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TECH MEMO

A HISTORY OF AN INDIVIDUALIZED INSTRUCTIONAL
PROGRAM OF VARYING FAMILIARITY
TO COLLEGE STUDENTS

Sigmund Tobias

Tech Memo No. 43
February 1, 1972

Project NR 154-280
Sponsored by
Personnel & Training Research Programs
Psychological Sciences Division
Office of Naval Research
Arlington, Virginia
Contract No. N00014-68-A-0494

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Duncan N. Hansen
Director
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Security Classification		
DOCUMENT CONTROL DATA - R & D (Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)		
1. ORIGINATING ACTIVITY (Corporate author) Florida State University Computer-Assisted Instruction Tallahassee, Florida 32306	2a. REPORT SECURITY CLASSIFICATION Unclassified	2b. GROUP
3. REPORT TITLE A History of an Individualized Instructional Program of Varying Familiarity to College Students		
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Tech Memo No. 43, February 1, 1972		
5. AUTHOR(S) (First name, middle initial, last name) Sigmund Tobias		
6. REPORT DATE February 1, 1972	7a. TOTAL NO. OF PAGES 15	7b. NO. OF REFS 18
8a. CONTRACT OR GRANT NO. NO0014-68-A-0494	9a. ORIGINATOR'S REPORT NUMBER(S)	
b. PROJECT NO. NR 154-280	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
c.		
d.		
10. DISTRIBUTION STATEMENT Approved for public release; distribution unlimited. Reproduction in whole or in part is permitted for any purpose of the United States Government.		
11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Personnel & Training Research Programs Office of Naval Research Arlington, Virginia	
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DD FORM 1473 (PAGE 1)

1 NOV 65

S/N 0101-807-6811

Security Classification

A-31408

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT

DD FORM 1 NOV 65 1473 (BACK)
S/N 0101-807-6821

Security Classification
A-31409



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A HISTORY OF AN INDIVIDUALIZED INSTRUCTIONAL
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Sigmund Tobias
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ABSTRACT

The present memorandum has described the evolution of a set of individualized instructional materials dealing with subject matter of varying familiarity to college students. The materials have been widely used by a number of investigators. In their full version, these materials contained content with which subjects have a fair amount of prior familiarity, and materials with which college-age students have been shown to have no prior experience. The materials have been used in both a programmed and computer-assisted instructional format. The types of modification made to the program by different investigators can, in part, account for some discrepancy between research findings. It is, therefore, strongly suggested that future researchers using these materials explicitly describe modifications made to the program.

A History of an Individualized Instructional
Program of Varying Familiarity
to College Students

Introduction

This report summarizes the evolution of a set of widely-used individualized instructional materials, and the modifications made to them. The development of a science of instruction demands the presence of well-standardized instructional materials to be used for research purposes. Since research is most easily conducted with a college population, it becomes important to develop programs especially applicable to college students. One of the problems encountered in such a population is that there is a good deal of previous familiarity with most topics. The college student has had twelve years of formal education in the primary and secondary schools, in addition to exposure to a wide range of subject matter in the media. Thus, it is difficult to present college students with meaningful, verbal instructional material with which they have little prior experience. If materials of substantial prior familiarity to students are used in instructional research, the problem always arises whether the data obtained are attributable to the student's previous experience with the area, or to the instructional manipulations. Another question arising is, are the results of instructional research different when subjects have had, or not had, prior experience with the content? It is the purpose of this report to detail the development of a set of instructional material to

facilitate studies such as these alluded to above. It is further intended to relate some of the data gained from the use of these materials at different universities to the modification made on the materials.

The materials are available in two major formats: a programmed instruction booklet in which the materials are presented via paper and pencil; and a format suitable for presentation via computer-assisted instruction (CAI). The CAI version was written in Coursewriter II, and intended for presentation on a system with graphics capability like the IBM 1500 instructional system.

The instructional program can be separated into two parts. The first of these has become known as the technical, unfamiliar section of the program. It deals with the diagnosis of myocardial infarction by means of electrocardiographic tracings taken from the fifth precordial lead of the electrocardiogram. This portion of the program uses the technical terminology dealing with the severity of heart disease, different degrees of coronary damage, their reversability, and stages in the healing cycle of recovery from heart disease. The material requires two types of answers: (a) verbal responses which frequently involve technical medical terminology dealing with heart disease; (b) graphic, or pictorial responses requiring drawing of the types of ECG tracings characteristic of various levels of heart disease, and a graphic representation of the type and severity of damage done to the heart muscle.

A nontechnical, familiar section of 55 frames was developed subsequently. This portion of the instructional material, usually

appearing as the first 55 frames of the program, consists of material dealing with the incidence and prevalence of heart disease, and of fatalities resulting from coronary attacks. This section covers, in nontechnical language, various risk factors with respect to contracting heart disease such as smoking, cholesterol, tension, and lack of exercise. In conception this program deals in a systematic manner with material on heart disease which is widely available in the public media.

The diagnosis of myocardial infarction was initially developed as a demonstration of programmed instruction by Francis Mechner (undated). This edition of the program will be referred to as Version I. Version I was subsequently employed by Cummings and Goldstein (1964) in a study comparing the effectiveness of overt and covert responding to programmed materials. That edition of the program consisted of 117 frames presented in booklet format with a frame appearing on one page, and the confirmation for the response in the left-hand margin of the next page. Students recorded their answers on an accompanying answer sheet. Version I of the program was also employed by Oppenheim (1965) in his study dealing response modes to programmed instruction. Holland (1967) found this version to be highly satisfactory in terms of requiring responses which were contingent upon the detailed inspection of content introduced in each frame, i.e., with respect to blackout ratio. Holland and Kemp (1965), and Kemp and Holland (1966) report a low blackout ratio for this version of the program, indicating that only small portions of frames could be blacked out without affecting program error rate. Holland (1967), and Anderson (1967) described the blackout

ratio as an effective index of the quality of programmed instructional materials, and in these terms the myocardial infarction materials were viewed as efficient exemplars of the programmed instructional format.

Major modifications to these materials were made in a study of the effects of creativity, response modes, and subject matter familiarity on achievement in programmed instruction (Tobias, 1968). These changes were of two types: (a) a revision of the technical materials; and (b) preparation of a new set of familiar materials. The technical material was modified in several important respects. Previous research had indicated an unusually high error rate for these materials. Content analysis of a preliminary tryout indicated that the sequence of the program and the clarity of various sections could be improved. Following tryout, revision, and pilot testing the 117 frames of the original material were reduced to a total of 89 frames which covered all of the content dealt with in the previous version. An original program of 55 frames dealing with relatively nontechnical subject matter was also developed at this point and tried out. Data gathered at this stage indicated that pretest scores for the familiar material in a college population approached 33 percent, whereas pretest scores for the technical material were virtually zero, that is, subjects typically gave up on the pretest indicating: "I don't know anything about this." This edition of the program will be referred to as Version II. Version II was employed in a subsequent series of studies dealing with the effects of different variables on achievement from programmed instruction. (Tobias, 1969, 1972; Tobias & Abramson, 1971).

The familiar section of the program was originally developed for a population of college students. In order to utilize this section of the material with a high school student population, this section of the program was changed by Shanstrom (1972). This modification is referred to as Version IIa and was intended to reduce the difficulty of the vocabulary level throughout the program. For example, "fatty substances in the blood," was changed to "bits of fat in the blood." Similarly, complex sentences were rewritten into simpler and shorter units. The content of the program was, however, unchanged.

Version II and IIa were administered in a booklet format. Frames appeared on one page, and the feedback for the responses to one frame typically appeared in the left hand margin of the next page, accompanied by the next frame. These were called the constructed response formats. Reading formats for Versions II and IIa were prepared by filling in response blanks and rewording question frames into declaratory statements. The reading versions did not require overt response of any kind. A no-reinforcement format of Version II was prepared for one study (Tobias & Abramson, 1971); this version was identical to the constructed response format, except that the feedback portion of the material had been eliminated. In another study (Tobias, 1972) the constructed response frame sequence had been reordered by means of a table of random numbers to create a random order for a study of the effects of sequence.

The results of investigations using these materials in a programmed format were quite consistent. In all of the studies in which the program was used, constructing responses and receiving reinforcement

for them resulted in superior achievement compared to other response modes, for the technical, unfamiliar subject matter. It was also shown (Tobias, 1972) that for this subject matter, scrambling the frame sequence resulted in significantly lower achievement compared to working the program in its logical sequence. On the other hand, for the familiar section of the program, no achievement differences have ever been reported favoring one response mode over another, nor did scrambling this subject matter affect the achievement negatively. These results have been interpreted (Tobias, 1969; Tobias & Abramson, 1971; Tobias, 1972) as indicating that optimal instructional method was probably modified by the subject's prior familiarity with the body of subject matter.

CAI Version

The materials developed in Version II were prepared for presentation on the IBM 1500 CAI system for utilization in a series of studies at the FSU CAI Center. Initially, an attempt was made to duplicate the programmed instruction version as closely as possible. Since the original program called for extensive graphic, or pictorial responses in which subjects drew ECG tracings characteristic of different types of heart disease, and of graphic representations of the type and extent of damage to the heart muscle, these procedures had to be changed for the CAI presentation. Subjects were presented with a xerographed handout in which each of the elements of different ECG tracings had been broken down into a series of discrete shapes. Each shape in turn was associated with a particular number. When the student had to make a drawing on the

CAI system, he typed in the number representing a particular shape and the shape then appeared on the cathode ray screen.

With the exception of this modification, the CAI materials were identical to Version II. On the constructed response program of this edition, students made all their responses to a frame at once. After responses were entered into the system, the correct answer was flashed onto the CRT screen to be followed by the next frame. This edition of the materials will be referred to as Version III.

Version III of the instructional materials was used by Leherissey, O'Neil, and Hansen (1971). The data with respect to achievement from different response modes failed to replicate Tobias' (1968; 1969; Tobias & Abramson, 1971) findings that the constructed response mode led to superior achievement on the technical material. Prior findings that there were no differences among response modes on the familiar material were replicated. The data suggested that this version of the instructional materials needed modification. Subjects in the constructed response mode verbalized considerable hostility towards the materials, in addition to which the mean amount of time required by the constructed response mode on the CAI system was approximately 20 minutes longer than required by similar students utilizing the programmed format (Version II).

In a further study (Leherissey, O'Neil, Heinrich, & Hansen, 1971), the technical portion of Version III was prepared in two forms, a short (Version IIIa) and a long form. The shortening of the technical materials did not succeed in replicating Tobias' findings regarding the superiority

of the constructed response mode. A detailed job analysis of the instructional task faced by students revealed one major problem. In the constructed response format of Version III, subjects were required to construct ECG tracings by typing out numbers with which the elements of the ECG tracings had been associated on a xerograph sheet. The posttest was administered off the terminal, in a paper and pencil constructed response test. On the test subjects were required to actually draw the electrocardiograph tracings, which they had hitherto responded to only by indicating appropriate numbers. This difference in procedure suggested that the discrepancy among previous findings might be partially attributable to the difference in the task.

Leherissey (1971) modified this aspect of the procedure. Instead of requiring subjects to actually draw a tracing on posttest, they were asked to respond with the appropriate numbers which they had used to construct the tracing while working on the program. Leherissey's findings replicated those previously reported by Tobias in that the constructed response group achieved more on the technical program than did the reading group. The fact that these findings coincided with those reported when the instructional material was presented via programmed instruction suggested that Leherissey's procedures were more similar to those employed in the programmed mode.

Further CAI Modifications

A further analysis of the task confronted by subjects working on these materials on a CAI system compared to the programmed mode revealed another fundamental difference between the tasks. The materials frequently require responses of more than one word, that is, responses of

a phrase or so. In the programmed mode, typically when a subject responded with a sentence and then flipped a page to look at the feedback, any phrase appearing in the reinforcement portion which was similar to his response was likely to be accepted as confirmation of the answer. On the CAI system, however, when subjects typed one phrase, and the system responded with an essentially similar phrase using different terms, subjects were less prone to accept this as confirmation of their response. The life-like quality of the CAI system and failure of the material to indicate that the subjects' response was equivalent to the pre-stored correct answer appeared to leave a considerable margin of doubt as to whether the response was, in fact, scored as correct. For these reasons, one major revision instituted in Version IV was that subjects' responses were scanned for the degree to which they compared to the pre-stored responses. Three types of feedback were provided:

1. That the response was correct and identical, or equivalent to the text book response which was then provided.
2. That the answer was generally correct, and the textbook response was then displayed.
3. That the answer was not quite right, and then the textbook response was presented.

It had also been noted that on many frames subjects had to provide several responses. In the previous versions the feedback had generally been supplied for all responses to a frame at one time. This appeared to leave some room for confusion with respect to the accuracy of each individual answer. In the present modification responses were

generally processed sequentially. Thus, the subject was typically informed about the accuracy of one response before making the next one. When the first response set to a particular frame had been processed, it was maintained on the screen while the subject continued to work on the material presented and responses required in the latter half of the frame.

The presentation and processing of the responses dealing with ECG tracings, and drawings representing different degrees of damage to the heart muscle were also changed. For the tracings, a paper insert was prepared showing both the number and the segment of the curve it represented. This insert was placed immediately above the first row of typewriter keys below the CRT, and was always in the subjects' view. Also, responses involving tracings were scored, and the feedback outlined above for textual responses was also presented for the graphic answers, together with the correct answer.

In Version III the subject represented the type of damage to the heart muscle by selecting from four choices flashed on the right side of the screen. Since in this case it also appeared possible that the subject might not be fully aware how close his response was to the standard, this procedure was also modified by providing feedback regarding the accuracy of response. In the graphic responses, as in the verbal responses, an attempt was made to split complex frames into component parts, and process them sequentially so that feedback was generally given for one response prior to making the second.

In Version III it was noted that the processing of the constructed response format required substantially more time than had been

true for the same group in the programmed booklet format. Therefore, the program was shortened for Version IV by eliminating both the familiar section of the material, and a part of the content dealing with the healing cycle (frames 127-143 in the original program booklet). A further modification instituted for Version IV was to rewrite that part of the posttest dealing with the healing cycle to reflect the shortened treatment of that area in Version IV. Finally, the new technical posttest was presented via terminal, instead of via paper and pencil as had been the case in previous versions. Version IV of the program was prepared in both a reading and constructed response format. In an attempt to study the effects of scrambling, and objectives on achievement from CAI, the sequence of frames in Version IV was changed by means of a table of random numbers, giving rise to IVa.

Two studies were run on Version IV of the instructional materials (Tobias, 1972b; Tobias & Duchastel, 1972). The first of these investigations studied the effects of distraction and response mode on achievement from CAI. In that study the group making constructed responses with reinforcement achieved significantly more than did the reading group. In the second investigation (Tobias & Duchastel, 1972), a comparison was made between a scrambled and a regular sequence group. The results indicated that the scrambled group achieved significantly less than did the regular sequence group. These data suggest that the failure to replicate earlier findings in previous CAI versions may have been attributable to the way the program was arranged. Apparently, in an attempt to replicate the programmed format most closely, the essential difference between the

CAI medium and the programmed format resulted in making the materials different, rather than more similar. Therefore, it is suggested that future researchers describe their procedures and modifications made to existing materials most carefully. It is apparently possible for results from instructional programs to be strongly affected by minor variations in the instruction material.

Another CAI version of this program was prepared at the University of Illinois for presentation on the PLATO CAI system. This version was not available for inspection for this memorandum, but is described in a study on feedback procedures and programmed instruction by Anderson, Kulhavy, and Andre (1971). This version apparently contained the total program (Version II) less 36 frames of the familiar material. In the Illinois version, subjects were not asked to construct drawings of any kind. Anderson also modified the posttest to eliminate questions requiring drawings, and included some multiple-choice items.

Summary

The present memorandum has described the development of a set of instructional materials dealing with heart disease which have been widely used by a number of investigators. In their full version, these materials contained both content with which subjects have a fair amount of prior familiarity, and materials with which college-age students have been shown to be relatively unfamiliar. The materials have been used in both the programmed, and computer-assisted instructional format. The types of modification made to the program by different investigators

can, in part, account for some discrepancy between research findings. It is, therefore, strongly suggested that future researchers using these materials explicitly describe modifications made to the program.

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