X^2 = 4.516^*\]

*Not significant

An analysis of variance, as shown in Table II, yielded no significant differences among the groups as measured by the Otis Self-Administering Tests for Mental Ability (higher examination). Therefore, the five groups were considered to be homogeneous.

![Table II](https://example.com/table2.png)

Table II: Analysis of Variance for the Otis Self-Administering Tests of Mental Ability (Higher Examination)

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>S&lt;sup&gt;2&lt;/sup&gt;</th>
<th>df</th>
<th>MS</th>
<th>(F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>622.9</td>
<td>4</td>
<td>155.71</td>
<td>1.61*</td>
</tr>
<tr>
<td>Within</td>
<td>41412.2</td>
<td>435</td>
<td>95.21</td>
<td></td>
</tr>
</tbody>
</table>

*Not significant

The Otis scores and the criterion scores were correlated for the five groups. The results are shown in Table III.
TABLE III
CORRELATIONS OF OTIS SCORES vs. CRITERION SCORES

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Otis Mean</th>
<th>Otis SD</th>
<th>Criterion Mean</th>
<th>Criterion SD</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>88</td>
<td>109.1</td>
<td>10.1</td>
<td>67.5</td>
<td>8.4</td>
<td>.44</td>
</tr>
<tr>
<td>Group II</td>
<td>88</td>
<td>109.0</td>
<td>10.0</td>
<td>67.9</td>
<td>10.0</td>
<td>.44</td>
</tr>
<tr>
<td>Group III</td>
<td>88</td>
<td>110.2</td>
<td>9.8</td>
<td>71.9</td>
<td>6.4</td>
<td>.38</td>
</tr>
<tr>
<td>Group IV</td>
<td>88</td>
<td>109.8</td>
<td>8.5</td>
<td>71.7</td>
<td>5.4</td>
<td>.37</td>
</tr>
<tr>
<td>Group V</td>
<td>88</td>
<td>112.4</td>
<td>9.6</td>
<td>70.4</td>
<td>8.0</td>
<td>.42</td>
</tr>
</tbody>
</table>

The relatively low correlations obtained may raise doubt as to the appropriateness of using the Otis as an indicator of success for the treatments in this experiment. The forecasting efficiency of the highest correlation coefficient (.44) is 10 per cent while the lowest (.27) is only about 4 per cent. However, for the purpose of this study, the Otis probably was as effective as any other general predictor of student achievement.

As described previously, class scheduling preceded the administration of a pre-test. However, the mean score (109.85) obtained on the Otis test for the sample 113 subjects who took the pre-test compared favorably with the subjects in the five treatments.

An analysis of variance for the five treatments was accomplished. The results are shown in Table IV.

TABLE IV
ANALYSIS OF VARIANCE FOR FIVE TREATMENTS

<table>
<thead>
<tr>
<th>Sources of Variance</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>1490.62</td>
<td>4</td>
<td>373.405</td>
<td>5.942*</td>
</tr>
<tr>
<td>Within</td>
<td>27332.70</td>
<td>435</td>
<td>62.833</td>
<td></td>
</tr>
</tbody>
</table>

*Significant at the .005 level

Since the analysis of variance for the five treatments showed a significant difference, t tests were made to determine which treatments were significantly different. The results are shown in Table V.
### TABLE V.
RESULTS OF t TESTS FOR FIVE MEDICAL TERMINOLOGY INSTRUCTIONAL MODES

<table>
<thead>
<tr>
<th>Group I vs:</th>
<th>t</th>
<th>Level of Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group II</td>
<td>1.29</td>
<td>Not significant</td>
</tr>
<tr>
<td>Group III</td>
<td>3.63</td>
<td>.005</td>
</tr>
<tr>
<td>Group IV</td>
<td>3.47</td>
<td>.005</td>
</tr>
<tr>
<td>Group V</td>
<td>2.39</td>
<td>.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group II vs:</th>
<th>t</th>
<th>Level of Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group III</td>
<td>3.34</td>
<td>.005</td>
</tr>
<tr>
<td>Group IV</td>
<td>3.18</td>
<td>.005</td>
</tr>
<tr>
<td>Group V</td>
<td>2.10</td>
<td>.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group III vs:</th>
<th>t</th>
<th>Level of Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group IV</td>
<td>.16</td>
<td>Not significant</td>
</tr>
<tr>
<td>Group V</td>
<td>1.24</td>
<td>Not significant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group IV vs:</th>
<th>t</th>
<th>Level of Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group V</td>
<td>1.07</td>
<td>Not significant</td>
</tr>
</tbody>
</table>

**KEY**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>( \bar{X} )</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>67.5</td>
<td>8.4</td>
</tr>
<tr>
<td>Group II</td>
<td>67.9</td>
<td>10.5</td>
</tr>
<tr>
<td>Group III</td>
<td>71.9</td>
<td>6.4</td>
</tr>
<tr>
<td>Group IV</td>
<td>71.7</td>
<td>5.4</td>
</tr>
<tr>
<td>Group V</td>
<td>70.4</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Groups I and II did not differ in achievement. Groups III, IV, and V, also did not differ in achievement. Groups III, IV, and V were significantly superior in achievement to Groups I and II.

**DISCUSSION.** Eliminating the usual redundancy in a linear instructional program significantly increased students' achievement. Equivalent achievement was achieved by students using (1) a minimally redundant linear program, (2) a brief narrative coverage of the same information, and (3) a study card which presented all essential behaviors. The desired terminal behaviors were the same for each instructional mode in the experiment. For some instructional goals, programmed practice or review may detract from the effectiveness of a self-instructural program. Lean programs are, therefore, more economical and efficient than programs which contain redundant verbal or other unnecessary support materials.
APPENDIX 1.

MSS-1 Program Sample

143. (b, c) Myo is the medical term for muscle. Myocardium is a/an
- a. arm muscle
- b. neck muscle
- c. heart muscle
- d. head muscle

144. (c) A cell of the muscular tissue is called
- a. myo-cardium
- b. myocyte

145. (b) Ren and neph are both mean kidney. Neph is used most often. Which of the words below pertain to the kidney or heart?
- a. nephro-cardin
- b. renocardiac
- c. both
- d. neither

146. (both) The most common form for kidney is
- a. ren
- b. neph

147. (b) Intrarenal means
- a. within the kidney
- b. inside the kidney
- c. upon the kidney

148. (a-b) Around the kidney is
- a. perin-blastal
- b. pericostal
- c. perirenal
- d. pericardial

149. (c) Endo-nephritis, renal, intrarenal, perirenal, nephrectomy.
Looking at the words above, select the correct statement or statements that tell how and when ren and nephro are used.
- a. Ren is always used as a word ending.
- b. Neph is always used as a word beginning.
- c. Ren is never used as a word beginning.
- d. Neph is never used as a word ending.
- e. Ren is usually used as a word ending with the suffix al.

150. (d, e) Oste is the medical term for bone. Removing a bone is accomplished through a/an
- a. cardiectomy
- b. pneumonectomy
- c. nephrectomy
- d. osteotomy

151. (d) Ostealgia would be a
- a. headache
- b. pain in the arm
- c. pain in the bone
- d. pain in the neck

152. (c) Osteopathy is a
- a. disease of the skin
- b. disease of the arm
- c. disease of the bone

153. (c) Nerv is the medical term for nerve. A neurocyte would be a
- a. muscle cell
- b. blood cell
- c. clotting cell
- d. nerve cell
154. (d) Within a nerve is
a. aseveral
b. acneural
c. endoneural
d. epineural

155. (c) Subepineural means
a. around an arm
b. upon a nerve
c. upon an arm
d. under a nerve

156. (d) Thrombosis is the medical term for clot. A thrombocyte is a blood platelet or
a. red cell
b. white cell
c. clotting cell
da. thrombocyte

157. (c) A blood clot within the hear is
a. thrombo-endarteritis
b. thrombocytopenia
c. thrombo-embolism
d. thrombo-endocaritis

158. (d) Producing a clot is
a. thrombogenic
b. thrombocyte

159. (a) You have learned many words. To help you retain this knowledge, the next four frames consist of a review. Column A contains medical terminology and Column B contains lay terminology. Match the medical term with the correct lay term.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. extension</td>
<td>a. a study of the functions of the body</td>
</tr>
<tr>
<td>2. anatomy</td>
<td>b. an imaginary plane which divides the</td>
</tr>
<tr>
<td>3. general</td>
<td>c. body into equal right and left halves</td>
</tr>
<tr>
<td>4. normal</td>
<td>d. an imaginary plane which divides the</td>
</tr>
<tr>
<td>5. gut-sagittal</td>
<td>e. body into a front and back section</td>
</tr>
<tr>
<td>6. transverse</td>
<td>f. a study of the structures of the body</td>
</tr>
<tr>
<td>7. coronal</td>
<td>g. movement toward the mid-line</td>
</tr>
<tr>
<td>8. abduction</td>
<td>h. the position of attention with the palms</td>
</tr>
<tr>
<td>9. adduction</td>
<td>i. facing forward</td>
</tr>
<tr>
<td>10. flexion</td>
<td>j. the shortening of an angle</td>
</tr>
</tbody>
</table>

160. (1-6, 2, 3-a, 4-b, 5-b, 6-j, 7-e, 8-g, 9-e, 10-i) Continue as in the preceding frame.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. medial</td>
<td>a. above the transverse plane</td>
</tr>
<tr>
<td>2. lateral</td>
<td>b. in front of the coronal plane</td>
</tr>
<tr>
<td>3. superior</td>
<td>c. closest to the point of origin</td>
</tr>
<tr>
<td>4. inferior</td>
<td>d. pertaining to or affecting the right side</td>
</tr>
<tr>
<td>5. anterior</td>
<td>e. pertaining to or affecting both sides</td>
</tr>
<tr>
<td>6. posterior</td>
<td>f. nearest to the mid-line</td>
</tr>
<tr>
<td>7. proximal</td>
<td>g. farthest from the point of origin</td>
</tr>
<tr>
<td>8. distal</td>
<td>h. below the transverse plane</td>
</tr>
<tr>
<td>9. unilateral</td>
<td>i. in back of the coronal plane</td>
</tr>
<tr>
<td>10. bilateral</td>
<td>j. farthest from the mid-line</td>
</tr>
</tbody>
</table>
181. (1-f, 2-j, 3-a, 4-b, 5-h, 6-d, 7-c, 8-g, 9-d, 10-e) Continue as in the preceding frame.
1. a. arachnial________
   b. axillary _________
2. a. aeryothocyte ______
   b. adrenal __________
3. a. epicalcal_________
   b. aeryothocyte ______
4. a. erythrocyte ________
   b. aeryothocyte ______
5. a. interrenal________
   b. erythrocyte ________
6. a. leukocyte__________
   b. erythrocyte ________
7. a. intracardiac________
   b. leukocyte__________
8. a. periauricular_______
   b. leukocyte__________
9. a. retrocardiac_______
   b. leukocyte__________
10. a. leukocyte__________
    b. leukocyte__________

182. (1-a, 2-f, 3-g, 4-a, 5-b, 6-j, 7-d, 8-c, 9-e, 10-b) Continue as in the preceding frame.
1. a. endocardial________
   b. bilateral__________
2. a. biocalcal__________
   b. hematology________
3. a. hematologic_______
   b. hyperleukocytosis____
4. a. hematology________
   b. hyperleukocytosis____
5. a. hyperleukocytosis____
   b. leukocytosis________
6. a. leukocytosis________
   b. subcostal__________
7. a. pneumocardial_____
   b. pneumocardial_____
8. a. pneumocaroidal____
   b. pneumocaroidal____
9. a. neocytosis________
   b. thrombocyte________
10. a. thrombocyte________
    b. thrombocyte________

183. (1-e, 2-j, 3-a, 4-i, 5-h, 6-g, 7-c, 8-d, 9-f, 10-h) Hepat is a root meaning liver. A patient with an inflamed liver would have
a. neuritis
b. hepatitis
c. carditis
d. nephritis

184. (a) Any disease of the liver would be
a. hepatopathy
b. osteopathy

185. (a) A removal of a portion of the liver would require:
a. hepatopathy
b. cardectomy
c. hemanectomy

10

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APPENDIX II.
MSS-2 Program Sample

42. (b, c) Myo is the medical term for muscle. Myocardium is a/an
   a. arm muscle           c. neck muscle
   b. heart muscle         d. head muscle

43. (b) Ren and Neph both mean kidney. Neph is used most often. Endosaphritis, renal,
   intrarenal, perirenal, nephrectomy.
   Looking at the words above, select the correct statement or statements that tell how
   and when ren and nephre are used.
   a. Ren is always used as a word ending.
   b. Neph is always used as a word beginning.
   c. Ren is never used as a word beginning.
   d. Neph is never used as a word ending.
   e. Ren is usually used as a word ending.

44. (d, e) Oste is the medical term for bone. Removing a bone is accomplished through a/an
   a. cardiectomy           c. pneumonectomy
   b. nephrectomy           d. osteotomy

45. (d) Neur is the medical term for nerve. Ben Casey is a neurosurgeon; this means he oper-
   ates on
   a. the arm               c. the kidneys
   b. the heart             d. the nerves

46. (d) Thrombo is the medical term for clot. A thrombocyte is a blood platelet or
   a. red cell              c. white cell
   b. clotting cell

47. (b) Hepat is a root meaning liver. A patient with an inflamed liver would have
   a. neuritis               c. hepatitis
   b. carditis               d. nephritis
   (c) By adding the correct root word, make each medical term below mean what the lay term
        indicates.

48. (white blood cell) leuko___________
    (leukocyte)

49. (heart muscle) _______________cardium
    (myocardium)

50. (around the kidney) peri_____________
    (perirenal)

51. (disease of the bone) ______________pathy
    (osteoarthritis)

52. (under a nerve) sub______________
    (subneural)
33. (clustering cell) ____________cyte
   (thrombocyte)
34. (inflamed liver) ____________itis
   (hepatitis)

35. Cephal means head. Medically speaking, if you had a headache you would have
   a. neuralgia
   b. cephalalgia
   c. cardalgia
   d. myalgia

36. (b) Chondri is a root meaning cartilage. Under the cartilage is
   a. hypochondrium
   b. intrachondrial
   c. hypocondroplasia
   d. subchondral

37. (a) The root for stomach is gast. An inflammation of the stomach is
   a. nephritis
   b. cephalitis
   c. gastritis
   d. nevritis

38. (c) Arter means artery. Arteriorenal would be an ____________of the ____________. 
   (artery—kidney)
APPENDIX III.

MSS-4 Narrative Review Sample

Unit IV

Neuro means nerve. Neurology is the study of the nervous system; neuralgia is a pain in a nerve; a neuritis is a functional nervous disease or emotional disorder; a neurosurgeon operates on the nerves.

Thrombo is the medical term for clot. Thrombosis is the clotting of blood in any part of the circulatory system. A thrombocyte is a clotting cell; producing a clot is thrombogenic.

A root meaning liver is hepat. Someone who has an inflamed liver would have hepatitis. If part of the liver is removed, this would be called a hepatectomy; any disease of the liver would be hepatopathy.

If you have a headache by now, you may be suffering from cephalalgia. Cephal is the root meaning head. A disease of the head would be classified under cephalopathy; encephalitis is an inflammation of the brain.

Chondro is a root meaning cartilage. A chondrocyte is a cartilage cell; under the cartilage is subchondral; chondrology is a study of the cartilage.

Gastronomy is the art of preparing good food; the root meaning stomach is gastr. Inflammation of the stomach is gastritis; if you are talking about both the heart and the stomach, the word is gastrocardiac.

An arterial highway is a through or main highway (or artery); the root arter means artery. Arteritis would be an inflammation of the arteries; arteriosclerosis means a narrowing of the arteries; stenosis means narrowing. The frequently heard term arteriosclerosis indicates a thickening of the blood vessels.

Crani or cranium means skull. A craniectomy would be a surgical removal of the skull. Craniotomy is an examination of the skull. Craniotherapy deals with diseases of the skull, pathy means disease.

You have learned that hypodermic is under the skin; derma or dermat- means skin. A dermatologist treats diseases of the skin; dermatitis is an inflammation of the skin.

The root meaning gland is aden. A gland can be removed by an adenectomy. A condition of enlarged glands would be hyperadenosis.
## APPENDIX V.
### Self-Test Sample

The following is a review of all the words you have learned. You should be able to translate all the medical terminology into lay terminology with little difficulty. Match the terminology in column A with the term in column B.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. erythroblastosis</td>
<td>a. excessive blood</td>
</tr>
<tr>
<td>2. gastroscopy</td>
<td>b. inflammation of the skin with redness</td>
</tr>
<tr>
<td>3. hyperemia</td>
<td>c. a condition of red-burning cells</td>
</tr>
<tr>
<td>4. pericardectomy</td>
<td>d. a condition of the cartilage and bone</td>
</tr>
<tr>
<td>5. osteochondrosis</td>
<td>e. forming blood cell</td>
</tr>
<tr>
<td>6. erythrodematitis</td>
<td>f. surgical removal of the sac around the heart</td>
</tr>
<tr>
<td>7. hematocytoblast</td>
<td>g. cutting into the stomach</td>
</tr>
</tbody>
</table>

(1-c, 2-g, 3-a, 4-f, 5-d, 6-b, 7-e) Continue with the following words.

| 8. hypochondrium   | a. pertaining to the lungs and the heart     |
| 9. subdural        | b. pertaining to the anus and head           |
| 10. pneumocardial  | c. under the cartilage (ribs)                |
| 11. periphetalsiris| d. not originating in the liver              |
| 12. biotriphalactic| e. an inflammation of the tissues around the eye |
| 13. anhepatogenic  | f. a condition in which the blood does not clot |
| 14. athrosclerosis | g. under the skin                            |

(8-c; 9-g; 10-a; 11-c; 12-b; 13-d; 14-f) Continue with the following words.

| 15. endoneural     | a. inflammation of both eyes                 |
| 16. perinphritis   | b. study of life                             |
| 17. retro-ocular    | c. inflammation of the sac around the kidney|
| 18. bilateral ophalmatitis | d. beneath the liver                     |
| 19. biology        | e. situated within a nerve                   |
| 20. subhepatic      | f. stopping bleeding                         |
| 21. hysteroscopy   | g. examination of the liver                  |
| 22. leptomeningitis | h. behind the eye                            |

(15-c, 16-c, 17-b, 18-a, 19-b, 20-d, 21-g, 22-f) Continue with the following words.

18
References


INFLUENCE ON STUDENT ACHIEVEMENT OF REDUNDANCY IN SELF-INSTRUCTIONAL MATERIALS

Final Report, August 1967 - February 1968

Horace H. Valverde
Ross L. Morgan, Ph.D.

REPORT DATE
December 1968

PROJECT NO.
1710

10. DISTRIBUTION STATEMENT
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11. SUPPLEMENTARY NOTES

12. ABSTRACT
Five versions of an instructional program on medical terminology were experimentally evaluated to determine the effect of redundancy or repetition on learning. The subjects (N = 440) were assigned to five groups (N = 88 for each group). A different instructional mode was administered to the subjects in each group as follows: Group I - 274-frame linear program; Group II - 160-frame linear program; Group III - 83-frame linear program; Group IV - Narrative, typographically cued, text; Group V - 4 by 6-inch summary card. The modes contained identical terminal behaviors and a 79-item multiple-choice test, which exhausted the population of behaviors, served as the achievement criterion. All groups studied the materials for an equal amount of time (3 hours). Groups I and II did not differ in achievement. Groups III, IV, and V also did not differ in achievement. Groups III, IV, and V all were significantly superior in achievement to Groups I and II. Therefore, for certain learning outcomes, i.e., terminology and procedure following, programmed practice and review may detract from the effectiveness of self-instructional program.
<table>
<thead>
<tr>
<th>KEY WORDS</th>
<th>LINK A</th>
<th>LINK B</th>
<th>LINK C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal Learning</td>
<td>Role</td>
<td>HT</td>
<td>Role</td>
</tr>
<tr>
<td>Programmed Instruction</td>
<td></td>
<td></td>
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<tr>
<td>Learning</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Military Training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-instruction</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>