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ABSTRACT

A study was devised to investigate the use of formative evaluation during the preparation of a course entitled "Education of Visually Handicapped Children" designed for presentation to students through computer-assisted instruction (CAI). Various models for formative evaluation were examined, the Baker and Schutz cycle for instructional product development was selected for use, and this model was implemented. Conclusions drawn from formative evaluation activities showed that the general model for the instructional product development as adapted for the study was appropriate, that formative evaluation can be carried out by the course author, that weaknesses in course material can be easily identified, that results of formative evaluation procedures can assist the course author in making revisions, and that initial success with CAI student terminal equipment is important to maintain a student's confidence and desire to continue in the course. EM 011 037 through EM 011 043, EM 011 046, EM 011 047, and EM 011 049 through EM 011 057 are related documents. (Author/SH)

Examination and Application of Formative Evaluation for Author Utilization During The Preparation of a CAI Course

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University of Pittsburgh

1972

Note to accompany the Penn State Documents.

In order to have the entire collection of reports generated by the Computer Assisted Instruction Lab. at Penn State University included in the ERIC archives, the ERIC Clearinghouse on Educational Media and Technology was asked by Penn State to input the material. We are therefore including some documents which may be several years old. Also, so that our bibliographic information will conform with Penn State's, we have occasionally changed the title somewhat, or added information that may not be on the title page. Two of the documents in the CARE (Computer Assisted Remedial Education) collection were transferred to ERIC/EC to abstract. They are Report Number R-36 and Report Number R-50.

Don McCall: ERIC/EM

EXAMINATION AND APPLICATION OF FORMATIVE EVALUATION FOR AUTHOR UTILIZATION DURING THE PREPARATION OF A CAI COURSE

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CHAPTER I

INTRODUCTION

Intriguing capabilities for computer-assisted instruction (CAI) have been developed during the past decade. CAI course material for students can be prepared to take advantage of the CAI system capabilities and to produce dynamic student-computer interactions. Such CAI course preparation is a time-consuming task involving course design, development, and evaluation.

Evaluation traditionally has been viewed as an activity to follow course completion. Authorities have recently indicated, however, that carefully applied, systematic evaluation may enhance the quality of a CAI course when it is concurrent with course design and development.

This study examined procedures for making evaluation an integral part of course design and development. The investigator conducted the study while she served as a course author for the preparation of a CAI course entitled "Education of Visually Handicapped Children."

A. Statement of the Problem

The purpose of this study was to investigate and to report an author's use of formative evaluation during the preparation of a course designed for presentation to students via computer-assisted instruction. The activities completed during the study were planned to answer the following questions:

1. What models for formative evaluation are reported in the literature related to the development of course materials?
2. Of the models examined, which model is appropriate for an author to use during the preparation of a CAI course?
3. What are the results of using the selected model for formative evaluation during the preparation of CAI course materials?
4. What information, procedures, and forms can be identified for possible inclusion in a manual for other authors to use in the formative evaluation process in the preparation of instructional programs?

B. General Plan of Study Report

In Chapter II the investigator will report the review of the literature pertaining to models for formative evaluation. Chapter III will include the rationale for the selection of a particular model for formative evaluation and will outline the procedures used to carry out the steps of that formative evaluation model during the development of a CAI course. The results of the formative evaluation program will be summarized in Chapter IV along with procedures, forms, and information suitable for other CAI course authors to use in formative evaluation. The conclusions, limitations, suggestions for further investigation, and summary of the study will be presented in Chapter V.

CHAPTER II

REVIEW OF THE LITERATURE

The review of the literature examines three main areas: evaluation of instructional programs, computer-assisted instruction (CAI), and evaluation of CAI course material during initial preparation. A distinction is made between formative and summative evaluation.

A. Evaluation of Instructional Programs

1. Formative and Summative Evaluation

Authorities have referred to Cronbach's paper entitled "Course Improvement Through Evaluation" presented in 1963 as a "classic."[1] In this paper Cronbach defined evaluation as the " . . . collection and use of information to make decisions about an educational program."[2] He indicated that such information could be used for course improvement, for decisions about individual students, or for administrative regulations. Cronbach emphasized the importance of evaluation for the purpose of course improvement:

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[1]Gene Glass, "Design of Evaluation Studies" (paper presented at the Council for Exceptional Children Special Conference on Early Childhood Education, New Orleans, December, 1969).

[2]Lee J. Cronbach, "Course Improvement Through Evaluation," Teachers College Record, LVII (May, 1963), p. 672.

> The greatest service evaluation can perform is to identify aspects of the course where revision is desirable. . . . To be influential in course improvement, evidence must become available midway in curriculum development, not in the home stretch, when the developer is naturally reluctant to tear open a supposedly finished body of materials and techniques. Evaluation, used to improve the course while it is still fluid, contributes more to improvement of education than evaluation used to appraise a product already placed on the market.[1]

Cronbach stated that the analysis of performance on single test items or the record of responses to different types of problems could be more informative than an analysis of total scores. He viewed evaluation as:

> . . . a fundamental part of curriculum development, not an appendage. Its job is to collect facts the course developer can and will use to do a better job, and facts from which a deeper understanding of the educational process will emerge.[2]

Scriven[3] proposed using the terms "formative" and "summative" to distinguish between evaluation to improve an instructional program or curriculum during its development and evaluation to determine the worth or effectiveness of an instructional program once it had been completed. He suggested that, in order to avoid potential clashes between curriculum writers and professional evaluators,

> . . . formative evaluators should, if at all possible be sharply distinguished from the summative evaluators, with whom they may certainly work in developing an

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[1] Ibid., p. 675.

[2] Ibid., p. 683.

[3] Michael Scriven, "The Methodology of Evaluation," in Perspectives of Curriculum Evaluation, AREA Monograph Series on Curriculum Evaluation, No. 1 (Chicago: Rand McNally and Company, 1967), p. 43.

> acceptable summative evaluation schema, but the formative evaluators should ideally exclude themselves from the role of judge in the summative evaluation.[1]

Scriven maintained that in the early stages of any kind of curriculum project general objectives or goals are formulated. These goals, which should not be considered absolute commitments but rather reminders subject to alteration, might range from motivational and cognitive goals to the goal of producing a marketable program. Scriven declared that these goals were to be themselves items for evaluation; performance measured against goals was not to be the only concern of the evaluator. To him it was " . . . obvious that if the goals aren't worth achieving then it is uninteresting how well they are achieved."[2]

Scriven outlined three types of activities which could facilitate both the evaluation of the goals and the evaluation of performance measured against those goals. These activities are:

1. Regular reexamination and modification of proposed general objectives or goals of the project.
2. Construction of a test-question pool, which thus becomes an "operational version of the goals"[3] and as such, also requires regular reexamination and modification in light of any changes in the project goals.
3. External judgments about the consistency of the project goals, content, and test-question pool.

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[1] Ibid., p. 45., [2] Ibid., p. 52., [3] Ibid., p. 56.

Scriven saw several refinements of the above activities as crucial to formative evaluation studies since they could uncover the causes of poor results:

> Essentially, we need to know about the success of three connected matching problems: first, the match between goals and course content; second, the match between goals and examination content; third, between course content and examination content. . . Only in this way are we likely to be able to track down the real source of disappointing results.[1]

Stolurow in a paper presented at a Council for Exceptional Children Special Conference on Instructional Technology commented on the function of formative evaluation:

> It is the formative evaluation process that results in specific revisions of a program to improve its rhetoric, instructional effectiveness, and acceptability.[2]

In Handbook on Formative and Summative Evaluation of Student Learning, Bloom, Hastings, and Madaus defined evaluation as:

> . . . the systematic collection of evidence to determine whether in fact certain changes are taking place in the learners as well as to determine the amount or degree of change in individual students.[3]

They distinguished between formative and summative evaluation on the basis of purpose, time at which evaluation occurs, and " . . . level of generalization sought by the items in the examination used to collect data for the evaluation."[4]

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[1] Ibid., p. 59.

[2] Lawrence Stolurow, "Instructional Technology" (paper presented at a Council for Exceptional Children Special Conference on Instructional Technology, San Antonio, Texas, December 1-4, 1970), p. 75.

[3] Benjamin S. Bloom, J. Thomas Hastings, and George F. Madaus, Handbook on Formative and Summative Evaluation of Student Learning (New York: McGraw-Hill Book Company, 1971), p. 8.

[4] Ibid., p. 61.

> We have chosen the term "summative evaluation" to indicate the type of evaluation used at the end of a term, course, or program for purposes of grading, certification, evaluation of progress, or research on the effectiveness of a curriculum. . . .
> . . . . . .
> Formative evaluation is for us the use of systematic teaching and learning for the purpose of improving any of these three processes. . . .[1]

In the Preface to their book the authors explained that their interest is the improvement of student learning, as the title of their book would indicate.

Airasian also focused on formative evaluation for the improvement of student learning. He stated that formative evaluation " . . . seeks to identify learning weaknesses prior to the completion of instruction on a course segment. . . ."[2] He summarized differences between formative and summative evaluation by indicating the verb tense used with each term:

> Formative evaluation provides data about how students are changing. Summative evaluation is concerned with how students have changed. . . .[3]

In the report of his development of a model for formative evaluation Abador viewed formative evaluation as " . . . the process wherein developers of prototype instructional systems collect and

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[1] Ibid., p.117.

[2] Peter W. Airasian, "Role of Evaluation in Mastery Learning." in Mastery Learning: Theory and Practice, ed. by B. S. Bloom (New York: Holt, Rinehart, and Winston, Inc., 1971), p. 79.

[3] Ibid., p. 78.

analyze information for purposes of correcting system deficiencies."[1] Abador had identified a formative evaluation component in the theoretic models for the development of instructional systems he had examined, but he concluded that:

> . . . the formative evaluation procedures in such models are either too general for direct application to complex multi-media instructional treatments--or, if specific, provide techniques applicable to simple stimulus configurations such as textual programed instruction. . . . New tryout and revision procedures are needed to enable developers of prototype multi-media systems to more effectively identify problems, develop revision hypotheses, and design, integrate, and evaluate revisions.[2]

2. Models for Evaluation of Instructional Programs

In the following discussion, five models for the evaluation of instructional programs will be described. The first four specify procedures for the initial preparation of instructional programs. The fifth represents a model for summative evaluation conducted by an outside evaluator.

Model I.--Stake[3] indicates that two main types of information are necessary for the evaluation of educational programs. The first type is

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[1]Allan J. Abador, "Development and Validation of a Model for Formative Evaluation of Self-Instructional Multi-Media Learning Systems" (paper presented at AREA Annual Meeting, April, 1972), p. 1.

[2]Ibid., pp. 1-2.

[3]Robert E. Stake, "Toward a Technology for the Evaluation of Educational Programs," in Perspectives of Curriculum Evaluation, AERA Monograph Series on Curriculum Evaluation, No. 1 (Chicago: Rand McNally and Company, 1967), p. 5.

the intents and outcomes, and the second is personal judgments as to the quality and appropriateness of the intents and outcomes.

In another article Stake[1] explained what his proposed evaluation program would involve. Descriptions of what intended antecedents or entry behaviors were expected, what intended transactions or instructional processes were planned, and what outcomes were anticipated would be evaluated for their logical relationship to each other. Then the descriptions of what actually happened would be examined to determine if what was intended actually occurred (see FIGURE 1). Finally, judgments of the value of the instructional program would be made based on absolute standards reflected by the evaluator's personal judgment and on relative standards reflected by comparison of the particular program to alternative programs. Program designers would prepare a rationale stating the basic purpose and philosophical background of their program which would assist the evaluators.

Stake posed five questions which he felt should be answered prior to the initiation of evaluation procedures:

1. Is this evaluation primarily descriptive, primarily judgmental, or both descriptive and judgmental?
2. Is this evaluation to emphasize the antecedent conditions, the transactions, or the outcomes alone, or a combination of these, or their functional contingencies?
3. Is this evaluation to indicate the congruence between what is intended and what occurs?
4. Is this evaluation to be undertaken within a single program or as a comparison between two or more curriculum programs?

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[1]Robert E. Stake, "The Countenance of Educational Evaluation," Teachers College Record LVIII (April, 1967), pp. 527-38.

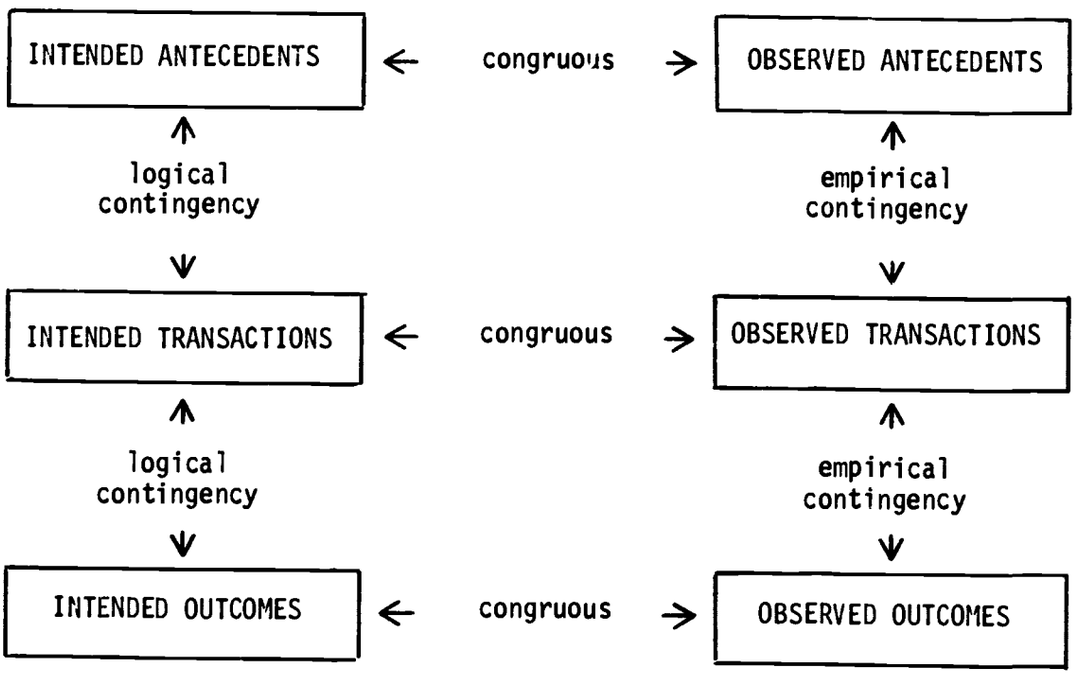

Fig. 1. A representation of the processing of descriptive data.

[a]Robert E. Stake, "The Countenance of Educational Evaluation," Teachers College Record, April, 1967, p. 533.

5. Is this evaluation intended more to further the development of curricula or to help choose among available curricula?[1]

Stake here did not report the sequence in which the steps of his process would be followed, nor did he illustrate his process. No reports of projects in which his evaluation procedures had been used were located in the literature.

Model II.--Briggs[2] in his monograph entitled Handbook of Procedures for the Development of Instructional Systems presented a model for the preparation of new instructional course material. His model, which encompasses course design, development, and evaluation, provides for the deliberate selection or creation of instructional materials on the basis of both learner characteristics and the nature of the competencies which the course is supposed to develop, as well as on the basis of the characteristics of the material alternatives (see FIGURE 2). The monograph is devoted to the design phase of Briggs' model. Briggs stated that formative evaluation procedures would start during the development and evaluation phases which he discussed briefly. He listed suggestions for formative evaluation which could be followed subsequent to what he called "formative design" steps taken during the development of first-draft materials in Steps 1-6. Briggs defined formative design as " . . . the use of performance tests (empirical data) for making the necessary decisions long before first-draft mate-

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[1] Ibid., p. 539.

[2] Leslie J. Briggs, Handbook of Procedures for the Design of Instructional Systems (Pittsburgh: American Institutes for Research, 1970).

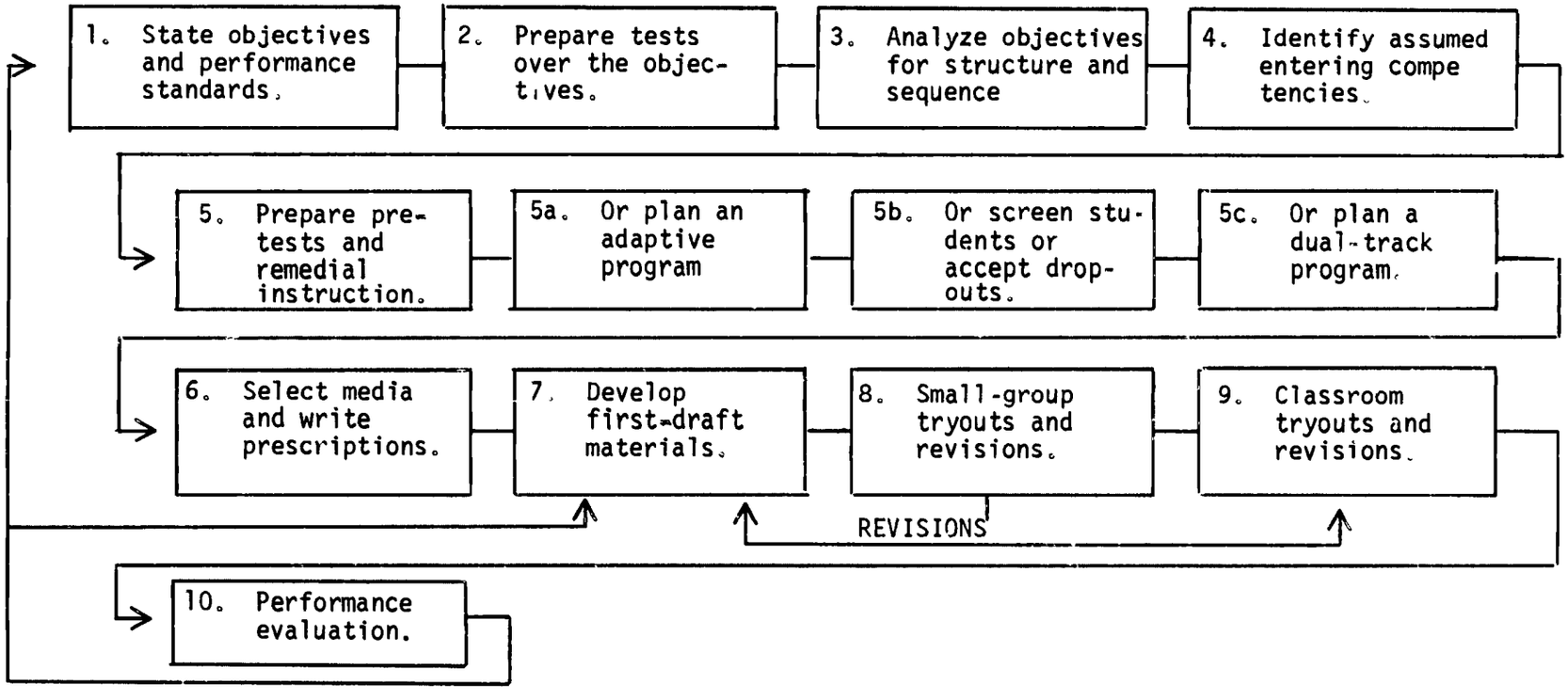

Fig. 2. Flow chart: A Model for the design of instruction[a]

[a]Leslie J. Briggs, Handbook of Procedures for the Design of Instruction (Pittsburgh: American Institutes for Research, 1970), p. 7.

rials are ready for try-out."[1] In his critique of his model written after he and his graduate students had examined twenty other models for instruction drawn from military, industrial, educational, and governmental settings, Briggs observed several limitations in his model:

> The model is somewhat limited from the point of view of planning the integration of materials, space, teachers, and learners into an administrative and management system for the operation of the learning environment. . . .
> . . . . . .
> Whereas the model may be inadequate for skills of inquiry needed for advanced types of problem solving, it is clearly useful as a guide for planning instruction at many of the less advanced levels.[2]

Model III.--Baker and Schutz declared, "Most instruction is dispensed, not developed."[3] They characterized instructional development as " . . . essentially a cyclical process, . . . a team effort, and . . . user-oriented."[4] They viewed an adequate instructional development program as one giving consideration to five program systems: Instructional, Training, Installation, Accountability, and Modification. The Instructional system in the opinion of Baker and Schutz is the key system from which specifications for the other four systems are derived. All systems share common characteristics and are closely interdependent, although each system has a distinct function within the total development program.

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[1] Ibid., p. 173.

[2] Ibid., p. 185.

[3] Robert L. Baker and Richard E. Schutz, eds., Instructional Product Development (New York: Van Nostrand Reinhold Company, 1971), p. xv.

[4] Ibid., pp. xv-svi.

Baker and Schutz listed seven components of their instructional development cycle which cut across all five program systems and system characteristics. These components are:

1. Formation
2. Instructional Specification
3. Item Tryout
4. Product Development
5. Product Tryout
6. Product Revision
7. Operations Analysis[1]

For each of the seven components in the development cycle Popham and Baker[2] specified general rules (Appendix A). In addition, Popham described principles demonstrated to be effective in following the rules for activities within each component of the development cycle. These principles are:

1. Provide relevant practice for the learner.
2. Provide knowledge of results.
3. Avoid the inclusion of irrelevancies.
4. Make the material interesting.[3]

To produce the interest required in the last principle listed above, Popham urged the deliberate use of variety, humor, game-type situations, suspense, and format variations.

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[1] Ibid., p. 131.

[2] W. James Popham and Eva L Baker, "Rules for the Development of Instructional Products," in Instructional Product Development, ed. by Robert L. Baker and Richard E. Schutz (New York: Van Nostrand Reihnold Company, 1971). pp. 167-68.

[3] W. James Popham, "Preparing Instructional Products: Four Development Principles," in Instructional Product Development, ed. by Robert L. Baker and Richard E. Schutz (New York: Van Nostrand Reinhold Company, 1971), p. 171.

Model IV.--Abador[1] developed a model for formative evaluation which incorporated technical review, small group tryout with tutorial assistance by the prototype designer, and large group tryout. He submitted his initial model (see FIGURE 3) to seven faculty members who had developed self-instructional multi-media lessons. He found that the model was unacceptable to the faculty members because of the time involved in carrying out the steps, the high cost of producing revisions, and the difficulties of coordinating prototype production, large group tryouts, revisions, and course schedules. In addition, most of those he asked considered themselves to be experts in their particular subject matter and ways to present it and felt a technical review was unnecessary.[2]

Abador developed another model for formative evaluation in which he substituted a group tryout and debriefing procedure for the tutorial and large group components of the initial model (see FIGURE 4). The revised model contained the technical review step to avoid errors or critical omissions of content.

To test the validity and effectiveness of his revised model, Abador had three Michigan State University faculty members use the model to prepare prototype lessons. Students were randomly assigned to control groups and experimental groups to take the lessons and were stratified on the basis of their scores on the Scholastic Aptitude Test. After the control group students had each completed the prototype lessons, they met as a group with the lesson developer in a

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[1]Abador, "Development and [illegible]," pp. 3-4.

[2]Ibid., p. 6.

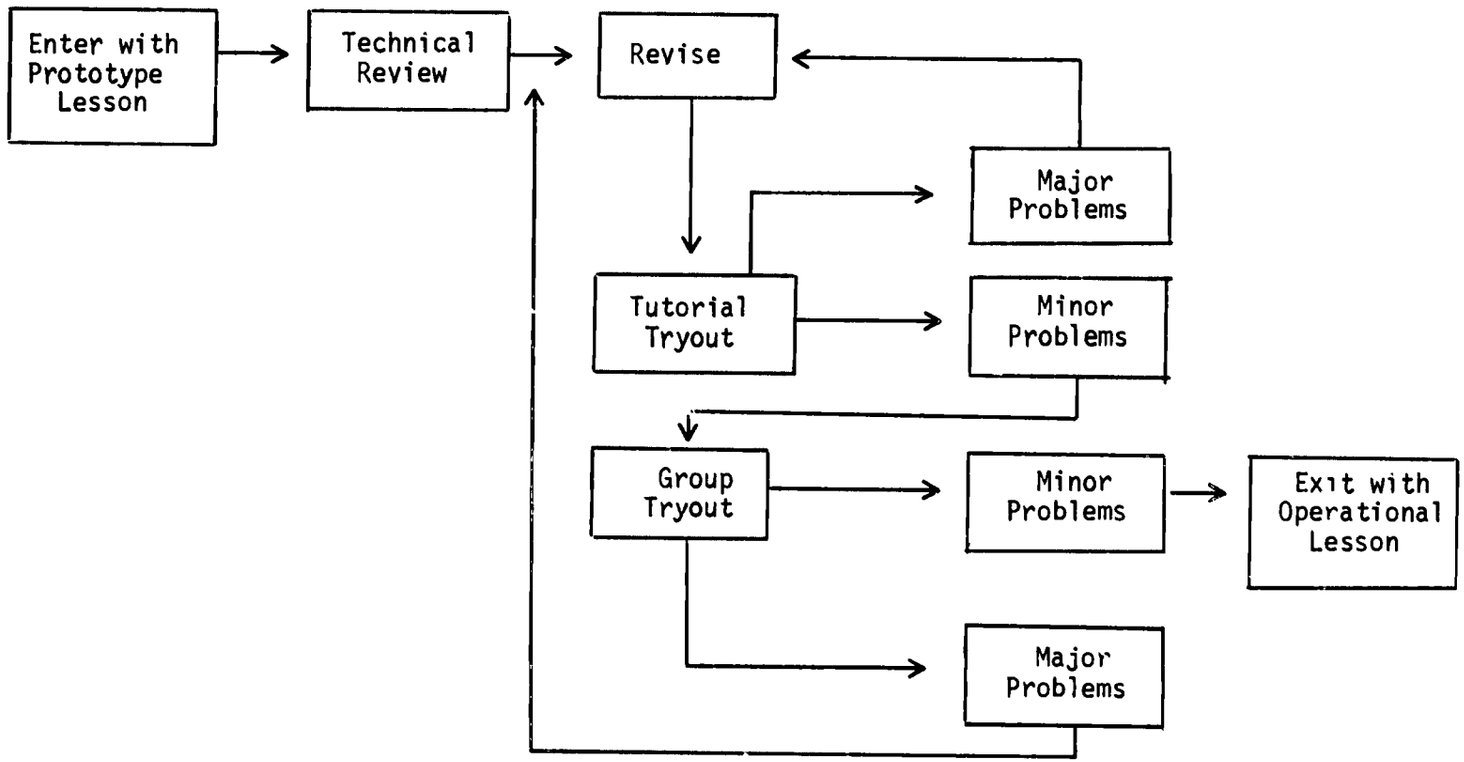

Fig. 3. Configuration of the MK I model of formative evaluation.[a]

[a]Allan J. Abador, "Development and Validation of a Model for Formative Evaluation of Self-Instructional Multi-Media Learning Systems" (paper presented at AERA Annual Meeting, April, 1972), p. 5.

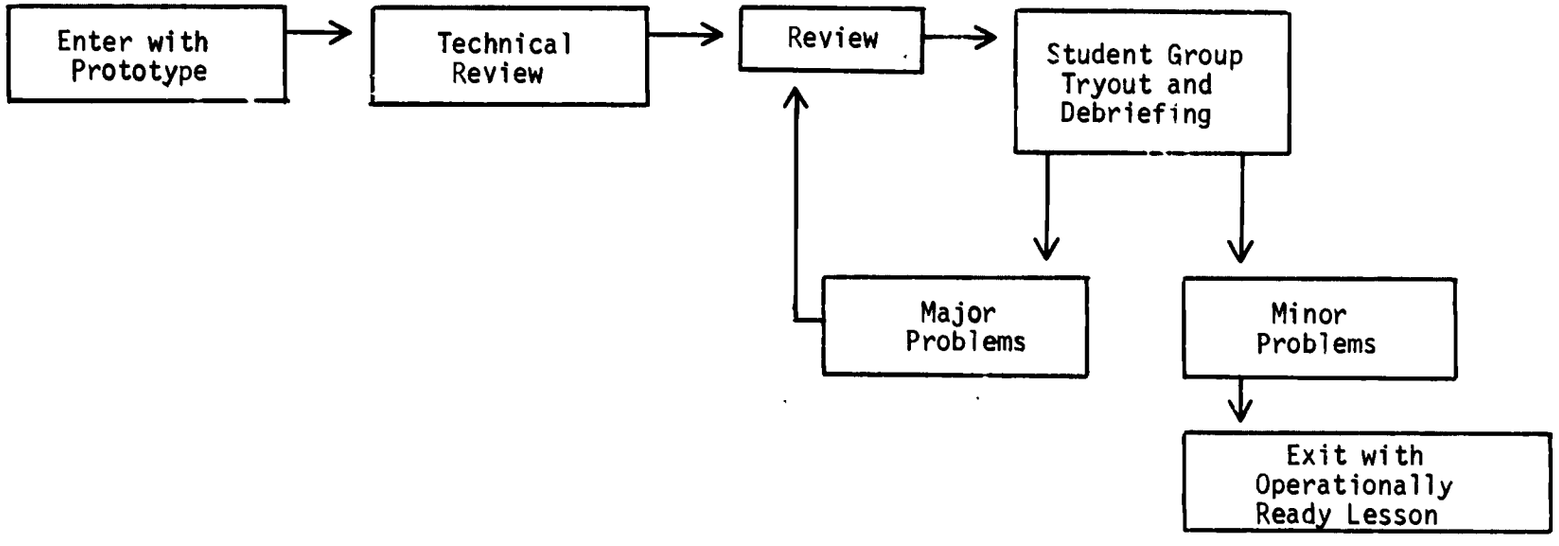

Fig. 4. MK II model of formative evaluation[a]

[a]Allan J. Abador, "Development and Validation of a Model for Formative Evaluation of Self-Instructional Multi-Media Learning System" (paper presented at AERA Annual Meeting, April, 1972), p. 12.

debriefing session to discuss instructional deficiencies in the lessons and to identify feasible solutions to correct those deficiencies. Revisions were made in the lessons before students in the experimental groups were permitted to begin instruction.

Abador reported that when group mean achievement, gain scores, percentage of students achieving mastery (defined as eighty percent or more correct on the post-test), and student attitude were considered, significant differences favoring the revised lessons were found for all four variables on two experiments. A significant difference on the post-test measure favoring the revised lessons was found on a third experiment. Abador emphasized that debriefing sessions with the control group enabled the lesson developers to identify precisely where weaknesses existed in the lessons and to collect suggestions regarding how those deficiencies might be remediated. He observed that the face-to-face debriefing sessions between students and lesson developers can be devastating and require a strong commitment to the principles of tryout and revision.

Model V.--Glass[1] applied a prototype evaluation format to the appraisal of an educational product already on the market, an instructional 100-foot cassette tape recording of a presentation entitled "Evaluation Skills" given by Dr. Michael Scriven. The model covered the following items:

1. Product description
2. Goals evaluation

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[1]Gene V. Glass, "Educational Product Evaluation: A Prototype Format Applied," Educational Researcher, I (January, 1972), pp. 7-10, 16.

3. Clarification of point of entry of the evaluator
   a. Irreversible decisions
   b. Reversible decisions (Enter the evaluator)
4. Trade-offs
5. Comparative cost analysis
6. Intrinsic (secondary) evaluation
   a. Technical quality
   b. Content evaluation
   c. Utilization of uniqueness of medium
   d. Survey of availability
7. Outcome (primary) evaluation
8. Summative judgments and recommendations
9. Circumstances modifying the summative judgments (scope and value claims)

Glass's prototype model was prepared for the outside evaluator to follow in appraising a finished instructional product.

3. Summary

Authorities have distinguished between formative and summative evaluation and have developed models for authors of instructional programs to follow. Stake's plan for evaluation provides a general outline for instructional development projects which make evaluation an integral part of the project. Briggs' model places emphasis on the selection of available materials or the design of new materials in order for students to reach instructional objectives. Abador's model offers a compromise acceptable to experienced developers of multimedia self-instructional lessons and requires the capability of

assembling tryout students for a final debriefing session with the lesson developer. Glass reports the results of his having used a model appropriate for the evaluation of finished products. Baker and Schutz outline a practical program for the newcomer in program development to follow.

Factors influencing the choice of a particular model would seem to include the purpose for and the scope of the evaluation, the point at which the evaluation is to be initiated, and the person to whom the task of evaluation is assigned.

B. Computer-Assisted Instruction

1. Definitions

Computer-assisted instruction (CAI) defined broadly includes " . . . the entire field of computer uses for instruction in which there is an interaction between student and machine."[1] A more narrow definition limits CAI to " . . . tutorial exercises of computerized programed instruction; . . . "[2]

In a paper presented at the Conference on Applications of Digital Computers to Automated Instruction held in 1963, Rigney discussed the computer as a teaching machine with an " . . . interactive

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[1]Karl L. Zinn and Susan McClintock, A Guide to the Literature on Interactive Use of Computers for Instruction (2nd ed.; Stanford: ERIC Clearinghouse on Educational Media and Technology, 1970), p. 22.

[2]Ibid.

capacity in relation to individual differences in learning."[1] He identified two ways the interactive capacity could be applied in student computer interactions. In the first, the computer would dominate by controlling the interactions according to rules specified by the author. In the second, the student would control the interaction by managing the general rules and determining what to ask the computer. Rigney described three types of learning environments in which the computer had been or could possibly be used:

1. In team training in games such as war gaming or tactical situations with the computer simulating environmental events.
2. In advanced technical and professional training of an individual with the computer serving as an " . . . inanimate assistant performing a variety of routine tasks for him, including pure information retrieval functions."[2]
3. In individual verbal tasks using teaching machine programs under computer control.

Atkinson and Wilson[3] in 1968 mentioned in their sampling of computer applications in education the use of the computer for

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[1]Joseph W. Rigney, "Potential Uses of Computers and Teaching Machines," in Programmed Learning and Computer-Based Instruction, ed. by John E. Coulson (New York: John Wiley and Sons, Inc.,, 1961), p. 156.

[2]Ibid.

[3]Richard C. Atkinson and H. A. Wilson, eds., "Computer-Assisted Instruction," in Computer-Assisted Instruction: A Book of Readings, (New York: Academic Press, 1969), pp. 8-9.

drill-and-practice procedures, tutorial programs, simulations and games. They also discussed the computer as a tool for computation in math and science.

Holtzman[1] specified CAI as just one of several applications of the computer in education. He described CAI as a system in which the student at a terminal interacts directly with the instructional materials which are stored in the computer or at the terminal. The materials can range from drill-and-practice exercises and tutorial interactions to complex simulations and problem-solving.

Zinn and McClintock[2] have identified five categories of current computer use in education. These categories are:

1. Drill, author-controlled tutorial and dialogue tutorial.--In these kinds of programs the author prepares the objectives and describes the course content in detail. The drill strategies are carried out according to the author's specifications. The tutorial programs allow for increasing amounts of variation in student response and initiative, but control of the interaction remains with the author.
2. Simulation and gaming.--In these applications the author outlines a general program model with appropriate replies for whatever responses a student supplies in answer to questions. The author does not specify frame-by-frame program content as he does in the drill and tutorial programs.

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[1]Wayne H. Holtzman, "Computers in Education," in Computer-Assisted Instruction, Testing, and Guidance, (New York: Harper and Row, Publishers, 1970), pp. 5-8.

[2]Zinn and McClintock, Guide to the Literature, pp. 6-8.

3. Information handling, computation, and display.--Essentially in these applications the computer serves as an information processing device and intellectual aid.
4. Tool for author and researcher.--Some computer systems have capabilities for interactive composition and revision of materials. They may also generate additional material for individual students from rules provided by the course author and may be programed to assist with data analysis and with reaching decisions in both research and modification of instructional systems.
5. Instructional management.--The computer takes over clerical work and routine handling of performance records to aid instructional management.

Holtzman[1] in his discussion further described computer-managed instruction as a "support" system for the teacher to use in prescribing, storing, and retrieving diagnostic, achievement, and other reference information about individual students. He distinguished instructional management from educational management in which the computer also serves as a support system. In the latter application the computer handles information regarding admission of students, registering, updating records, scheduling, and reporting grades.

Focusing on the use of computer programs to individualize instruction, Suppes classified three possible levels of interaction between the student and computer program. At the simplest level are

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[1]Holtzman, "Computers in Education," p. 6.

individualized drill-and-practice systems " . . . which are meant to supplement the regular curriculum taught by the teacher."[1] At the next and deeper level are tutorial systems " . . . which take over the responsibility both for presenting a concept and for developing skill in its use.[2] Suppes considered the deepest level of interaction to be the dialogue system " . . . aimed at permitting the student to conduct a genuine dialogue with the computer."[3] Writing in 1968, he made the following prediction:

> I would predict that within the next decade many children will use individualized drill-and-practice systems in elementary school; and by the time they reach high school, tutorial systems will be available on a broad basis. Their children may use dialogue systems throughout their school experience.[4]

Hall[5] summarized the characteristics of present computer applications to instruction;

1. Ability of a pre-stored program in a computer system to evaluate a student's response and provide information regarding the accuracy of the response.
2. Active responding by the student.
3. Ability to individualize instruction not only at the level of achievement but also in reference to specific interests and abilities of the student taking the course.

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[1]Patrick Suppes, "Computer Technology and the Structure of Education," in Computer-Assisted Instruction: A Book of Readings, ed. by Richard C. Atkinson and H. A. Wilson (New York: Academic Press, 1969), p. 43.

[2]Ibid. [3]Ibid., p. 44. [4]Ibid.

[5]Keith A. Hall, "Computer-Assisted Instruction: Problems and Performances," Phi Delta Kappan, June, 1971, p. 628.

Feldhusen has stated:

> There appear to be some things which CAI will become able to do better than any other media:
>
> 1. Secure, store and process information about the student's performance prior to and/or during instruction to determine subsequent activities in the learning situation,
>
> 2. Store large amounts of information and make it available to the learner more rapidly than any other medium,
>
> 3. Provide programed control of several media such as films, slides, TV, and demonstration equipment,
>
> 4. Give the author or teacher an extremely convenient technique for designing and developing a course of instruction, and
>
> 5. Provide a dynamic interaction between student and instructional program not possible with most other media.[1]

The dynamic interaction capability characteristic of current CAI systems contributes both to the usefulness of CAI systems in education and to the complexity of CAI program development and evaluation. The investigation of an effective approach to the preparation of CAI course material for use in current dynamic interactive CAI systems would seem to be worth careful consideration.

2. CAI Course Design

Gage commented in 1963, "The heart of machine teaching is the program, . . . "[2] This would seem to be particularly true for CAI.

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[1] John H. Feldhusen, A Position Paper on CAI Research and Development, (Stanford: ERIC Clearinghouse on Educational Media and Technology, 1970), pp. 1-2.

[2] N. L. Gage, "Paradigms for Research on Teaching," in Handbook of Research on Teaching, (Chicago: Rand McNally and Company, 1963), p. 132.

Hickey[1] discussed three of the decisions CAI course authors must make during the preparation of their programs: what order concepts are to be presented, whether they are to be presented as rules or as examples or both, and in what sequence student responses are to be reinforced. Dean[2] advised course authors to learn what the capabilities for interaction were in the particular CAI system for which they anticipated writing course material. Pipe[3] expressed concern over student attitudes and urged authors to talk to members of the population they intended to instruct before attempting to write any course material.

Zinn[4] from his work concluded that available texts, students' answers to constructed response questions, and transcriptions of student/instructor interactions could be used as sources of first-draft CAI course material.

Wassertheil[5] found that writing concept units rather than larger units, a procedure she called a modular strategy, had certain

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[1]Albert E. Hickey, ed., Computer-Assisted Instruction: A Survey of the Literature (3rd ed.; Newberryport, Mass.: Entelek Incorporated, 1968), p. 79.

[2]Peter Dean, "Course Authoring Techniques for CAI," in Adult Basic Education: An Institute for State and University Level Adult Basic Education Personnel, ed. by Mary Louise Collings (Raleigh, N. C.: Adult Learning Center, 1971), p. 118.

[3]Peter Pipe, "Student Attitudes - The Neglected Dimension," NSPI Journal, IV (September, 1965), p. 13.

[4]Karl L. Zinn, "Computer Technology for Teaching and Research in Instruction," Review of Educational Research, XXXVII (December, 1968), p. 19.

[5]Sylvia Wassertheil, "A Modular Strategy for Developing Computer-Assisted Instruction Programs," NSPI Journal, VII (May, 1968), pp. 618-34.

advantages. By concept units she meant materials designed to teach a particular concept, skill, technique, or set of facts. Among the advantages she attributed to writing concept units were greater flexibility in arrangement of units, greater chance of success in writing units, and less chance of traumatic revisions.

Meredith and Ferguson[1] described a method for measuring the value of student feedback in aiding refinement of CAI frames presenting open-ended questions for which there might be several legal or acceptable responses. They collected fifty responses to a question, checked the students' answers and the appropriateness of the proposed frame replies to the students' answers, and then revised the frame replies. They found that by using this procedure they could construct more appropriate intercepts or replies to anticipated correct and incorrect student answers.

Wachner[2] encouraged authors to be creative in their programs, to adopt attention-getting techniques similar to those used on television, and to consider both horizontal and vertical continuity. Horizontal continuity covered the interrelationship of media in use at the same time, while vertical continuity referred to the sequencing of media.

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[1]Joseph C. Meredith and Douglas Ferguson, "Student Feedback As a Tool in CAI Frame Development," International Journal of Experimental Research in Education, VII (1970), pp. 221-302.

[2]Barbara Wachner, "I Forgot How to be Interesting," NSPI Journal, VI (March, 1967), pp. 10-14.

Scott and Yelon have indicated that other persons can be helpful in determining program effectiveness during the developmental stages. They have suggested that modifications in course design can be made on the basis of reactions of individual students or small groups of students prior to any field testing. The students must, however, understand that the materials, not they, are being tested. First bright students, who possibly would be less confused by instructional sequences in rough form, and then slower students can give some indication of how appropriate and effective the materials are. Scott and Yelon have also pointed out that "subject matter sophisticates" (SMS's) can be helpful to authors in identifying inconsistencies and format errors and can evaluate the content of the course. As to how much try-out with individual students or SMS's is enough, Scott and Yelon have stated:

> A rule of thumb for determining a cut-off point is to stop when two or three successive sessions have shown that target population students can perform the instructional outcomes without help from the person conducting the try-out.[1]

C. Evaluation of Computer-Assisted Instruction Course Material During Initial Preparation

Rogers[2] several years ago reviewed problems in CAI and observed that lack of quality CAI course material constituted a major problem. He called attention to the need for evaluated course materials.

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[1] Roger O. Scott and Stephen L. Yelon, "The Student as a Co-Author - The First Step in Formative Evaluation," Educational Technology, October, 1969, p. 76.

[2] James L. Rogers, "Current Problems in CAI," Datamation, (September, 1968), pp. 28-33.

Cartwright has identified recent trends in curriculum evaluation: evaluation is becoming acceptable and broader in base; as the contribution that formative evaluation can make to curriculum development receives greater recognition, there is a corresponding decrease in emphasis on summative evaluation; and, in spite of this recognition, " . . . the large majority of CAI publications and papers that have become available in the last two years still are reporting summative evaluation activities. . . . "[1]

1. Formative and Summative Evaluation

Cartwright and Mitzel[2] described both the formative and summative procedures they followed during the preparation of a three-credit CAI course designed for regular classroom teachers primarily in rural areas entitled "Early Identification of Handicapped Children." During the formative evaluation procedures, which covered approximately six months, fifteen students took the course while a proctor observed and recorded any student comments and program bugs. Technical problems went to the programer and content problems were given to the author who made necessary changes. Once all revisions has been organized, the course was revised and a second pilot group of fifteen students took the course unattended by a proctor. In addition, two graduate students

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[1]Cartwright, "Issues," p. 2.

[2]G. Phillip Cartwright and Harold Mitzel, Development of a CAI Course in the Identification and Diagnosis of Handicapping Conditions in Children: Final Report No. R-44 (University Park, Pa.: The Pennsylvania State University CAI Laboratory, June, 1971).

in special education completed the course and submitted their evaluation reports. Finally, 115 inservice teachers completed the course. Extensive revisions were made as a result of the analyses of the responses, requests for assistance, and response latencies collected from these students.

To conduct a summative evaluation of the course, on-campus students who registered for "Introduction to the Education of Exceptional Children" or CARE 1[1] were randomly assigned to conventional instruction (CI) and to CAI. Objectives for both courses were the same; in fact, the teacher of the CI class had been one of the CAI course authors. Using time to complete the course and score on the 75-item final exam as variables, the authors reported that analyses of their data indicated the CAI students (n=27) scored significantly higher than CI students (n=87) on the final exam and completed the course in twelve hours less time than the CI students.

At the University of Texas CAI Laboratory[2] a summative evaluation of CARE 1 was conducted to determine both the acceptability of CARE 1 to inservice teachers in Texas and the value of CARE 1 for preservice teacher training at the University of Texas. Thirteen graduate students in special education examined the content and presentation of CARE 1 and estimated the course to be feasible for both inservice and preservice training.

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[1]Computer Assisted Remedial Education 1 or CARE 1 is the three credit course entitled "Introduction to the Education of Exceptional Children."

[2]Agnes Edwards and Wilson A. Judd, Evaluation of CARE 1 for Projected Use at The University of Texas: Technical Report No. 12 (Austin, Texas: The University of Texas at Austin Computer Assisted Instruction Laboratory, January, 1972).

During a summer inservice teacher training workshop, seventeen teachers from El Paso completed CARE 1 at the CAI Lab. In addition to their on-line time, these teachers met for a one-hour discussion each day to consider the course content in light of each teacher's own teaching experience. At the completion of the final exam, the teachers were asked to fill out a forty-two item Student Opinion Survey dealing with such things as attitudes toward CAI, likes and dislikes of the course, and operation of the equipment. The Lab reported that the teachers expressed "a relatively favorable opinion."[1]

During the 1971 fall term, selected chapters of CARE 1 were used as an adjunct to a regular course entitled "Behavioral Science Foundations of Elementary Education." The purpose was to determine the efficacy of CAI compared to conventional instruction and to see how well CAI worked in combination with conventional instruction. The sixty-nine students who had registered for the conventional courses were randomly assigned to one of three groups. All three groups attended class lectures. Only groups A and B were provided with an abridged version of the CARE 1 Handbook. Groups B and C met weekly for a one-hour discussion session. Group A worked through the on-line CARE 1 course material. Groups B and C were not exposed to any CAI material. Analysis of pre- and post-test adjusted means for the three groups showed a significant difference favoring Group A on both the CARE 1 section of the test and on the total test. There were no significant differences among the three groups on the lecture portions of

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[1] Ibid., p. 13.

the test, but the differences that did occur were in favor of Groups A and B, the groups that used the Handbook. From the results of this summative evaluation, the staff at The University of Texas concluded that:

> Although CARE 1 was designed primarily for the training of inservice teachers, this evaluation shows that the course is also applicable to preservice training, and can be used as an adjunct to an existing conventional course.[1]

Confer[2] reported another summative evaluation of a CAI course designed to teach general math. Students, all repeaters in general math, were randomly assigned to regular class instruction and to CAI instruction during a summer school session. Performance at the end of instruction in computation and problem-solving was measured with the Stanford Achievement Test (SAT). Analysis of covariance indicated no significant differences between the two groups on SAT scores. Confer concluded that his results neither confirmed nor rejected CAI as a method of instruction. Among his recommendations was the need for an analysis of all students' responses to help determine necessary changes in the CAI general math course.

In a speech at the Association for the Development of Instructional Systems in 1971, Cartwright stated:

> It is unlikely that summative evaluation per se will improve the quality of instruction. Formative evaluation, however, is a model that can be used to improve the quality of instruction.
> . . . . . .

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[1] Ibid., p. 22.

[2] Ronald W. Confer, "The Effect of One Style of CAI on the Achievement of Students Who Are Repeating General Math." (unpublished Ph.D. dissertation, University of Pittsburgh, 1970).

> It seems to me that criterion-referenced instruction as a goal and formative evaluation as a method is the way to go at this point in time in the development of CAI.[1]

2. Criteria for Evaluation of CAI

Seltzer has written:

> What the computer can and cannot do is a matter of research and fact. What the computer should and should not do in instruction is based on value judgments. . . .[2]

Seltzer suggested that, in order to be in a position to make value judgments, criterion statements should be drawn up for use in evaluating the selection of the computer to assist in any particular instructional process. The criterion statements proposed are:

1. If the computer poses a unique solution to an important problem in the instructional process, then it should be used regardless of the cost involved.

2. If the computer is more efficient or effective and the cost of its use to instruct is minimal, then it should be used. And conversely,

3. If the cost of development and use of the computer in instruction is relatively high with the relative efficiency or effectiveness only marginal, then the computer should not be used in the instructional process.[3]

These criterion statements look at CAI cost, effectiveness, and efficiency in comparison to alternative means of instruction. They

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[1] Cartwright, "Issues," p. 9.

[2] Robert A. Seltzer, "Computer-Assisted Instruction - What It Can and Cannot Do," American Psychologist, XXVI, No. 4 (April, 1971), p. 373.

[3] Ibid., p. 375.

could logically be considered during the initial design of a proposed CAI application to instruction before much instructional material had been developed.

3. Model for CAI Course Preparation and Evaluation

Bunderson constructed a prescriptive model for the design of CAI course material. He explained the circumstances which prompted his effort:

> The instructional design model described in this chapter was originated to provide management and quality control for curriculum development, to provide a bridge between the curriculum development and basic research activities of the laboratory, and to serve as a focus for teaching students and others how to design quality CAI programs. Its development was influenced by the author's attempts to adjust to a joint appointment between educational psychology and computer science and to communicate with staff members and students from both fields.[1]

Bunderson discussed the activities to be performed by the instructional designer, their approximate sequence, and the product of each activity. The design activities in the sequence Bunderson outlined are:

1. Intent and justification
    a. Write societal needs.
    b. Write institutional needs.
    c. Write program goals.
        1. Describe job requirements.
        2. Describe student population.
        3. Describe institutional constraints.
    d. Write justification for CAI.

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[1] C. Victor Bunderson, "The Computer and Instructional Design," in Computer-Assisted Instruction, Testing, and Guidance, ed. by Wayne H. Holtzman (New York: Harper and Row, Publishers, 1970), p. 46.

2. Instructional design: analysis
   a. Derive operational requirements from goals.
      1. Derive terminal objectives.
      2. Set entering performance standards.
      3. Consider effect of constraints on program design.
   b. Behavioral analysis.
      1. Obtain intermediate objectives through analysis of terminal objectives.
      2. Construct learning hierarchy.
   c. Analysis of learner traits.

3. Instructional design: synthesis
   a. Specify interface.
      1. Display and response devices.
      2. Representation.
   b. Construct individualizing flow chart.
      1. Hierarchy-based gating mechanisms.
      2. Trait-by-treatment branches.
      3. Continuously adaptive mechanisms.
   c. Write working draft.
      1. Construct curriculum-embedded tests controlling major flow.
      2. Write steps and describe format of steps.

4. Produce program materials.
   a. Code from author's draft.
   b. Produce media.
   c. Debug code and proof media.

5. Evaluate and revise.
   a. Editorial evaluation.
   b. Internal empirical evaluation.
   c. External empirical evaluation.
      1. Validation testing.
      2. Longitudinal validation.

6. Use of feedback
   Return to any previous step as indicated by evaluation, revise, and recycle.

In his discussion of parts of his model, Bunderson observed that the construction of a learning hierarchy (see above, 2.b.2.) seems

> . . . readily applicable to any cumulative subject matter such as mathematics, much of science, and even music. It seems less applicable to highly verbal areas.[1]

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[1] Ibid., p. 56.

4. Summary

A survey of the literature related to both evaluation and CAI reveals that models for formative evaluation are available for use in developing course materials, that authorities urge formative evaluation be incorporated into initial CAI course development projects, and that to date formative evaluation procedures have not been reported in many completed projects. In the one model designed specifically for CAI course preparation, the author observed that some of the activities he outlined were more suitable for subject matter with inherent structure rather than for highly verbal subject matter on which several structures might be imposed.

Authorities continue to stress the need for formative evaluation during initial CAI course preparation for purposes of course improvement. They see little information in summative evaluation results that can help authors locate course weaknesses or errors.

The application by a course author of a formative evaluation model to the initial preparation of a CAI course would seem strongly indicated.

CHAPTER III

PROCEDURES

In order to complete this study involving the use of formative evaluation during the initial preparation of a CAI course, the investigator performed the following activities:

1. Reviewed professional literature pertaining to evaluation of instructional programs, computer-assisted instruction, and evaluation of CAI course material during initial preparation (see Chapter II).
2. Selected a model for formative evaluation appropriate for an author to use during the preparation of a CAI course (see Chapter III.B).
3. Conducted a formative evaluation during the preparation of a CAI course (see Chapter IV, A-G).
4. Identified information suitable for possible inclusion in a manual for use by other authors conducting formative evaluation during the preparation of instructional programs (see Chapter IV, H).

A. Definition of Terms

Computer-Assisted Instruction.--Computer-assisted instruction or CAI is a means of individualizing instruction for students through the use of student/computer interactions. For purposes of this study CAI referred to the IBM 1500 Instructional System with capabilities for

tutorial and simulation programing strategies With this system course materials can be presented to students on a cathode ray tube (CRT) which resembles a television screen, on pre-recorded tapes, and on 16mm color or black and white microfilm projected from an image reel. The system can accept and process student responses entered either on the typewriter keyboard or with a light pen and can consult decision rules specified in advance by the course author to direct each student's path and progress through the course. The IBM 1500 Instructional Systems used in this study were located in the Computer Assisted Instruction Laboratory at The Pennsylvania State University and on The Pennsylvania State University CAI Mobile Laboratory. The Mobile Laboratory, a complete fifteen-terminal CAI system, is housed in a forty-foot long expandable van which can be transported from one location to another by diesel tractor. (See Appendix B for a more complete description of the IBM 1500 Instructional System and for a picture of the Mobile Laboratory.)

CAI Course.--For purposes of this study the CAI course was "Education of Visually Handicapped Children"[1] designed for regular classroom teachers in rural areas. This course will be called CARE 4 in the following discussion. (See Appendix C for a list of course objectives and a description of the course content and Appendix D for a list of references used in writing the course.)

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[1]The Special Project funded to develop "Education of Visually Handicapped Children" was performed pursuant to a grant under Title VI of the Education of the Handicapped Act (PL 91-230), Special Project Grant OEG-0-71-1604) at the University of Pittsburgh in the Department of Special Education and Rehabilitation in cooperation with the CAI Laboratory at The Pennsylvania State University.

Formative Evaluation.--For purposes of this study formative evaluation was " . . . outcome evaluation of an intermediate stage"[1] in the development of CARE 4 for the purpose of determining deficiencies and strengths during initial preparation.

Off-Line.--"performed outside of the operation of the central processor of a computing system"[2]

Off-Line Materials.--materials in hard copy or in some form accessible away from the CAI student terminal

On-Line.--"connected directly to the central computer"[3]

On-Line Material.--course material available to student only via the CAI system at a student terminal

On-Line Time.--time spent working at a CAI student station in interaction with the computer

Semi-structured Interview.--interview conducted while following an interview schedule only as a guide to discussion, not necessarily adhering to the exact wording of the questions or their order of written presentation

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[1]Michael Scriven, "The Methodology of Evaluation," Perspectives of Curriculum Evaluation, AERA Monograph Series on Curriculum Evaluation, No. 1 (Chicago: Rand McNally and Company, 1967), p. 51.

[2]Karl L. Zinn and Susan McClintock, A Guide to the Literature on Interactive Use of Computers for Instruction (2nd ed.; Stanford: ERIC Clearinghouse on Educational Media and Technology, 1970), p. 24.

[3]Ibid.

B. Selection of a Model

A review of the literature related to formative evaluation indicated that the selection of a suitable model for formative evaluation would seem to depend upon the person made responsible for conducting the formative evaluation, the point at which evaluation would begin, and the purpose of the evaluation. For purposes of this study, it was determined that the formative evaluation model selected would have to be suitable for a CAI course author, the investigator, to use from the early stages of course design to the completion of the course development for purposes of course improvement.

Five models for formative evaluation were examined:

Model I — Stake's theoretic model for curriculum evaluation (above, p. 8)

Model II — Briggs's procedures for designing multi-media instruction (above, p. 11)

Model III — Baker and Schutz's cycle for instructional product development (above, p. 13)

Model IV — Abador's model for formative evaluation of self-instructional multi-media learning systems (above, (p. 15)

Model V — Glass's prototype model for the outside evaluator of instructional programs (above, p. 18)

Bunderson's prescriptive model, which is specifically for the development of CAI course materials, was also studied (above, p. 34).

Stake's model includes both an outside evaluation of the goals, rationale, and course material and a comparison of the intended results of the instruction with the actual results. Stake did not, however,

provide the potential user with any illustration of how his model might be followed or the sequence in which the steps of his model should be carried out. No reports of anyone having used his model were located in the literature examined.

Briggs's model specified procedures to assist in the selection of materials for instructional programs, but the emphasis of the model falls on the design phase of course preparation. Briggs has stated that his model may be inadequate for skills of inquiry necessary for higher levels of learning and problem-solving.[1]

Abador's model requires that tryout students be available for a final group debriefing session with the instructional program developer, a procedure which could not easily be followed given the target population and field testing possibilities for the CARE 4 project. The model provides for no assessment of the overall project rationale and objectives.

Glass's model outlines procedures for the outside evaluator to follow in looking at a finished instructional product; it is not suitable for use by the developer of the product during initial preparation.

Bunderson's model does include essentially the same steps as the Baker and Schutz cycle; but, according to Bunderson,[2] the procedures are applicable to highly structured subject matter. During the initial design stage, the content proposed for CARE 4 was not found to be highly structured or hierarchical in nature; on the contrary, one of

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[1]Leslie J. Briggs, Handbook of Procedures for the Design of Instructional Systems (Pittsburgh, Pa.: American Institutes for Research, 1970), p. 185.

[2]C. Victor Bunderson, "The Computer and Instructional Design," in Computer-Assisted Instruction, Testing, and Guidance, ed. by Wayne H. Holtzman (New York: Harper and Row, Publishers, 1970), p. 56.

the early tasks the authors found necessary was the imposition of a structure on the proposed content in order to bring about efficient learning.[1]

The programed-style book presenting the Baker and Schutz cycle for instructional program development and the principles for using it has been described as "Wide in scope with sufficient depth to make this a must on the novice's bookshelf."[2] The instructional development cycle is basic to establishing the requirements for the components of a larger evaluation system which can include training to equip personnel, installation of the instructional product, accountability and procedural adequacy of the operating program, and a procedure for modifying all programs in the system.[3] The Baker and Schutz model does not specify an outside evaluation such as Stake has suggested.[4]

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[1]Glaser and Resnick have suggested that the logical order of a body of information is not necessarily the order most appropriate to bring about learning in students who are not already familiar with that body of information. See Robert Glaser and Lauren B. Resnick, Instructional Psychology (Pittsburgh, Pa.: Learning Research and Development Center, University of Pittsburgh, 1972), p. 209.

[2]Paul A. Twelker, Floyd D. Urbach, and James E. Buck, The Systematic Development of Instruction: An Overview and Basic Guide to the Literature (Corvallis, Oregon: United States International University in Oregon, March, 1972), p. 15.

[3]Robert L. Baker and Richard E. Schutz, eds., Instructional Product Development (New York: Van Nostrand Reinhold Company, 1971), pp. xvi-xviii.

[4]Robert E. Stake, "Toward a Technology for the Evaluation of Educational Programs," in Perspectives of Curriculum Evaluation, AERA Monograph Series of Curriculum Evaluation, No. 1 (Chicago: Rand McNally and Company, 1967), p. 5.

The investigator, after consultation with members of the dissertation committee, elected to follow the Baker and Schutz cycle for instructional product development but with the addition of an outside evaluation step to the Instructional Specification stage of the cycle. The revised model for formative evaluation which the investigator followed called for these procedures which will be discussed in detail in the next section:

1. Formulation
2. Instructional Specifications and Outside Evaluation
3. Item Tryout
4. Product Development
5. Product Tryout
6. Product Revision
7. Operations Analysis

C. Activities

Although the procedures carried out in this study are listed sequentially below, many were actually carried out concurrently. They took place between June, 1971 and August, 1972.

1. Formulation

During the Formulation period the investigator wrote a rationale for a CAI course about the education of visually handicapped children for regular classroom teachers. The investigator drew upon information available from The Pennsylvania State University CAI Lab regarding one solution to problems of inservice training of teachers in rural areas. The solution was delivery of courses to rural area teachers via a mobile CAI laboratory. (See Appendix E for a copy of the rationale.)

As a part of initial course design, the investigator surveyed the existing professional literature regarding the education of visually handicapped children. (See Appendix D for a list of references used in writing CARE 4 course material.)

In addition to examining the professional literature, the investigator conducted semi-structured interviews with three regular classroom elementary teachers and one teacher of physically handicapped children. These teachers were located through the state consultant and the coordinator and itinerant teachers in a program for visually handicapped children operated by an intermediate unit near the University of Pittsburgh. The total number of teachers interviewed was kept small because of the constraints on conducting interviews imposed by the U. S. Office of Education which was providing funds for the development of CARE 4. Each of the four teachers interviewed had had at least one visually handicapped child in her class. The questions asked (Appendix F) were designed to determine what information these teachers thought, based on their own experiences with visually handicapped children, would be helpful to other regular classroom teachers who would have visually handicapped children in their classes. The questions served as an opening to more informal conversation to uncover the desired information. The interviews each lasted approximately thirty minutes. Three were held in the teachers' schools; the fourth was held in the teacher's home at her request.

2. Instructional Specifications

As the review of the literature pertaining to education of visually handicapped children progressed, instructional objectives for CARE 4 were written in terms of students' (classroom teachers')

expected terminal behavior, and a proposed course content outline was composed along with items for the final examination. The need for a handbook became apparent as course preparation continued. The handbook was prepared during Product Development. A text for the course and a pamphlet were selected as off-line materials; these supplemented the handbook and on-line course material.[1]

Three outside experts were asked to examine the rationale, course objectives, content outline, final examination, and CARE 4 Handbook and respond to the following questions based on Stake's suggestions for outside evaluation procedures:

1. Is the rationale logical?
2. Do the purpose and objectives meet the need presented in the rationale?
3. Does the content relate to the purpose and objectives?
4. Does the final exam cover the content?
5. Does the final exam actually test the student's mastery of the course objectives?

The outside experts were chosen because of their teaching and supervisory experience, their present professional positions, and their leadership roles in national professional organizations. One was the supervisor of programs for visually handicapped children in the Pennsylvania Department of Education, another a teacher of young deaf-blind children, and the third a supervisor of programs for visually handicapped for the Boston, Massachusetts City Schools. Materials were submitted to these evaluators once copies of the CARE 4 Handbook were available.

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[1] In addition to the CARE 4 Handbook, off-line materials included Teaching About Vision published by the National Society for the Prevention of Blindness, Inc., New York, 1972; and "Helping the Partially Seeing Child in the Regular Classroom" available from the Pittsburgh Branch, Pennsylvania Association for the Blind, 308 South Craig Street, Pittsburgh, Pa.

3. Item Tryout

After sections of the course material had been written on author sheets provided by the CAI Laboratory but before they were sent to the Laboratory for programing, the course authors (the investigator and co-author) examined the CRT sheets, audio messages, image sketches, and slides for accuracy, consistency, wording, lay-out, flow within the total course, appropriateness to target population, and relevance to course objectives. Extensive revisions were made before these author sheets were sent to the Lab.

After the CAI Laboratory staff had programed the course sections, recorded the audio messages, and prepared the images, the investigator went through course sections to check content and sequence of presentation in the dynamic on-line setting.

Subject matter experts in the area of education of visually handicapped children and others in the general area of special education were asked to work through course sections and write their evaluation comments pertaining to course content, sequence, and quality on evaluation cards (Appendix G). Over several months, these evaluators spent varying periods of time on-line totaling from approximately one hour to over eight hours.

CAI Laboratory staff members also recorded their comments on course presentation as they continued their technical revisions and made revisions specified by the authors. The Lab comments were turned over to the investigator for consideration and appropriate action.

4. Product Development

Evaluation comments made early in the Instructional Specification step began to indicate the need for a handbook for students to use

in conjunction with on-line course material. In addition, students had to have access to certain off-line information in order to complete the sixth chapter of CARE 4 on-line. The authors, therefore, prepared the CARE 4 Handbook referred to in the discussion of Instructional Specifications.

To evaluate the CARE 4 Handbook and other off-line materials (above, p. 45, n. 1), copies of each were submitted to two post-master's students in special education. These students were to review the three publications giving consideration to the clarity of the Handbook chapters, the relationship of the Handbook content to the course objectives, the attitudes reflected toward regular classroom teachers and toward persons with visual impairments, consistency among the three publications, repetition of content, and the relevancy of all three publications to the course objectives. In Appendix H are reported the specific questions these students were to answer and the comments returned by one of the students.

The CAI Laboratory kept a record of the hours of on-line time spent by the authors and evaluators. Comments which had been collected from Lab personnel, subject matter experts, and special education personnel were examined by the investigator and co-author. Revisions in the sequence, content, and format of CRT's and audio messages based on these comments were sent to the CAI Laboratory. Most content and technical revisions were completed before CARE 4 was sent to the Mobile Lab for the field test.

5. Product Tryout

CARE 4 was offered for one graduate credit through Penn State Continuing Education in August, 1972 while the Mobile Laboratory was

located at The Woods School in Langhorne, Pennsylvania. Because of time constraints and because of the purpose for the tryout, the maximum number of students allowed to register for CARE 4 was set at fifteen, specifically the first fifteen to register for the course. These fifteen were to represent students in the target population for CARE 4 since they would have themselves initiated the request to take the course and would be using the facilities in the Mobile Laboratory. Only after each student had completed CARE ˙ was he permitted to start CARE 4.

6. Product Revision

After the completion of the field test, the investigator examined student response records, on-line time records for each chapter and for the total course, print-outs of unanticipated responses to course questions, print-outs of student comments made on-line by students who had branched themselves into the comment routine, and results of the final examination. On the basis of this information, further revisions were specified for CARE 4. Based on the comments received about the off-line materials, revisions were planned for the CARE 4 Handbook as well.

7. Operations Analysis

As the development work went on, the investigator identified steps that were essential for an author to take to make formative evaluation an integral part of CAI course preparation and to produce CAI course material in a form suitable for turning over to the CAI Lab for programing. These steps were reviewed with the CAI Lab staff members to uncover points where critical time delays occurred or where problems

developed and points where specific activities facilitated course preparation. Forms and procedures thought to be useful to other course development projects were also identified.

CHAPTER IV

RESULTS OF FORMATIVE EVALUATION

Formative evaluation for purposes of course improvement yields a mass of information in terms of both amount and content. The results of the formative evaluation of CARE 4 have been organized and will be reported here under the headings used in the Baker and Schutz cycle for instructional product development according to the Product Development Rules stated in Appendix A of this document.

A. Formulation

The activities during the Formulation stage of CARE 4 included the preparation of a rationale for the development of CARE 4 (Appendix E), a review of the professional literature pertaining to the education of visually handicapped children (Appendix D), and the completion of four semi-structured interviews with classroom teachers who had had at least one visually handicapped child in their classes.

The replies to the interview questions (Appendix F) showed that these teachers were concerned about the availability of special materials, the need for delivery of material on time, the attitudes of other children toward visually handicapped children, extra demands on teachers' time, and visual perception problems. Three teachers indicated a certain amount of frustration could be expected, particularly if materials were not available when needed. One mentioned that merely knowing that an itinerant teacher was available alleviated her worries.

Three stressed the need for patience. One warned of the danger of assuming that a child has had experience to give meaning to the words he uses.

Based on a study of interview comments and drawing from practical experiences as teachers of visually handicapped children, the investigator and co-author decided to:

1. Stress early in the course the importance of teacher attitudes toward visually handicapped children and the possible effects of teacher attitudes on both normally seeing and visually handicapped students.
2. Emphasize to CARE 4 students that
   a. Special materials answer neither the needs of all visually handicapped students nor all the needs of any one visually handicapped student.
   b. Many special materials are available locally or through instructional materials centers.
3. Specify early in the course that CARE 4 is about education of partially seeing and blind children.
4. Describe the role of the itinerant teacher.
5. Explain the importance of concrete experiences to the language development of children with impaired vision.

B. Instructional Specifications

The investigator used the instructional objectives for CARE 4 (Appendix C-2) as a guide in selecting and sequencing course material from the content outline which had been prepared after completion of

the review of the literature. The content outline also served as a source of items for the final examination. (See Appendix C-3 for an abbreviated form of the content outline.)

Suggestions and ideas from the teacher interviews discussed in this chapter under Formulation were incorporated into on-line materials in the following ways:

1. A CRT message in the second chapter of CARE 4 addresses itself to teacher attitudes that may be inferred from patterns of behavior. Also in the second chapter after a section of educationally relevant information a CRT message points out that, just as parents' attitudes can influence normally seeing children, so can teachers' attitudes; and that the same is true even if the children have impaired vision.
2. In the third chapter of CARE 4 students must work through a section in which they see that a child's needs may not be met just by special books or seating. The availability of special books and equipment takes up a major portion of the fourth chapter of CARE 4.
3. One section of the first chapter of CARE 4 discusses the possible implications of impaired sensory input channels in general and the visual input channel in particular. In the second chapter definitions for both partial vision and blindness are discussed and various criteria used to identify each are presented. Emphasis is placed on the process of seeing and the components of visual functioning.

The CAI Laboratory staff had suggested, as mentioned in Chapter III of this document, that a handbook be prepared to provide students

with a hard-copy of course-related information. In addition, the investigator's proposed design for the sixth chapter of CARE 4 called for certain data to be available off-line for students to use as they completed on-line material during a simulation exercise. For these reasons, plans were formulated for the CARE 4 Handbook, although no actual writing was done until the on-line course material had been composed, reviewed, and turned over to the CAI Laboratory for programing.

The three outside evaluators who were asked to examine the course rationale, objectives, content outline, final examination, and Handbook returned their comments to the investigator while the Product Tryout activities were in progress. Their replies are reported in Appendix J.

The three outside evaluators agreed that the rationale was satisfactory. Evaluator 01 suggested that more compassion be expressed for the difficulty rural schools may have in finding and keeping teachers. Evaluator 02 thought details about length and amount of course credit should be added. Evaluator 03 felt the statement defining the intended target population might be broadened to take in city teachers.

While all three evaluators judged the purpose and objectives to be adequate, they all mentioned the need for discussing resource personnel outside the school to whom regular classroom teachers could make referrals and from whom they might request assistance. The evaluators seemed particularly concerned that resource persons for vocational counseling and basic mobility be identified.

Each evaluator viewed the course content outline as meeting the purpose and objectives, but each offered items which might be appropriately inserted. These items included a distinction between acuity and

diagnosis, the importance of peer attitudes, additional criteria for selection of materials, greater emphasis on utilization of low vision, additional causes of loss of vision, and suggestions for formulating a more useful definition of partial vision.

The final examination was described as sufficiently long and comprehensive to cover the course materials. Two evaluators commented that they liked the questions which set up hypothetical situations calling for students to make decisions. Two concluded that the best examination would be the observation and report of any changes in teacher behavior in the classroom related to having completed CARE 4.

C. Item Tryout

The activities completed under Item Tryout included author revision, both before material was programed and after it was on-line, and on-line evaluation by subject matter experts and special education personnel. The author revision prior to programing preceded all other activities in Item Tryout.

The evaluators were scheduled over a five month period. Revisions viewed as necessary after examination of each evaluator's comments upon the completion of his on-line time were made as soon as possible. Those evaluators who were scheduled later in the evaluation period, therefore, actually were evaluating an already-revised version of CARE 4.

A report of the author revisions and evaluators' comments follows. The Item Tryout section concludes with illustrations of the evaluation and revision process.

1. First Author Revision

After the completion of original authoring of a course section varying in length from six format sheets with accompanying audio messages and image sketches to an entire chapter, the investigator and co-author together examined the section for accuracy, consistency, wording, lay-out, flow within total course, appropriateness to target population, and relevancy to course objectives.

For example, the investigator and co-author spent approximately three hours revising the fifth chapter of CARE 4 before sending it to the CAI Lab. They made over twenty changes in the original version by:

1. Adding seven examples to clarify statements and a question to assess student understanding;
2. Deleting three CRT messages and parts of two audio messages;
3. Rewriting six CRT and audio messages to state ideas more clearly;
4. Substituting more appropriate words or phrases for less precise ones in five CRT and audio messages; and
5. Anticipating additional answers to a CRT question and writing suitable responses for those answers.

2. Second Author Revision

The review of CARE 4 on-line began as soon as course material had been debugged at the CAI Lab. The investigator and co-author spent a total of 78.5 hours on-line on six separate occasions before and during the evaluators' on-line work.

Table 1 presents a summary of the kinds of changes that were made according to the medium to which each pertained (CRT, audio message, or image), the type (technical point, error, content remark, or compliment), and the chapter to which each applied.

3. Subject-Matter Expert Evaluation

Six subject-matter experts acted as CARE 4 students and recorded their comments on comment cards as they progressed through the course. Table 2 shows the summary of their comments according to the medium to which each referred, the type, and the chapter to which each pertained.

4. Special Education Personnel Evaluation

Six individuals with background in special education but with emphasis in areas other than the education of visually handicapped children reviewed course sections and recorded their comments on the comment cards. Table 3 summarizes the comments made by this group of evaluators according to the medium to which each applied, the type, and the chapter to which each referred.

5. Illustration of the Revision Process

Comments collected from the subject-matter experts and special education personnel were separated into remarks about technical programing aspects of the course, comments regarding course content, identification of errors, or compliments pertaining to either course content or manner of presentation. Technical problems were usually turned over immediately to Lab personnel; some, however, required author decisions as to what, if any, changes were indicated in presentation, sequence, or

TABLE 1

NUMBER OF AUTHOR REVISIONS MADE DURING ON-LINE EVALUATION

Date	Total Time[a]	Medium			Type[b]			Comments per Chapter[c]								Total Revisions
		CRT	Aud.	Im.	Tec.	Err.	Con.	1	2	3	4	5	6	7	8	
3/9-11[d]	30	50	15	9	32	4	38	18	56	-	-	-	-	-	-	74
5/12	2 1/2	15	2	6	10	3	10	0	23	-	-	-	-	-	-	23
6/21-22	12	24	10	0	23	1	10	1	32	0	0	1	-	-	-	34
6/27	5	14	8	2	9	0	15	5	2	0	2	9	6	0	0	24
7/5-7[d]	26	52	6	2	21	0	39	0	17	11	8	5	1	1	17	60
7/17	0[e]	8	0	1	2	0	7	x	3	x	x	x	1	x	5	9
7/25	3	23	0	2	12	0	13	2	4	3	0	2	4	5	5	25
Total	78 1/2	186	41	22	109	8	132	26	137	14	10	17	12	6	27	249

[a]Total time is expressed in hours.

[b]"Tec." indicates technical point, "Err." means error, and "Con." refers to a content remark.

[c]The (-) indicates that the chapter was either not written or not yet prepared for inspection on-line. The (x) indicates that the chapter, although available, was not examined on-line.

[d]Two authors participated in this on-line revision.

[e]These changes were specified after studying notes taken during the on-line sessions 7/5-7.

TABLE 2

NUMBER OF SUBJECT-MATTER EXPERT EVALUATION COMMENTS
AND AMOUNT OF ON-LINE TIME

Date and Evaluator	Total[a] Time	Medium			Type[b]				Comments per Chapter								Total Revisions
		CRT	Aud.	Im.	Te.	Co.	Er.	Com.	1	2	3	4	5	6	7	8	
#1 3/9-11	4 1/2	14	7	4	16	7	1	1	10	15	-	-	-	-	-	-	25
#2&#3 6/22	5 1/2	11	3	2	2	6	0	8	7	8	0	1	-	-	-	-	16
#4 6/28-9	4 3/4	18	4	1	3	17	1	2	4	7	8	4	x	x	x	x	23
#1 7/6-7	7	23	3	6	13	17	2	0	1	11	2	5	4	2	1	6	32
#3 7/25	2 1/4	12	4	1	3	13	0	1	x	x	x	x	2	1	6	8	17
#5 7/25	4 1/2	3	2	0	2	3	0	0	3	1	0	0	1	x	x	x	5
#6 7/25	3 1/2	10	1	3	2	12	0	0	5	9	x	x	x	x	x	x	14
Total	32	91	24	17	41	75	4	12	30	51	10	10	7	3	7	14	132

[a]Total time is expressed in hours.

[b]"Te." indicates a technical point, "Co." refers to a content remark, "Er." means error, and "Com." indicates a compliment.

[c]The (-) indicates that the chapter was either not written or not yet prepared for inspection on-line. The (x) indicates that the chapter, although available, was not examined on-line.

TABLE 3

NUMBER OF SPECIAL EDUCATION PERSONNEL EVALUATION COMMENTS
AND AMOUNT OF ON-LINE TIME

Date and Evaluator	Total[a] Time	Medium			Type[b]				Comments per Chapter[c]								Total Comments
		CRT	Aud.	Im.	Te.	Co.	Er.	Com.	1	2	3	4	5	6	7	8	
A 3/10	2 1/2	7	2	1	2	5	3	0	0	10	-	-	-	-	-	-	10
B 6/21-2	6[d]	13	3	3	6	8	4	1	5	2	0	0	11	1	0	0	19
C 6/22	3[d]	11	4	1	5	11	0	0	7	7	2	x	x	x	x	x	16
D 6/26-7	6 1/4	21	0	7	4	10	1	13	3	13	3	4	3	2	x	x	28
E 6/26-7	6 1/4	17	5	1	3	9	1	10	5	6	2	8	1	1	x	x	23
F 7/5	1 2/3	8	0	3	0	11	0	0	4	6	0	1	x	x	x	x	11
	25 2/3	77	14	16	20	54	9	24	24	44	7	13	15	4	0	0	107

[a]Total time is expressed in hours.

[b]"Te." indicates a technical point, "Co." refers to a content remark, "Er." means error, and "Com." indicates compliment.

[c]The (-) indicates that the chapter was either not written or not yet prepared for inspection on-line. The (x) indicates that the chapter, although available, was not examined on-line.

[d]Approximate total time.

mode. All other comments were reviewed by the investigator who specified what alterations were to be made in light of those comments. For example:

Technical Comment.--Near the beginning of the first chapter of CARE 4, students hear a person pull a chair out from a table, sit down, move the chair closer to the table, insert paper into a typewriter, and type several lines. The students are to identify what they have heard. The ancitipated correct reply is some form of the word 'type' and any one of the set: adjust, move, pull, push, chair, seat; insert, roll paper, typing paper; bell, ring bell. A student who types in only one anticipated correct response is asked to listen to the audio message again to see if he can identify any other sounds. If after the second time the student has not responded correctly in terms that the system can recognize, he is told the 'correct' answer and is reminded how important auditory cues are to children with limited or no vision.

Evaluator #5 did not respond correctly after the second time. Because of a technical error, she heard the message five times before she finally called for assistance. Her frustration and annoyance were apparent, and she expressed a feeling of personal failure at CAI. The error was immediately explained to her, a note was made for the programer to check the directions for progression, and several more answers were made acceptable to the system on the basis of the replies Evaluator #5 had been giving. Evaluator #5 was encouraged to continue and later reported that she was extremely impressed with CAI as a means of learning and that she had recovered from her initial bad experience.

Identification of Error.--In the section describing the sources of special materials for students in Pennsylvania, an image displays a map of Pennsylvania on which the locations of three instructional materials centers are marked. Addresses accompany each location. Evaluator E, who happened to be an assistant director of one of the centers, indicated that the suite number in one address was incorrect; the error would not probably cause any loss of mail, but it might cause a delay. The investigator made a note of the error for correction when the CARE 4 image reels are revised.

Course Content.--In the second chapter of CARE 4, students are shown a teacher observation report of a child. From the report they are to select the behaviors described which might indicate the possibility of the child's having limited vision. Evaluator A pointed out that the report actually presented only one description of behavior; the other information was the child's self-report of his visual behavior. The child's self-report information was deleted from the teacher observation report, and descriptions of the child's actual behavior were inserted.

Because CARE 4 was originally planned for teachers in Pennsylvania, one section in the original version of the course described sources of materials and equipment in Pennsylvania. It was recently reported that the Mobile Laboratory has been scheduled to travel to sites outside Pennsylvania. Branches have, therefore, been written to take CARE 4 students who are not Pennsylvania residents through similar information but of a more general nature.

Compliment.--Several complimentary remarks were made about both sections of content and manner of presentation.

In the first chapter of CARE 4 students see parts of an elephant appear on the CRT while an audio message explains how a person with limited visual input might build an idea of 'elephant.' At least five evaluators wrote that they thought the animation on the CRT reinforced the discussion on the auditory message.

In the second chapter of CARE 4 the introductory statement on an audio message stresses that using the eyes cannot hurt them or cause further impairment except in rare instances. Evaluators #2 and #3 commented that the discussion made an excellent point in favor of sight utilization.

D. Product Development

Table 4 summarizes by chapter the components of CARE 4 after all revisions were completed prior to the field test. The total number of student/computer interactions represents the total number within the course. When one considers the variety and number of programing strategies used in individualized instruction in CARE 4, it is unlikely that any one student would be confronted with every possible interaction written into the course.

Table 5 shows the final sequence of CARE 4 as it was delivered to the field test students. The segment numbers and labels indicate the relative location of chapters on the storage discs assembled for the computer.

Once course materials were prepared for the CAI Laboratory, work began on the CARE 4 Handbook. The version of the Handbook which was submitted to the outside evaluators and used for the Product Tryout contained seven chapters, one corresponding to each of the seven chapters

TABLE 4

COMPONENTS OF CARE 4

Chapter	CRT's	Audios	Images	Student/Computer Interactions	Coursewriter II Statements
I	49	,9	12	12	3806
II	216	62	56	137	9883
III	54	16	7	33	2746
IV	60	15	35	31	2797
V	67	16	9	41	3046
VI	50	7	10	31	2287
VII	35	8	5	11	1595
VIII	66	-	6	67	4048
Total	597	143	140	363	30208

TABLE 5

CARE 4 COURSE SEQUENCE

Chapter	Title	Segment	Labels
	How to	Ø	aaØl/ bibØla
1	Introduction	1	baØla
2	Identification of Educationally Relevant Characteristics of Visually Handicapped Children	2	caØla
3	Construction of Instructional Objectives	3	daØla
4	Selection of Instructional Materials	4	eaØla
5	Arrangement of Classroom Environmental Conditions	5	faØl
6	Design of Instructional Procedures	6	gaØl
7	Utilization of Appropriate Techniques for Evaluating Performance	7	haØl
8	Summary and Final Exam	8	jaØl
	Drop; Sign-off	126	drop/ fini

on-line, but excluding the final examination. Excerpts from CRT's and audio messages and illustrations taken from the images made up the contents of the Handbook.

The evaluation of the CARE 4 Handbook and other off-line materials was completed by one post-master's special education student (see Appendix H for his report). The Handbook had also been given to the outside evaluators to examine (see Appendix J-3). Based on the comments of these evaluators the off-line materials were judged to be suitable for use in the field test, but suggestions for revisions were noted for future reference.

E. Product Tryout

During August, 1972 fourteen students registered to take CARE 4 for credit while the Mobile Lab was located at the Woods School. One Lab proctor also signed up for the course but not for credit. Of these fifteen students, thirteen completed the course and two dropped it before spending any time on-line.

Table 6 shows the final exam scores for the thirteen students who finished CARE 4. Out of a possible 107 points, the mean was 92.5 and the standard deviation 6.2. Seven scores were above the mean and six fell below.

An examination of the student response record revealed how many students responded with each of the anticipated correct and incorrect answers and how many gave unanticipated answers. The CAI Laboratory provided the investigator with a computer printout of the unanticipated replies given to specific questions. These replies will be used in later revisions of CARE 4 to broaden the restricted vocabulary of

TABLE 6

CARE 4 FIELD TEST RESULTS

Student Code	Final Exam Score
Proctor	103
VWBC	93
VWGD	100
VWJH	86
VWLM	100
VWSC	91
VWAT	98
VWWK	94
VYWJ	86
VYZR	82
VZWC	94
VZFR	90
VZSS	86

$\bar{X}$ = 92.5
SD = 6.2
Highest Possible Score = 107

correct anticipated keyboard answers. These replies will also show unanticipated wrong answers which may require recognition with a special remedial response.

Within the first, second, and fourth chapters of CARE 4 are thirteen options which students may select in order to review material previously seen or to receive more information about a particular topic. Student options are recorded in Appendix K. Table 7, which summarizes the number of times each option was chosen according to information reported on the student response record, reveals that twelve of the thirteen options were selected by at least one student, and three options were chosen by at least six students.

In addition to a response record for the fifteen students, the computer stored comments made by students who chose to branch into the comment routine. A total of three students offered sixteen comments, mainly about audio quality, acceptable recognized responses, and space allowed for typing in answers. These comments are reported in Appendix L.

F. Product Revision

The investigator gathered information from the following records to plan the revision of CARE 4 at the completion of the field test:

1. Student response records;
2. Printout of unanticipated responses;
3. Student on-line comments;
4. Final examination results
5. Comments by evaluators of the off-line materials; and

TABLE 7

STUDENT OPTIONS TO BRANCH

Chapter Location	Number of Students Selecting Option
CARE 4-1[a]	
ba25a	6
CARE 4-2	
cal0a	6
cd03a	1
ce38a	2
ce49a	6
ce64b	1
ce70b	1
ce97b	2
cf05a	2
CARE 4-4	
ec02a	4
ec04a	7
ec26a	0
ec33b	5

[a]CARE 4-1 means Chapter I of CARE 4. The alpha-numeric code, ba25a, indicates a specific CRT or frame within Chapter I where the branching option was presented.

6. Comments by the outside evaluators of the rationale, objectives, content outline, and final examination.

Any decisions to revise course material were based upon a number of considerations, not just specific objective criteria. Such considerations included course objective, professional backgrounds of evaluators, technical complexity of suggestions, similarity of other comments, frequency, and the relative importance of the specific comment in light of other comments.

Based on a study of the comments offered by the evaluators and the records of student progressions through CARE 4, these changes were indicated:

1. Re-recording of audio messages.--All the evaluators and two field test students commented on the quality of portions of audio messages. In addition to changes in the content and length of some messages, and a request for another voice to do the recording, several new messages were inserted where explanations were found to be incomplete.
2. Division of Chapter Two.--A glance at Table 4 shows that the second chapter of CARE 4 is longer than any other chapter in the course. Several evaluators commented on the length and suggested that it be divided. The content allows division into four chapters with the insertion of very little additional material for the sake of continuity. The proposed separations would create the following chapters: Identification of Visually Handicapped Children, Collection of Educationally Relevant Information About Visually Handicapped Children, The Process of Seeing, and Common Causes of Limited Vision in School Children.

3. Use of comment routine more frequently.--Although all the field test students had completed CARE 1 and knew how to use the comment routine, few actually chose to comment. This may have been because only once in CARE 4 were they invited to make comments. It may have also been because these students had no comments to offer. In any event, the investigator decided to have inserted reminders to students that the comment routine was available and that course authors would carefully consider any comments students made.

4. Additions to anticipated responses.--The student response record indicated to the investigator that field test students had responded to several questions in the course with acceptable answers which were subsequently treated as unrecognized, and possibly incorrect, because the words used to communicate the answer had not been anticipated and stored in the program.

For example, in the second chapter of CARE 4 after a rather detailed discussion of clinical and functional definitions used to differentiate partial vision and blindness, students are asked five questions as a review. The first is:

> 1. Definitions describing visually handicapped children are usually one of two kinds. Name the kinds.

The anticipated answers considered correct are "clinical" and "functional." No anticipated incorrect answers are specified for this question; all answers not recognized are counted as wrong. Five students, however, gave "partially seeing" and "blind" as answers. Although counted wrong, they are reasonable wrong answers considering the phrasing of the question and the

course material that had preceded the question. Among the alternatives available, the investigator chose to let the question remain unchanged, since seven of the twelve whose answers were recorded replied correctly; add "partially seeing" and "blind" as anticipated incorrect answers; and write an appropriate response to correct any student who gives those answers.

Printouts of unanticipated responses show where typing errors cause replies to be counted as incorrect. The anticipated correct answer to another question in the second chapter is "right" which has been reduced to the key letters "ri" and "rt." One student typed "fight" which was tallied as wrong. There is no provision presently, however, to ascertain whether the student knew he was wrong for the right reason. Presumably, since he was asked to answer the question again, he would notice the typing error.

5. Content changes.--A review of the evaluation comments uncovered a number of suggested additions to course content but no deletions. Because CARE 4 is to remain a one credit course, the total size of all additions to course material must be limited. Changes currently under consideration are:

    a. Addition of options to request more information about vision screening, sight utilization, and the use of the abacus.

    b. Revision of section on clinical and functional descriptions of limited vision.

    c. Substitution of frequently missed final exam questions with more hypothetical situations requiring students to make decisions.

d. Revision of Handbook, particularly if the second chapter CARE 4 is divided into four chapters; in addition, other chapters need editing.

G. Operations Analysis

As course development and formative evaluation steps proceeded, it became apparent that the completion of certain author activities hinged upon the completion of other activities. The investigator identified the activities which seemed to be critical and arranged them in a flowchart as illustrated in FIGURE 5. Only those events which must be completed by the author before materials are submitted to the CAI Laboratory are indicated.

The flowchart of author events was given to the educational programer who managed the technical aspects of CARE 4 development. She pointed to events five, six, and eleven as crucial to the completion of any CAI project: an author must know how the CAI system for which he is writing operates, he must know exactly what his objectives are for his course, and then he must start writing course material. Authoring material, although a demanding and time-consuming task, requires only a small part of the total course development time. (Appendix M summarizes the steps which must come after course material is submitted to the CAI Laboratory at The Pennsylvania State University.) Programing and debugging consume many hours of CAI Laboratory time in addition to time for the preparation of audio tapes and image reels. Table 8 summarizes the on-line times of the course authors, technical programers, subject matter experts, special education personnel, and others. The times reported in Table 8 do not reflect the use of the 1500 System in the Mobile Laboratory.

1. Possible need for a CAI course identified.
2. Preparation of CAI course rationale completed.
3. Review of professional and research literature related to course completed.
4. Representatives of target population interviewed.
5. Practice at CAI student terminal to learn system capabilities completed.
6. Course objectives prepared.
7. Final exam prepared.
8. Course outline prepared.
9. Comparison of course objectives, final exam, outline, and rationale for consistency.
10. Outline, objectives, final exam and rationale submitted to outside evaluators.
11. CRT's written.
12. Audio messages written.
13. Image sketches completed.
14. Photographs taken.
15. Evaluation of outside evaluation comments completed.
16. Modifications in course rational, objectives, final exam, and outline completed.
17. Course material completed.
18. Author revisions on paper completed.
19. Clean copy for CAI Lab completed.
20. Clean copy mailed to CAI Lab.

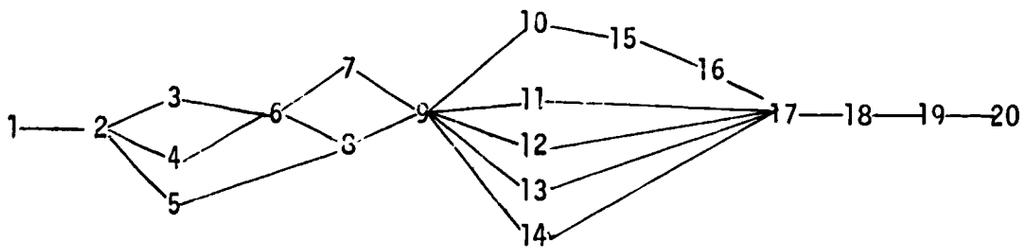

Fig. 5. Autho events prior to submitting course material to CAI Laboratory.

TABLE 8

1500 SYSTEM USAGE FOR CARE 4[a]

Date		Author	Student	Total Time-Sharing System	Listing[d]	Total Dedicated Use
October 1971	b	37.10	-	37.10	0.10	0.10
November		0.13	-	.13	-	-
December		23.65	-	23.65	.31	.31
January 1972		64.96	-	64.96	0.70	0.70
February		35.83	2.07	37.90	1.36	1.36
March		85.73	3.47	89.20	2.10	2.10
April		22.16	-	22.16	0.37	0.37
May		34.06	-	34.06	0.65	0.65
June	c	183.60	52.58	236.18	2.78	6 48
July		141.56	103.32	244.88	2.83	4.39
August		2.10	11.01	13.11	0.07	0.07
TOTAL		630.88	172.45	803.33	11.17	16.53

[a]System usage is expressed in terms of hours on the 1500 System in the CAI Laboratory only.

[b]Period of course development.

[c]Period of subject-matter expert and special education personnel evaluation and author revision; field testing was done on the 1500 System in the Mobile Lab for which times are not available.

[d]Listings refer to printouts the computer prepares. The time indicated means the System spent that amount of time dedicated exclusively to printing out CARE 4 data.

The educational programer emphasized the importance of an author's beginning to write course material as soon as possible since all CAI Laboratory work is tied to whatever the author specifies on the authoring sheets. She stressed the necessity of adhering to realistic deadlines for the completion of author activities

In analyzing the completion of CARE 4 activities, the educational programer and investigator agreed that course material should have been submitted to the CAI Laboratory sooner than it was in order to prevent the rush of activity that occurred as the course preparation time came to an end. Since time, which could have been devoted to online revision of course material had material been submitted earlier, had to be dedicated to programing, the quality of the final product may have suffered.

H. Procedures and Forms Found Effective and Suitable for Possible Inclusion in a Manual for a CAI Course Author to Use While Conducting A Formative Evaluation

As a result of having completed the formative evaluation activities and of having reviewed the operations analysis of CARE 4, the investigator identified certain procedures and forms which were effective in the preparation of CARE 4. These procedures and forms may be useful to other CAI course authors preparing course material for th 1500 System while at the same time conducting formative evaluation

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[1]Times differ from those reported under Item Tryout because individuals besides those described in this document also spent time on CARE 4 for other purposes, one of which was to learn how the 1500 System operates, and their times were included in the total times.

activities. Some discussion of these procedures and forms might be appropriate to include in a manual for authors of CAI course material.

Use of the Baker and Schutz cycle.--The Baker and Schutz cycle for instructional product development provided a framework within which the investigator could schedule procedures appropriate for CARE 4 course development. This model for formative evaluation was judged to be quite satisfactory for purposes of formative evaluation of CARE 4 course material.

On-line time to learn the 1500 System capabilities.--Time spent on-line learning the capabilities of the 1500 System and how others had exploited them provided the investigator with ideas about how system capabilities might be used effectively and illustrated the advantages and disadvantages of certain formats for content presentation and questioning. The investigator also had the opportunity to see various forms of feedback to both correct and incorrect student responses.

Author revision prior to submission of material to CAI Laboratory.--The author revisions prior to submitting course material to the CAI Laboratory eliminated many corrections and changes which would have consumed on-line time to make or which would have necessitated the programer's discussing with the author just what was the intent of certain author instructions.

Use of evaluation comment cards --Evaluators reported that use of comment cards with space to identify the label and medium made the evaluator's task of recording comments less time-consuming. The investigator found that the cards reduced the investigator's time required to iden-

tify the material to which each comment referred. Laboratory personnel adopted the same comment card format the investigator had set up for course evaluators, another apparent indication of the usefulness of the card. Prior to that time blank cards had been provided for evaluators by the Laboratory. Comment Card A, described by some evaluators as too restrictive, was chosen only occasionally by three of the twelve on-line evaluators. All other comments were written on Card B (Appendix G-2 and G-3).

CHAPTER V

SUMMARY, CONCLUSIONS, LIMITATIONS, AND SUGGESTIONS FOR FURTHER INVESTIGATION

This examination and application of formative evaluation by an author during the preparation of CAI course material required the completion of a variety of activities which will be summarized in this chapter. The conclusions drawn from the results of the formative evaluation activities will also be reported along with certain limitations of the study and several suggestions for further investigation. Attention is called to the fact that, because of the descriptive nature of this study, the conclusions reported here and the suggestions for further investigation based on those conclusions reflect the experiences of the investigator during the particular activities as described in this document.

A. Summary

The purpose of this study was to investigate and report an author's use of formative evaluation during the preparation of a course designed for presentation to students via computer-assisted instruction. In order to complete the study the investigator examined models for formative evaluation of course material and then, after conferring with dissertation committee members, selected a model appropriate for an author to use during the preparation of CAI course material. Using the model selected, she conducted the

formative evaluation of a CAI course entitled "Education of Visually Handicapped Children" and identified information suitable for possible inclusion in a manual for other CAI course authors to follow when conducting formative evaluation during the preparation of instructional programs. The model chosen, the Baker and Schutz cycle for instructional product development, called for seven general procedures: formulation of a rationale for the proposed course; specification of the instructional objectives, course content, and final examination; tryout of small sections of the course; development and assembly of the entire instructional product; product tryout with a small group of students representative of the target population; product revision subsequent to analysis of product tryout results; and operations analysis of the complete development program to identify strengths and weaknesses in the formative evaluation procedures. From the Stake model for formative evaluation the investigator added to the general procedures the outside evaluation of rationale and course components.

The completion of the procedures necessitated interviews with regular classroom teachers, evaluation of rationale and course components by outside evaluators, evaluation of on-line course material by subject matter experts and special education personnel, and two author revisions of course material. In addition, a field test with fifteen students was conducted in a mobile CAI Laboratory operated by The Pennsylvania State University. At the conclusion of the study, revisions were specified for both on- and off-line course material, and procedures and forms were identified that possibly could be

included in a manual for other CAI course authors to follow while conducting formative evaluation activities during preparation of CAI course material.

B. Conclusions

Based on the completion of the examination and application of formative evaluation by an author during the initial preparation of a CAI course, the investigator drew the following conclusions:

1. The Baker and Schutz general model for instructional product development as adapted for this study is appropriate as a guide in designing formative evaluation procedures for CAI course preparation.
2. Formative evaluation procedures can be carried out by a CAI course author.
3. Weaknesses in course material can be easily identified when evaluators specify precisely where difficulties arise and when student response records reveal exactly what questions students miss and what incorrect responses they offer.
4. Results of formative evaluation procedures can assist the CAI course author to identify errors and weaknesses in CAI course material before any students take the course for credit.
5. Initial success with CAI student terminal equipment is important in order to maintain a student's confidence and desire to continue with the course; system delays, technical errors, and unnecessary program loops detract from the efficiency of the system and seem to affect student attitudes toward CAI as a means of learning.

C. Limitations of the Study

The investigator in reviewing the formative evaluation procedures as they actually were performed noted several limitations in the procedures of this study.

1. The investigator did not make formative evaluation an integral part of course design and development in a systematic manner until several months into the CARE 4 project. This resulted in inefficient use of the CAI Laboratory staff time in the early stages of course development and cut into author revision time near the end of course development.
2. Reports from outside evaluators were received too late to be used in revising CARE 4 for presentation to students during the field test in Langhorne. They were, however, available for use during Product Revision.
3. No accurate time records were collected from field test students in the Mobile Laboratory. As a result, no reliable estimate of the average amount of time students took to complete CARE 4 could be made.
4. Copies of Teaching About Vision were distributed through a bookstore located at some distance from the Mobile Laboratory site in Langhorne; and it was reported that few CARE 4 field test students purchased this book, even though the book was listed as a required text for the course. The student response record for the second chapter of the course may reflect this fact since it was assumed by the authors that students would refer to this text for review of information necessary to complete that chapter on-line.

5. Only four classroom teachers were interviewed during the formulation activity because of the constraints imposed upon the study by time, budget, and the U. S. Office of Education regulations on conducting interviews without prior approval of the interview schedule by the U. S. Office of Education.
6. This study had to be completed during the time specified and the budget agreed upon by the cooperating universities before the exact procedures for the study had been determined. As a result, some of the procedures such as teacher interviews had to be arranged in the most expedient way rather than in the most helpful way for purposes of the study.

D. Suggestions for Further Investigation

Suggestions for further investigation are grouped under three major headings: CARE 4, CAI course preparation, and formative evaluation during course preparation for the IBM 1500 System.

1. Suggestions for Further Investigation Relating to CARE 4

The following suggestions for additional consideration of CARE 4 include:

a. Preparation of a pretest.--Comparison of pretest and posttest scores of students could indicate whether in fact the students were increasing their mastery of course material as a result of completing CARE 4 or whether they knew much of the course material before starting the course.

b. Comparison of final examination scores of students receiving different amounts of on- and off-line course material.--Posttest scores of three groups of students might be compared: students who had completed CARE 4 on-line and who also had used all off-line materials, students who had completed CARE 4 on-line but who had used no off-line materials other than those necessary to complete on-line material in the sixth chapter of the course, and students who had read only the off-line material. Such a comparison might show differences in the relative importance of off-line materials, on-line materials, and their combination in preparing students to meet the course objectives.

c. Consequential evaluation of CARE 4.--Such an evaluation could determine whether completion of CARE 4 had a / effect on the behaviors of teachers when they were in their classrooms working with children.

d. Effects of having completed CARE 4 on working relationships between itinerant teachers and classroom teachers.--The working relationships between itinerant teachers having completed CARE 4 and regular classroom teachers having completed CARE 4 may be influenced by the itinerant teachers' knowing the kinds of information the classroom teachers had acquired. Such a study as this would require itinerant teachers to take CARE 4 even though the target population for the course was regular classroom teachers.

2. Suggestions for Further Investigation of Procedures for CAI Course Preparation for the IBM 1500 Instructional System

A study of student response records as well as a review of the decisions which the investigator and co-author had to make regarding the effective manner in which to present course material to students prompted many questions about how to design and sequence course material. Out of these questions came these suggestions for further investigation.

a. Investigation of the differential effects of audio, audio-visual, and visual sequences on student learning of small course sections.--Students may prefer one sensory input channel over another or a combination of two; further study may or may not show that their preference is their most efficient channel for learning. Results might also suggest that one channel or combination is consistently more efficient for learning than another or that the level of complexity of course material must be considered when deciding how to present course material.

b. Development of inductive and deductive instructional sequences.--Further study may indicate that some students learn more efficiently when course material is presented either inductively or deductively. Other factors such as intellectual ability, age, and complexity of course material may also be identified as influencing learning efficiency.

c. Effects of providing student options either to branch into additional or to review previously seen information.--Although tutorial CAI courses can be designed to provide some student control of movement

through the course, most decisions concerning progress through the course are made by the author and are programed into the computer directions. Further study may reveal among other things that students prefer to be given as much control of their progress through the course as is possible or that the desire for control is related to other factors.

d. Effects of different levels of critical thinking skills on achievement in CAI courses.--It may be that success in CAI courses is related to skills involved in critical thinking as measured by instruments such as the Watson-Glaser Critical Thinking Appraisal. Students may demonstrate a range of abilities to analyze and synthesize information and to make decisions based on that information. There may be a relationship between these abilities and achievement on specific CAI courses.

e. Usefulness of Flowchart of Author Events to other CAI course development projects.--The author events identified as important to the completion of CARE 4 may or may not be important in other CAI course development projects.

f. Usefulness of the Baker and Schutz cycle for the development of instructional products to designers of other CAI course material.--The Baker and Schutz model is presented as a general model. Further application of the model by CAI course authors could increase the amount of data regarding the usefulness of the model in CAI course design.

g. Usefulness of other models for formative evaluation to designers of other CAI course material.--It was the purpose of this study to select only one model for formative evaluation to use during the development of CARE 4. Because the Baker and Schutz model as modified was judged appropriate at the conclusion of the study does not preclude the possibility that other models might also be appropriate. Other models such as those reviewed in Chapter II of this document should be tried to help determine their usefulness in CAI course design.

h. Investigation of factors in the affective domain which influence student performance on CAI courses.--Factors such as motivation, attention span, connotations included in course material, physical condition of student, and mode of presentation may have some interrelationship with the performance of students on CAI courses as well as on attitudes toward CAI as a tool for learning.

3. Suggestions for Further Investigation of Formative Evaluation

Areas for further study of formative evaluation include:

a. Usefulness of the Baker and Schutz cycle for instructional product development.--Application of this model to the design of instructional programs other than CAI courses could reveal how effectively the model can be adapted for a variety of product development projects.

b. Effects of having completed formative evaluation activities on the instructional product development skills of those persons involved in formative evaluation.--A study of the instructional product development procedures and skills of those having performed

formative evaluation activities could indicate if any effects of having completed those activities influence procedures and skills used in other instructional development projects.

BIBLIOGRAPHY

BIBLIOGRAPHY

Abador, Allan J. "Development and Validation of a Model for Formative Evaluation of Self-Instructional Multi-Media Learning Systems." Paper presented at American Educational Research Association Annual Meeting, Chicago, Illinois, April, 1972.

Airasian, Peter W. "Role of Evaluation in Mastery Learning." Mastery Learning: Theory and Practice. Edited by Benjamin S. Bloom. New York: Holt, Rinehart and Winston, Inc., 1971.

Atkinson, Richard C. and Wilson, H. A. "Computer-Assisted Instruction." Computer-Assisted Instruction: A Book of Readings. Edited by Richard C. Atkinson and H. A. Wilson. New York: Academic Press, 1969.

Baker, Robert L. and Schutz, Richard E., eds. Instructional Product Development. New York: Van Nostrand Reinhold Company, 1971.

Bloom, Benjamin S.; Hastings, J. Thomas; and Madaus, George F. Handbook on Formative and Summative Evaluation of Student Learning. New York: McGraw-Hill Book Company, 1971.

Briggs, Leslie J. Handbook of Procedures for the Design of Instructional Systems. Pittsburgh: American Institutes for Research, 1970.

Brothers, Leroy A. "Operations Analysis in the United States Air Force." Operations Research for Management: Volume II - Case Histories, Methods, Information Handling. Edited by Joseph F. McCloskey and John M. Coppinger. Baltimore: The Johns Hopkins Press, 1956.

Bunderson, C. Victor. "The Computer and Instructional Design." Computer-Assisted Instruction, Testing, and Guidance. Edited by Wayne H. Holtzman. New York: Harper and Row, Publishers, 1970.

Cartwright, G. Phillip. "Issues in Curriculum Development." Paper presented at the Association for the Development of Instructional Systems, State University of New York at Stony Brook, February, 1971.

Cartwright, G. Phillip and Mitzel, Harold. Development of a CAI Course in the Identification and Diagnosis of Handicapping Conditions in Children: Final Report R-44. University Park, Pa.: The Pennsylvania State University CAI Laboratory, June, 1971.

Churchill, C. West; Ackoff, Russell L.; and Arnoff, E Leonard, eds. Introduction to Operations Analysis. New York: John Wiley, 1957.

Confer, Ronald W. "The Effect of One Style of CAI on the Achievement of Students Who Are Repeating General Math." Unpublished Ph.D. dissertation, University of Pittsburgh, 1970.

Cronbach, Lee J. "Course Improvement Through Evaluation." Teachers College Record, LVII (May, 1963), 672-83.

Dean, Peter. "Course Authoring Techniques for CAI." Adult Basic Education: An Institute for State and University Level Adult Basic Education Personnel. Edited by Mary Louise Collings. Raleigh, N. C.: Adult Learning Center, North Carolina State University, March, 1971.

Edwards, Agnes and Judd, Wilson A. Evaluation of CARE 1 for Projected Use at The University of Texas: Technical Report No. 12. Austin, Texas: The University of Texas Computer Assisted Instruction Laboratory, January, 1972.

Feldhusen, John H. A Position Paper on CAI Research and Development. Stanford: ERIC Clearinghouse on Educational Media and Technology, 1970.

Gage, N. L., ed. "Paradigms for Research on Teaching." Handbook of Research on Teaching. Chicago: Rand McNally and Company, 1963.

Glass, Gene V. "Design of Evaluation Studies." Paper presented at the Council for Exceptional Children Special Conference on Early Childhood Education, New Orleans, December, 1969.

Hall, Keith A. "Computer-Assisted Instruction: Problems and Performances." Phi Delta Kappan, June, 1971, pp. 628-31.

Hickey, Albert E., ed. Computer-Assisted Instruction: A Survey of the Literature 3rd ed. Newberryport, Mass.: Entelek Incorporated, 1968.

Holtzman, Wayne H., ed. "Computers in Education." Computer-Assisted Instruction, Testing, and Guidance. New York: Harper and Row, Publishers, 1970.

McCormick, Ernest J. Human Factors Engineering. New York: McGraw-Hill Book Company, 1964.

Meredith, Joseph C. and Ferguson, Douglas. "Student Feedback as a Tool in CAI Frame Development." International Journal of Experimental Research in Education, VII (1970), 221-302.

Pipe, Peter. "Student Attitudes - The Neglected Dimension." National Society for Programmed Instruction Journal, IV (September, 1965), 12-13.

Popham, W. James. "Preparing Instructional Products: Four Development Principles." Instructional Product Development. Edited by Robert L Baker and Richard E Schutz New York: Van Nostrand Reinhold Company, 1971.

Popham, W. James and Baker, Eva L. "Rules for the Development of Instructional Products." Instructional Product Development. Edited by Robert L. Baker and Richard E. Schutz. New York: Van Nostrand Reinhold Company, 1971.

Rigney, Joseph W. "Potential Uses of Computers and Teaching Machines " Programmed Learning and Computer-Based Instruction. Edited by John E. Coulson. New York: John Wiley and Sons, Inc., 1969

Rogers, James L. "Current Problems in CAI." Datamation, September, 1968, pp. 28-33.

Roy, Robert H. "The Development and Future of Operations Research and Systems Engineering." Operations Research and Systems Engineering. Edited by Charles D Flagle, William H Huggins, and Robert H. Roy. Baltimore: The Johns Hopkins Press, 1964.

Scott, Roger O. and Yelon, Stephen. "The Student as a Co-Author - The First Step in Formative Evaluation." Educational Technology, October, 1969, pp. 76-78.

Scriven, Michael. "The Methodology of Evaluation." Perspectives of Curriculum Evaluation, American Educational Research Association Monograph Series on Curriculum Evaluation, No. 1. Chicago: Rand McNally and Company, 1967.

Seltzer, Robert A. "Computer-Assisted Instruction - What It Can and Cannot Do." American Psychologist, XXVI (April, 1971), 373-77.

Solandt, Omond. "Observation, Experiment, and Measurement in Operations Research." Operations Research for Management: Volume II - Case Histories, Methods, Information Handling. Edited by Joseph F. McCloskey and John M. Coppinger. Baltimore: The Johns Hopkins Press, 1956.

Stake, Robert E. "The Countenance of Educational Evaluation." Teachers College Record, LVIII (April, 1967), 527-38.

Stake, Robert E. "Toward a Technology for the Evaluation of Educational Programs." Perspectives of Curriculum Evaluation. American Educational Research Association Monograph Series on Curriculum Evaluation, No. 1. Chicago: Rand McNally and Company, 1967.

Stolurow, Lawrence. "Instructional Technology." Paper presented at a Council for Exceptional Children Special Conference on Instructional Technology, San Antonio, Texas, December 1-4, 1970.

Suppes, Patrick. "Computer Technology and the Structure of Education." Computer-Assisted Instruction: A Book of Readings. Edited by Richard C Atkinson and H. A. Wilson. New York: Academic Press, 1969.

Wachner, Barbara. "I Forgot How To Be Interesting." National Society for Programmed Instruction Journal, VI (March, 1967), 10-14.

Wassertheil, Sylvia. "A Modular Strategy for Developing Computer-Assisted Instruction Programs." National Society for Programmed Instruction Journal, VII (May, 1968), 19-20.

Zinn, Karl L. "Computer Technology for Teaching and Research in Instruction." Review of Educational Research, XXXVII (December, 1967), 618-34.

Zinn, Karl L. and McClintock, Susan. A Guide to the Literature on Interactive Use of Computers for Instruction. 2nd ed. Stanford: ERIC Clearinghouse on Educational Media and Technology, 1970.

APPENDICES

APPENDIX A

A REVIEW OF PRODUCT DEVELOPMENT RULES[1]

FORMULATION

F:1. The extensiveness of a proposed product's justification should be commensurate with the importance of the product.

F:2. Excessive time should not be spent in formulation.

F:3. In justifying the development of the new product, make certain there are no competing products of high quality.

INSTRUCTIONAL SPECIFICATIONS

IS:1. All instructional objectives should be stated in terms of the learner's post-instructional behavior.

IS:2. En-route and entry behaviors should also be described behaviorally in the instructional specifications.

IS:3. Criteria for judging the adequacy of the learner's response should be specified.

IS:4. A clearly specified method for determing learner affect toward the completed instructional product should be specified.

ITEM TRYOUT

IT:1. The criterion test must be completely prepared prior to the development of the instructional product.

IT:2. Measures of the entry and en-route behaviors should be constructed during the item tryout stage.

IT:3. Prototype items should not deviate from the behaviors described in the instructional specifications.

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[1] Robert L. Baker and Richard E. Schutz, eds., Instructional Product Development (New York: Van Nostrand Reinhold Company, 1971), pp. 167-68.

IT:4. Prototype items should be tried out with a small number of learners first, later with a larger number of learners.

PRODUCT DEVELOPMENT

PD:1. Supply the learner with appropriate practice during an instructional sequence.

PD:2. The product should provide the learner with the opportunity to obtain knowledge of results.

PD:3. The instructional product should contain provisions for promoting the learner's interest in the product.

PD:4. Avoid the development of an inflexible strategy in approaching product development tasks.

PD:5. If teachers are involved in the instructional process, make their participation as replicable as possible.

PD:6. In general, adopt a "lean" programming strategy.

PD:7. If the product is to be used in the classroom, develop it so that teacher attitudes toward the product will be positive.

PD:8. Selection of the instructional medium should be made in light of the desired instructional objectives, intended target population, cost, and other relevant considerations.

PD:9. The time devoted to the development of the product should be commensurate with the importance of the product.

PRODUCT TRYOUT

PT:1. Avoid an extremely small or extremely large number of learners when field testing the product.

PT:2. Verify that the procedures associated with the use of the product result in a replicable treatment.

PT:3. Data from field trials should be efficiently summarized for use by those who will revise the product.

PT:4. Those involved in field testing the product should collect data; they should not, themselves, engage in drawing inferences from the data.

PRODUCT REVISION

PR:1. Base product revisions on legitimate inferences from field test data.

PR:2. The primary inferences regarding product revision should be made from criterion data.

PR:3. Learner response data during the program should be considered a valuable source of cues for product improvement

PR:4. No loss of face for the initial developer should be associated with revisions of an instructional product.

OPERATIONS ANALYSIS

OA:1. Operations analysis should be performed at the conclusion of all systematic development of instructional products.

OA:2. The operations analysis should be written and transmitted to some central repository.

APPENDIX B

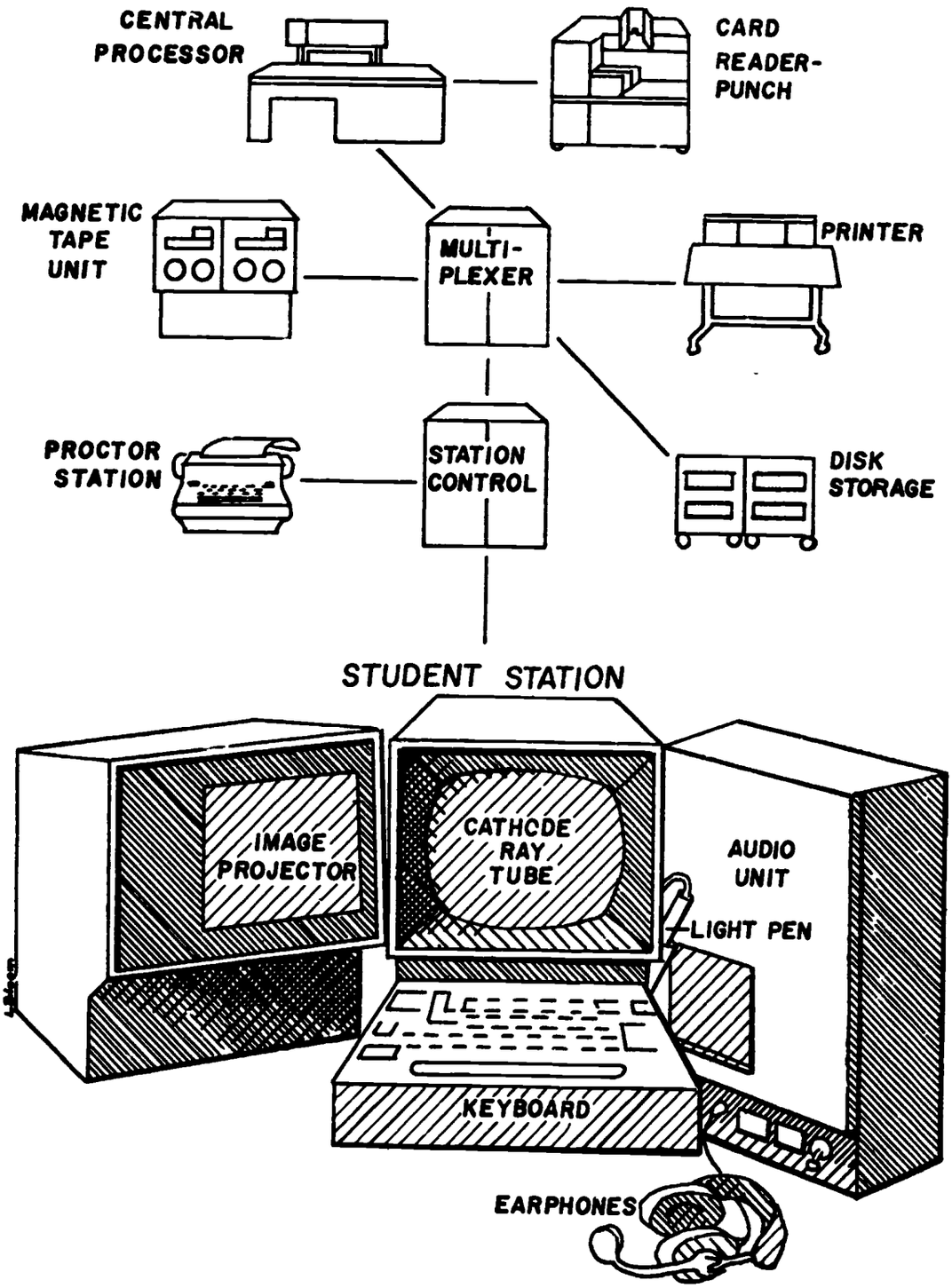
IBM 1500 INSTRUCTIONAL SYSTEM

Each student station in the IBM 1500 Instructional System in both the CAI Laboratory on the campus of The Pennsylvania State University and in the Mobile Laboratory is equipped with a cathode ray tube or CRT, light pen, typewriter keyboard, audio playback unit, and image projector. All of these components operate under program control.

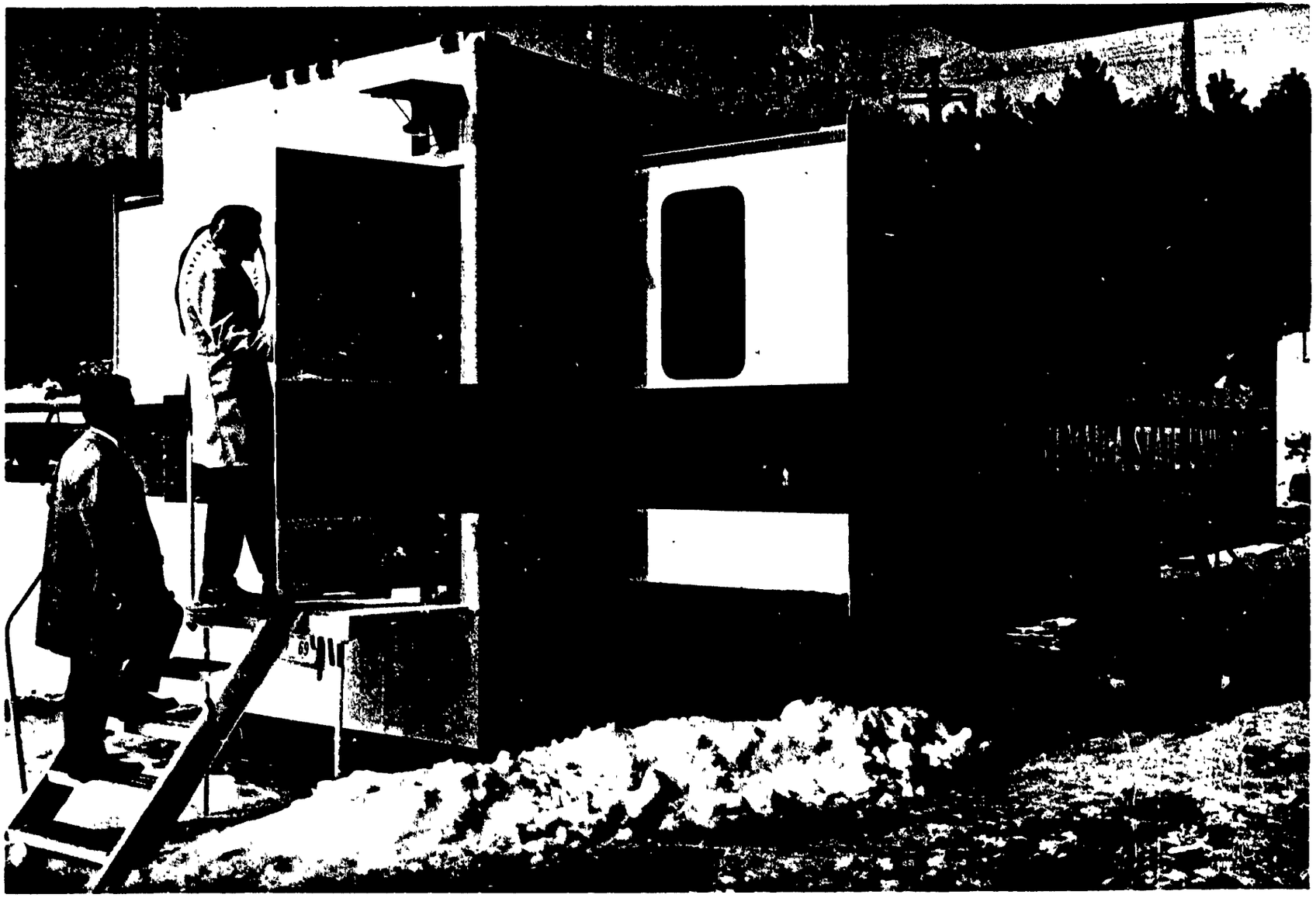
Information can be presented to the student on the CRT, on prerecorded audio messages, and/or on images shown on the image projector. The CRT screen has an area equivalent to 640 display positions or sixteen horizontal rows and forty vertical columns. Audio messages can be programed to pause while displays appear on the CRT or while images appear on the image projector. The image projector can hold a one-thousand image 16mm microfilm reel.

Students can respond to the system either by typing responses on the keyboard which appear immediately on the CRT or by pointing to specific areas on the CRT with the light pen. Responses entered either on the keyboard or with the light pen can be processed and answered appropriately by the computer according to author instructions.

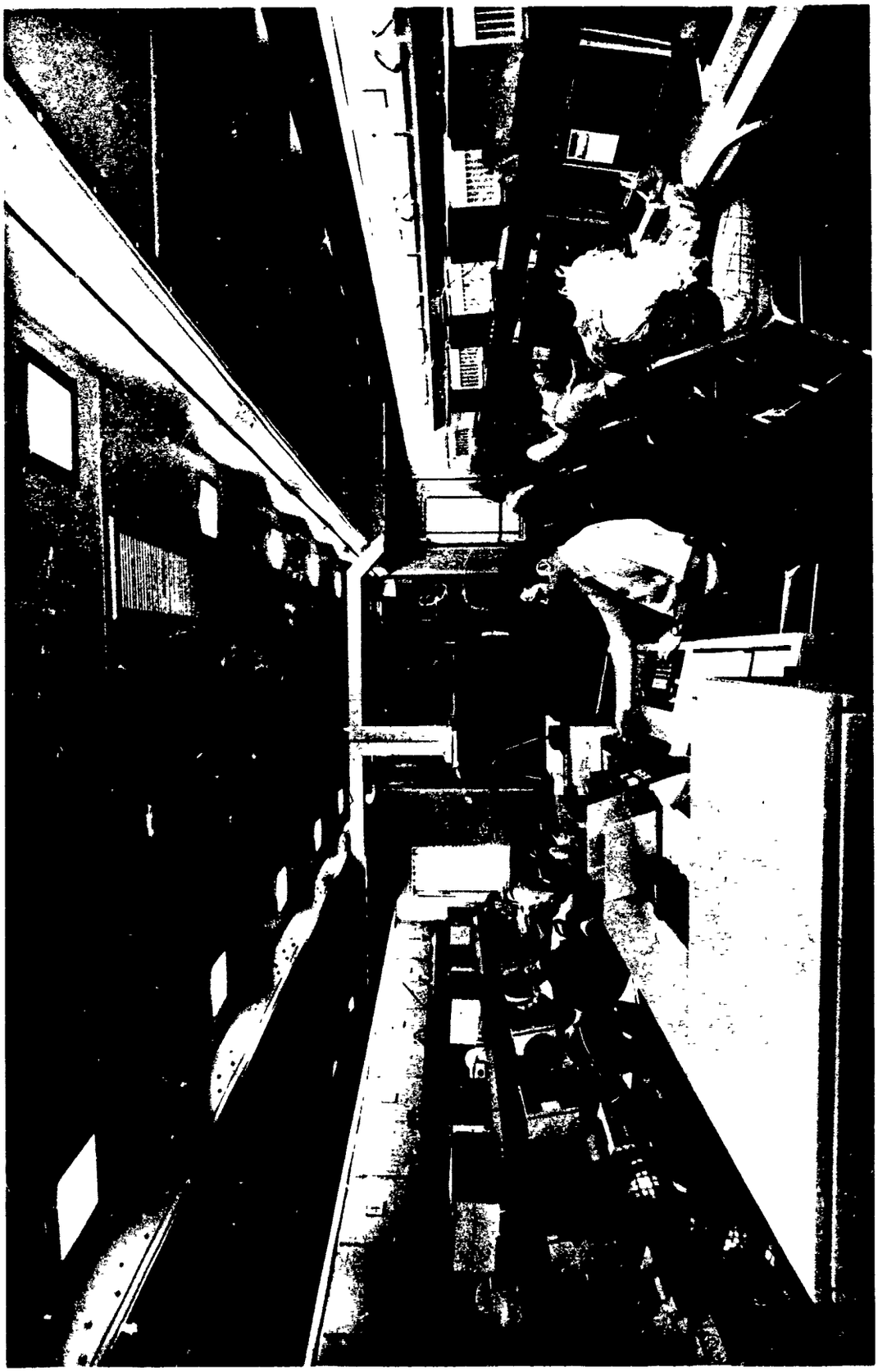
The Central Processing Unit or CPU with its support system permits the dynamic interaction between the student and the instructional system. The CPU in the 1500 System can accommodate up to thirty-two student stations. It contains 32,786 sixteen bit words of core storage.



Configuration of 1500 System



Exterior View of Mobile CAI Laboratory



Interior View of Mobile CAI Laboratory

APPENDIX C-1

CARE 4

CARE 4 was developed at the University of Pittsburgh in consortium with The Pennsylvania State University as a one-credit course for inservice training of regular classroom teachers in rural areas who have or may have visually handicapped children enrolled in their classes. The initial writing and revising of CARE 4 was done on author sheets in a format specified by the CAI Laboratory to insure clear communication between author and programer. (See Appendix H for sample author sheets.)

Although most of the images for CARE 4 were drawn and prepared by the CAI Laboratory graphic artist according to author specifications, some images were processed from 35mm color slides which show actual children with limited vision in the school environment. Other images were processed from slides showing materials and equipment frequently used by many school children who have limited or no vision.

Audio messages in the course vary in length from several seconds to several minutes. Most present information to students or elaborate upon information displayed on the CRT or on an image. Other messages indicate whether students' responses are correct or incorrect and why. On still others, students hear conversations which simulate discussions between two teachers and between a teacher and parent.

The course required 30,208 Coursewriter II statements to program for the IBM 1500 Instructional System. The course preparation time lasted fifteen months. Student time to complete the course is approximately eight hours on-line at one of the student stations in the 1500 System.

The abbreviated CARE 4 content outline which follows in Appendix C-3 shows only the main topics covered in the course.

APPENDIX C-2

STATEMENT OF PURPOSE AND OBJECTIVES
FOR CARE 4

The purpose of CARE 4, "Education of Visually Handicapped Children," is to equip regular classroom teachers, particularly those in rural areas, with the knowledge and skills they need to manage the instruction of visually handicapped children, partially seeing or blind, in their classes. The course material has been selected with rural classroom teachers in mind since educational services for visually handicapped children in rural areas at present are minimal or nonexistent in Pennsylvania and in most other states.

At the completion of CARE 4, students should be able to demonstrate their abilities to:

1. IDENTIFY educationally relevant characteristics of visually handicapped children.
2. CONSTRUCT instructional objectives for these children.
3. SELECT suitable media and materials for instruction.
4. ARRANGE proper classroom environmental conditions.
5. DESIGN instructional procedures to facilitate learning.
6. UTILIZE appropriate techniques for evaluating the performance of visually handicapped children.

APPENDIX C-3

ABBREVIATED CARE 4 CONTENT OUTLINE

I. INTRODUCTION
   A. Welcome
   B. Purpose of CARE 4
   C. Sensory Input Channels
   D. Organizational Patterns for Instruction
      1. Kinds
      2. History of educational programs
      3. Trends in placement
      4. Pennsylvania programs
   E. CARE 4 Objectives
      1. Identify educationally relevant characteristics of visually handicapped children.
      2. Construct instructional objectives for these children.
      3. Select suitable media and materials for instruction.
      4. Arrange proper classroom environmental conditions.
      5. Design instructional procedures to facilitate learning.
      6. Utilize appropriate techniques for evaluating performance of visually handicapped children.

II. IDENTIFICATION OF EDUCATIONALLY RELEVANT CHARACTERISTICS OF VISUALLY HANDICAPPED CHILDREN
   A. Identifying Children
      1. Visually handicapped children
      2. Descriptions
   B. Kinds of Information about Children
      1. Family information
      2. Diagnostic information
      3. Visual acuity
      4. Visual functioning
   C. Collecting Educationally Relevant Information about Children
      1. Refer to CARE 1
      2. Emphasis on direct observation - purpose, conditions, focus
   D. Characteristics of Typically Visually Handicapped Children
   E. The Process of Seeing
   F. The Human Eye
   G. Common Causes of Limited Vision in School Children
      1. Types by etiology
      2. Results of visual impairment in terms of visual functioning

III. CONSTRUCTION OF INSTRUCTIONAL OBJECTIVES
- A. Definition of Instructional Objectives
- B. Importance
- C. Kinds - cognitive, affective, psychomotor
- D. Sources of Instructional Objectives
  1. Observation of student performance
  2. Curriculum
  3. Special needs of visually handicapped students

IV. SELECTION OF INSTRUCTIONAL MATERIALS
- A. Factors to Consider
- B. Materials - books and equipment
- C. Criteria for Selection of Equipment
- D. Criteria for Selection of Printed Materials
- E. Attitudes Toward Special Materials

V. ARRANGEMENT OF CLASSROOM ENVIRONMENTAL CONDITIONS
- A. Factors
  1. Light
  2. Noise level
  3. Temperature
  4. Furniture
  5. Space - storage, work, moving about
  6. Equipment
  7. Learning task for particular student
- B. Arrangements for Amy, age 10, grade 5
  1. Information available
     a. Instructional task
     b. Materials to be used
     c. Visual acuity
     d. Family information
     e. Visual functioning
     f. Other sensory deficits
     g. Achievement
     h. Intellectual ability
  2. Decisions to be made
     a. Seating
     b. Furniture
     c. Supplementary lighting
     d. Location of work area

VI. DESIGN OF INSTRUCTIONAL PROCEDURES

Application segment for practice using rules and principles learned so far and for analyzing key elements of situations given and evaluating decisions made in particular given situations.

VII. UTILIZATION OF APPROPRIATE TECHNIQUES FOR EVALUATING PERFORMANCE
- A. Testing
  1. Kinds
  2. Value
  3. Considerations

B. Test Materials
   1. Alternatives to regular print tests
   2. Alternatives to writing test answers
C. Test Administration Procedures
   1. Time limits
   2. Limitations
   3. Alternatives
   4. Teacher attitudes toward evaluation
D. Use of Test Results
   1. Guide in making instructional decisions
   2. Source of information about present performance

VIII. SUMMARY AND FINAL EXAMINATION
A. Summary
   1. Review of purpose
   2. Review of several main points
      a. Learning behavior
      b. Student characteristics
      c. Attitudes and their potential influence
B. Final Examination

APPENDIX D

CARE 4 REFERENCES

Almy, Millie. Ways of Studying Children. New York: Teachers College Press, 1959.

Alonso, Lou and Henley, Charles E. "The Role of the Resource Consultant in the Education of the Visually Impaired." The Role of the Resource Consultant In Special Education. Edited by Kenneth R. Blessing. Washington, D. C.: Council for Exceptional Children, NEA. 1968.

Alpern, Mathew. "Vision." Sensory Processes. Edited by Mathew Alpern, Merle Lawrence, and David Wolsk. Belmont, California: Brooks/Cole Publishing Company, 1967.

American Printing House for the Blind, Inc.: Its History, Purposes, and Policies. Louisville, Kentucky: American Printing House for the Blind, 1966.

Ashcroft, Samuel C. "Blind and Partially Seeing Children." Exceptional Children in the Schools. Edited by Lloyd M. Dunn. New York: Holt, Rinehart and Winston, Inc., 1963.

Ball, Martha J. "Mobility In Perspective." Blindness: 1964. Washington, D. C.: American Association of Workers for the Blind, Inc., 1964, pp. 107-41.

Barker, Roger G.; Wright, Beatrice A.; Myerson, Lee; Gonick, Mollie R. Adjustment to Physical Handicap and Illness: A Survey of the Social Psychology of Physique and Disability. Bulletin 55. New York: Social Science Research Council, 1953.

Barraga, Natalie. Increased Visual Behavior in Low Vision Children. Research Series No. 13. New York: American Foundation for the Blind, 1964.

Bartel, Nettie R. and Guskin, Samuel L. "A Handicap as a Social Phenomenon." Psychology of Exceptional Children and Youth, 3rd ed. Edited by William M. Cruickshank. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971.

Braley, A. E., M.D. "The Problem of Definition of Blindness." Research Bulletin No. 3. New York: American Foundation for the Blind, 1963.

Carbonara, Nancy Trevorrow. Techniques for Observing Normal Child Behavior. Pittsburgh, Pennsylvania: University of Pittsburgh Press, 1961.

Classroom Lighting. New York: National Society for the Prevention of Blindness, 1963.

Cowen, E. L., Underberg, Rita P., Verrillo, R. T. and Benham, F. G. Adjustment to Visual Disability in Adolescence. New York: American Foundation for the Blind, 1961.

Dorf, Maxine B. "How Many Braille Books?" Volunteer News. No. 25 (October, 1971), 1.

Gagné, Robert M. The Conditions of Learning, 2nd ed. New York: Holt, Rinehart and Winston, Inc., 1970.

Graham, Milton D. "Toward a Functional Definition of Blindness." Research Bulletin No. 3. New York: American Foundation for the Blind, 1963.

Hathaway, Winifred. Education and Health of the Partially Seeing Child. 4th ed. Revised by Franklin Foote, M.D., Dorothy Bryan, and Helen Gibbons. New York: Columbia University Press, 1959.

Haupt, Charlotte. "Clay Modelling--A Means and An Education." Concerning the Education of Blind Children. Compiled by Georgie Lee Abel. New York: American Foundation for the Blind, 1959.

Hoover, Richard E., M.D. "Visual Efficiency as a Criterion of Service Needs." Research Bulletin No. 3. New York: American Foundation for the Blind, 1963.

Johnson, Ysabel. A Blind Child Becomes a Member of Your Class. American Foundation for the Blind, Educational Series No. 14. New York: American Printing House for the Blind, 1961.

Jones, John Walker. "Problems in Defining and Classifying Blindness." Research Bulletin No. 3. New York: American Foundation for the Blind, 1963.

Jones, John Walker. The Visually Handicapped Child at Home and School. Washington, D. C.: U. S. Government Printing Office, 1963.

Jones, John Walker. The Visually Handicapped Child at Home and School. Washington, D. C.: U. S. Government Printing Office, 1969.

Jones, John Walker, and Collins, Anne P. Educational Programs for Visually Handicapped Children. Washington, D. C.: U. S. Government Printing Office, 1966.

Kibler, Robert J., Barker, Larry L., Miles, David T. Behavioral Objectives and Instruction. Boston: Allyn and Bacon, Inc., 1970.

Kircher, Clara J. Behavior Patterns in Children's Books: A Bibliography. Washington, D. C.: Catholic University of America Press, 1966.

Lowenfeld, Berthold. "Psychological Problems of Children with Impaired Vision." Psychology of Exceptional Children and Youth. 3rd ed. Edited by William M. Cruickshank. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971.

Mager, Robert T. Preparing Instructional Objectives. Palo Alto, California: Fearon Publishers, 1962.

Mann, Ida and Pirie, Antoinette. The Science of Seeing. Perth, West Australia: Paterson Press, 1962.

Manshardt, Clarice E. "The Role of the Public School System in the Education of Blind with Sighted Children." Concerning the Education of Blind Children. Compiled by Georgie Lee Abel. New York: American Foundation for the Blind, 1959.

Meyerson, Lee. "Somatopsychology of Physical Disability." Psychology of Exceptional Children and Youth. 3rd ed. Edited by William M. Cruickshank. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971.

Mobility Training for the Visually Handicapped: A Guide for Teachers. Springfield, Illinois: Illinois Office of Superintendent of Public Instruction. Printed by Title VI ESEA, 1970.

Moor, Pauline M. "The Pre-School Blind Child, His Needs and Resources." Concerning the Education of Blind Children. Compiled by Georgie Lee Abel. New York: American Foundation for the Blind, 1959.

Murphey, Albert. "Attitudes of Educators Toward Visually Handicapped." Sight Saving Review. XXX (Fall, 1960), 157-61.

Patz, Arnall, M.D. and Hoover, Richard E., M.D. Protection of Vision in Children. Springfield, Illinois: Charles E. Thomas, 1969.

Peabody, Ralph L. and Birch, Jack W. "Educational Implications of Partial Vision: New Findings from a National Study." Sight Saving Review. XXXVII (Summer, 1967), 92-96.

Pelone, Anthony J. Helping the Visually Handicapped Child in a Regular Class. New York: Bureau of Publications, Teachers College, Columbia University, 1957.

Perera, Charles A., M.D., ed. May's Manual of the Diseases of the Eye. 22nd ed. Baltimore: The Williams and Wilkins Company, 1957.

Scholl, Geraldine T. "The Education of Children with Visual Impairments." Education of Exceptional Children and Youth. Edited by William M. Cruickshank and G. Orville Johnson. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1967.

Seagers, Paul W. Light, Vision, and Learning. New York: Better Light Better Sight Bureau, 1965.

Slater, D. C. "An Experiment in Visual Perception." Developmental Medicine and Child Neurology. IX (June, 1967), 271-73.

Sloan, Louise L. Aids for the Partially Sighted. New York: National Society for the Prevention of Blindness, 1966.

Stephens, Thomas M. Directive Teaching of Children with Learning and Behavioral Handicaps. Columbus, Ohio: Charles E. Merrill Publishing Company, 1970.

Teaching About Light and Sight. Washington, D. C.: National Education Association, NEA Publications Division, 1962.

Thurrell, Richard J. and Rice, David G. "Eye Rubbing in Blind Children: Application of a Sensory Deprivation Model." Exceptional Children. XXXVI (January, 1970), 325-30.

Why Safety Glasses? Pub. G-112, National Society for the Prevention of Blindness, Inc.: New York City, 1969.

APPENDIX E

RATIONALE FOR CARE 4

Recently it was reported that approximately 3.75 million of the estimated six million handicapped children in the United States are not receiving the special education services they need. Many of these handicapped children live in sparsely populated areas where school districts are too small to provide programs for even those handicapped children already identified. In addition, trained personnel are frequently not available for existing programs in rural areas, and inservice regular classroom teachers may not possess adequate knowledge to make appropriate instructional decisions for handicapped children.

One group among these handicapped children are those with limited vision, both partially seeing and blind. Many of these children can function well in regular classes with a minimal amount of direct service from a specialist, if the regular classroom teacher and school district personnel are adequately informed. Adequate and accessible inservice teacher training which allows for individual differences in background and teaching experience, in teacher performance, and in teacher availability for time for inservice coursework presents a challenge to those wishing to improve the skills of inservice regular classroom teachers.

A feasible solution to the problem of providing inservice teacher education that is accessible to teachers in rural areas and that is responsive to individual differences among teachers would seem to be

computer-assisted instruction (CAI). In a tutorial CAI system the computer selects sequences of instruction which are appropriate to an individual's background knowledge of the course content, his rate of progress through the materials, and the types of errors the student makes as he interacts with the system.

The goal of the Computer Assisted Remedial Education 4 (CARE 4) project is to design a course entitled "Education of Visually Handicapped Children" which will contribute to the inservice education of regular classroom teachers, particularly those in rural areas, who cannot return to a college campus for on-going training. Course content is to be selected for its appropriateness for regular classroom teachers who have or will have visually handicapped children enrolled in their classes.

CARE 4 course materials are to be prepared by course authors at the University of Pittsburgh and programmed for use in the IBM 1500 Instructional System by the staff of the Computer Assisted Instruction Laboratory at The Pennsylvania State University. Once developed, the course is to be made available to teachers in a custom-built expandable van operated by The Pennsylvania State University CAI Laboratory. The van contains 560 square feet when expanded and houses fifteen student stations or consoles at which inservice teachers and other education personnel take courses. The van with the CAI system can be hauled by diesel tractor to remote parts of a state and set up for instruction in a short period of time. The mobile CAI system is located for approximately six- to eight-week periods on a location adjacent to centrally located school buildings. Teachers and other interested persons drive to the central location in the afternoon or evening at their convenience

to take the course on an individual basis. The Mobile CAI Laboratory can serve more than 200 persons during each six- to eight-week stop.

It is the hope of the project staff that CARE 4 will benefit regular classroom teachers and result in more visually handicapped children being able to remain in their local communities for their education.

APPENDIX F-1

INTERVIEW QUESTIONS

1. Was your student partially seeing, totally blind, or functionally blind?

2. For what subjects and for what grade did you have the student?

3. How did he function in reading, travel, and identification of objects and people?

4. How frequently did your student and/or you receive services from the itinerant teacher?

5. What functions of the itinerant teacher did you find most helpful? least helpful?

6. Do you remember any particular worries or concerns you had prior to your first day in school with the student?

7. How would you evaluate your experience with the student?

8. If you had the opportunity to offer advice or suggestions to another classroom teacher, what would you consider important to say?

9. Were special materials provided for your student? What kinds? Were they adequate? What else would have been useful?

APPENDIX F-2

INTERVIEW REPORT

#1 and #2

1. Was your student partially seeing, totally blind, or functionally blind?

   answer: could see in one eye, but only peripheral vision

2. Grade:

   answer: grades 1 and 2

3. Function:

   answer: travel - took taxi to school; little participation in playground activities
   reading - low level if any at all
   identifying objects and people - no answer

4. Frequency of itinerant service

   answer: grade 1 - each day
   grade 2 - three times a week

5. Functions of itinerant teacher most helpful and least helpful:

   no answer

6. Concerns prior to first day with student?

   no answer

7. Evaluation of experience with visually handicapped child?

   answer: frustrating

8. Advice for other regular classroom teachers:

   answer: patience
   concern for attitudes of children toward visually handicapped child
   have materials ready on time
   expect frustration

#1 and #2 - continued

9. Special materials provided:

answer: books and special teaching "for what it was worth"

COMMENTS:

Both teachers felt frustration in having student in with the regular children when she could and would do little for herself, such as pull her seat up to the board. She demanded too much individual attention when considering the demands of the other children. Both agreed another child who did not have the additional problems might work out more satisfactorily. They suggested that a full-time aide would have helped.

INTERVIEW REPORT

#3

1. Was your student partially seeing, totally blind, or functionally blind?

   answer: had light perception

2. Grade:

   answer: special class for physically handicapped children

3. Function:

   answer: travel - in wheel chair
   reading - low
   identification of people and objects - no

4. Frequency of itinerant service

   answer: daily

5. Function of itinerant teacher most helpful and least helpful:

   answer: most helpful - obtained Talking Book, flash cards, print and braille books, got cassettes which all used
   least helpful - no answer

6. Concerns prior to first day with student?

   answer: no particular concerns; helped to know that itinerant service would be available

7. Evaluation of experience with visually handicapped child?

   no answer

8. Advice for other regular classroom teachers:

   answer: It helps to know that help is available. Blindness is or can be only one problem among many. Watch for verbalism; child may not have the real experiences to give meaning to words.

9. Special materials provided:

   answer: Talking Book, cassettes, corduroy blocks, clock

#3 - continued

a. Were they adequate?

answer: especially the clock

b. What others would have been useful?

answer: textured flag, money glued down, canvas animals

As for borrowing from the IMC, two weeks isn't long enough to use the items.

INTERVIEW REPORT

#4

1. Was your student partially seeing, totally blind, or functionally blind?

   answer: partially seeing

2. Grade:

   answer; grade 1

3. Function:

   answer: travel - no answer
   reading - no answer
   identification of people and objects - no answer

4. Frequency of itinerant service

   answer: only for tutoring

5. Function of itinerant teacher most helpful and least helpful:

   answer: most helpful - visual perception work
   least helpful - tutoring for classroom work

6. Concerns prior to first day with student?

   answer: mostly about availability of materials

7. Evaluation of experience with visually handicapped child?

   answer: Frustrating if materials were not available; otherwise a great experience for the teacher and the children.

8. Advice for other regular classroom teachers:

   answer: I would have to know about the child. Providing materials were available, it would be a great experience.

9. Special materials provided:

   no answer

   a. Were they adequate?

      no answer

   b. What others would have been useful?

      telephone number of teacher

#4 - continued

COMMENTS:

Both the teacher and the principal made little distinction between children with visual impairment and those with visual perception problems.

APPENDIX G-1

NOTE TO EVALUATORS

TO:

FROM:

You have been asked to participate in the formative evaluation of CARE IV, a CAI course entitled "Education of Children with Limited Vision." The course is being designed for presentation to regular room teachers in rural areas who may have partially seeing or blind students in their classes.

As an evaluator, your task is to 'take' the course and to comment on the content, sequence, quality, and any other aspect of the course you think appropriate. Remember, the course is the object of the evaluation, not you. Your responses to questions in the course, which will be recorded by the computer for us, along with your Evaluation Cards and those of the other evaluators will assist us in revising CARE IV during the early stages of its development.

Use one of the Evaluation Cards you receive for each CRT, audio message, or image on which you wish to comment. YOU ARE NOT EXPECTED TO COMMENT ON EVERY CRT, AUDIO MESSAGE, OR IMAGE - only those which you would like to call to our attention either because they are particularly effective or because they need revision.

On each card you use, beside FRAME LABEL fill in the alphanumeric code you see displayed in the lower right hand corner of the CRT. If you are referring to an image or audio message, use whatever frame label shows while the image is visible or while the audio message plays.

The items listed on the Evaluation Cards are suggestions upon which you can base your appraisal. Feel free to make additional remarks in the space provided.

When you have finished, please return your cards to the proctor.

Thank you very much for your help. Take CARE!

MEW/sp

APPENDIX G-2

EVALUATION CARD A

FRAME LABEL

MEDIUM: _____CRT _____IMAGE _____audio

Content:
- vocabulary
- sentence structure
- logic
- clarity
- importance

Sequence:
- logical
- congruous

Quality:
- color
- composition
- length
- pace

COMMENTS:

APPENDIX G-3

EVALUATION CARD B

FRAME LABEL: _____ MEDIUM: _____CRT

_____image

_____audio

APPENDIX H-1

QUESTIONS FOR EVALUATION OF OFF-LINE MATERIALS

1. Does the content of the Handbook relate to the purpose of CARE 4 as stated on page 2 of the Introduction?

2. Does the content of the Handbook provide what is necessary for a student to meet the course objectives as stated on page 2 of the Handbook?

3. Does the content of each chapter actually deal with the topic as expressed in the chapter title?

4. Are any Handbook sections confusing or unnecessarily complicated? If so, where?

5. What would you like to see included or omitted in a revision of the Handbook?

6. What attitudes, if any, do you find reflected in the Handbook content regarding:

    a. persons with visual handicaps
    b. regular classroom teachers
    c. school placement of children with visual handicaps?

7. Refer to page iii for the coordination of CARE 4 Handbook chapters with Teaching About Vision and the pamphlet entitled "Helping the Partially Seeing Child in the Regular Classroom."

    a. Do the Handbook and Teaching About Vision chapters actually fit together or complement each other?
    b. Are there any contradictory statements/

8. Please make any additional comments you feel would be helpful.

APPENDIX H-2

EVALUATION OF CARE 4 HANDBOOK

1. Does the content of the Handbook relate to the purpose of CARE 4 as stated on page 2 of the Introduction?

The purpose of the Handbook is to provide knowledge and skills necessary to deal with visually impaired children in the classrooms. The Handbook readily meets this challenge in terms of providing the theoretical knowledge. I am however, not quite sure that adequate guidelines in terms of providing necessary skills receive sufficient attention.

The types of skills necessary for teachers of the visually impaired children as applied to the purpose of the Handbook should receive further consideration. The necessary skills should be spelled out to enhance easier reading and practical application in a classroom situation.

2. Does the content of the Handbook provide what is necessary for a student to meet the course objectives as stated on page 2 of the Handbook?

If knowledge and skills are synonymous, I would contend that the content of the Handbook provides what is necessary for a student to meet the course objectives. It seems to me, however, that knowledge as an entity cannot be described as skills. It is the application of knowledge that I consider as skills. To really meet the objectives as stated in the Handbook, some kind of real life situation should be included in the course activities.

3. Does the content of each chapter actually deal with the topic as expressed in the chapter title?

The content of each chapter clearly and relevantly deals with the topic as expressed. The content of each chapter gives direct, precise accounts that I believe are well organized and should be helpful to students who take the course.

4. Are any Handbook sections confusing or unnecessarily complicated? If so, where?

As I indicated in question three above, the Handbook is orderly, well organized, and I do not see any confusing or complicated sections of the book.

5. What would you like to see included or omitted in a revision of the Handbook?

The Handbook proposes that teachers who are responsible for making decisions regarding the selection of instructional materials consider three factors (p. 32) I would like the fourth factor to be included in making a revision of the Handbook

The fourth factor that I would like you to consider is: The particular INTEREST of the group of students should not be neglected and should be considered in making decisions regarding selection of instructional materials. Although, literature reveals that the psychological feelings of the visually impaired have no significant deviation from the average population, I would, however, like a chapter on the psychological effects of blindness, if any, to be included in the Handbook. I would also like to see summaries of the salient points in each chapter of the Handbook made in the process of future revision.

6. What attitudes, if any, do you find reflected in the Handbook content regarding: persons with visual handicaps, regular classroom teachers, and school placement of children with visual handicaps?

The Handbook deals more specifically on methods or procedures of acquiring knowledge and skills useful to teachers in dealing with visually handicapped children rather than on attitudes. The Handbook content does not in my view present any specific attitudes outside the realm of knowledge and skills development.

7. Refer to page iii for the coordination of CARE 4 Handbook chapters with Teaching About Vision and the pamphlet entitled "Helping the Partially Seeing Child in the Regular Classroom." Do the Handbook and Teaching About Vision chapters actually fit together or complement each other? Are there are contradictory statements?

A thorough examination of the Handbook, and Teaching About Vision and even the pamphlet clearly reveals that the three books fit together beautifully. Teaching About Vision, however, contains more technical terminologies than either of the other two books. There seems to be lack of complement in the sixth chapter of the Handbook and the sixth chapter of Teaching About Vision. Chapter six in the Handbook deals with the design of instructional procedures while chapter six in Teaching About Vision seems to dwell on the problems encountered in reading as a result of poor vision.

8. Please make any additional comments you feel would be helpful.

As I stated in my view to question two, the knowledge and skills that the Handbook intend to impart to students will be more effective and meaningful if some kind of practical application goes with the use of the book. This may be done by having the students do some demonstrations or dramatizations of the contents of each chapter or actually work with the visually impaired children for a short period of time to supplement the factual contents of the Handbook.

APPENDIX I

AUTHOR FORMAT SHEETS

IMAGE PLANNING FORM Image No. _____

Date: _____ Author: _____ Date Required: _____ Course: _____

SPECIAL INSTRUCTIONS: _____

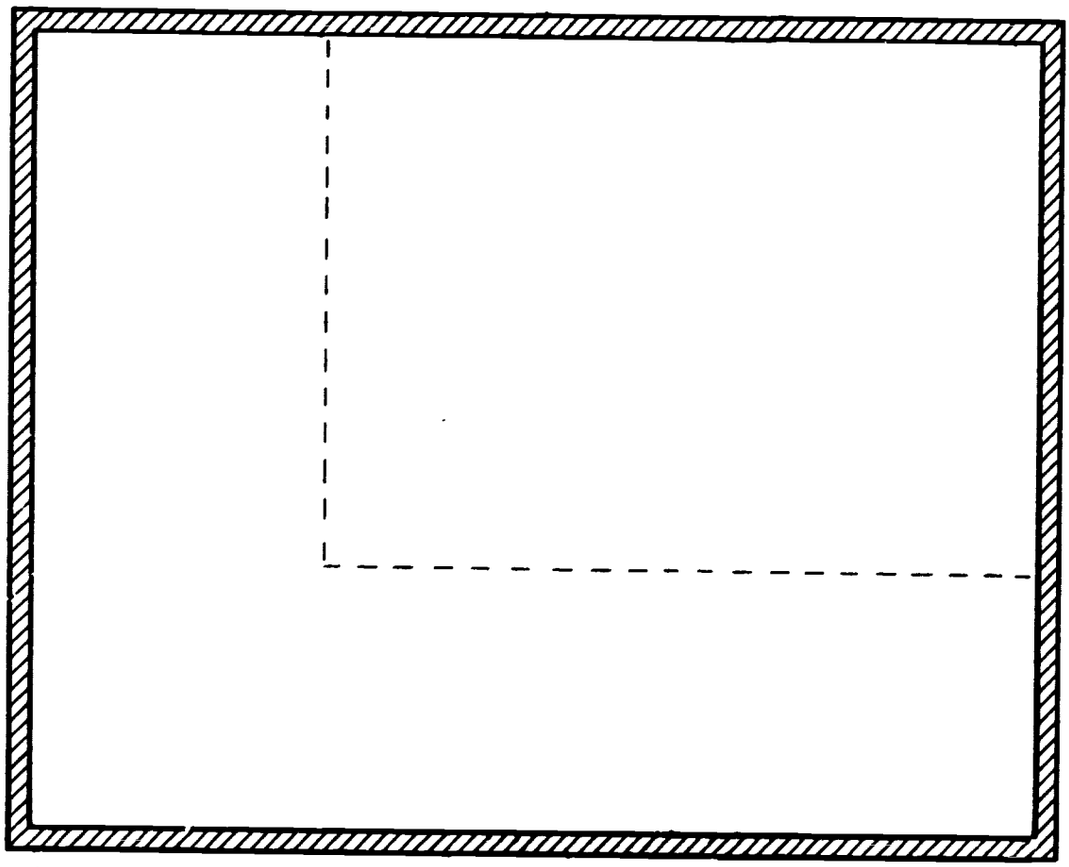
_____

If lettered:	If drawn:	If Photographed:
[] Black letters on white ground	[] Line drawing	Description: _____
[] White letters on black ground	[] Area drawing	_____
[] Colored letters _____	[] Other _____	_____
Colored ground _____	_____	_____

SKETCH

Please use the space enclosed by dotted lines for typewritten copy.
Use the large rectangle for drawing (remember to use letters no smaller than the minimum size in the large rectangle, and typewritten size in the small area).*

THIS SIDE UP! Horizontal Format Must Be Used for Images. THIS SIDE UP!



*Minimum letter size for use in large rectangle = a

2/72

AUDIO MESSAGE PROGRAM SHEET - CAI Laboratory

Course Name: _____ Segment: _____ Symbol Table Name: _____ Date: _____ Page: ___/___

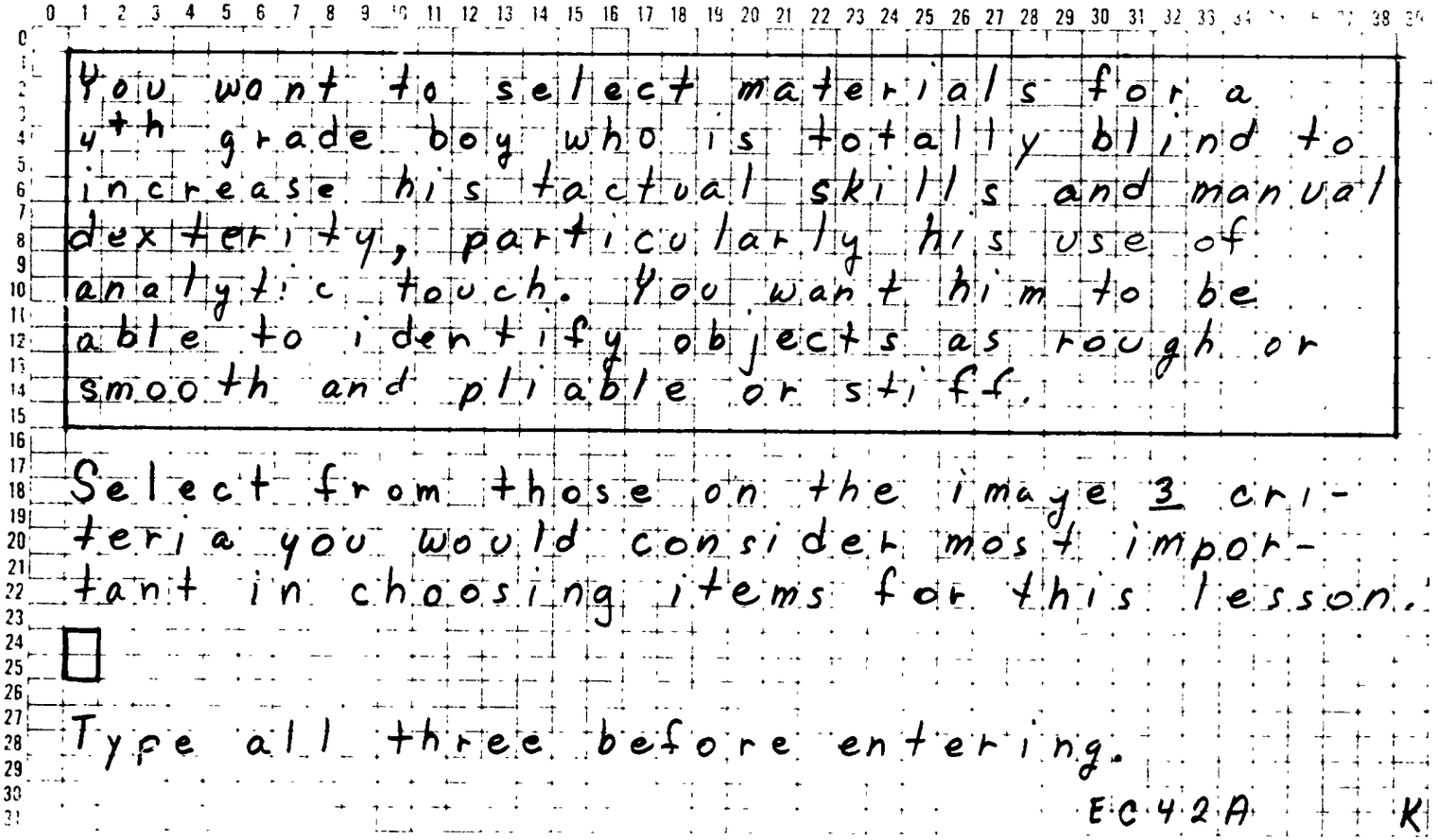
Author: _____ Recorded by: _____ Date: _____ Assembled by: _____ Date: _____

Programmer: _____

Message No.	Course Label	Ans. Code	Code	Symbolic Name	Set I.D.	No. Emp. Mks.	Track	Address	MESSAGE

Column

Row (Half line)



CRT Coding Sheet

APPENDIX J-1

COMMENT SHEET

Evaluator 01

1. Rationale.--OK - although can be polished. Your first paragraph, which is prominent because it is first, ought to be improved - especially the last sentence. I'd like to see you convey more "compassion" for the real issues facing rural areas in getting and keeping qualified teachers, since your statement now sounds more like an indictment! Also, I think the last half of the sentence refers to regular teachers who have been assigned some handicapped children along with their "normal" children, but the present statement is a bit muddy.

2. Purpose and Objectives.--generally OK. Perhaps one minor point should be mentioned for your consideration. You've approached the problem from the standpoint that the regular classroom teacher can be helped through CAI to be much more effective in her day-to-day dealings with the VH child. I'm wondering though if somewhere in the presentation we should not also convey the idea that there are resources available to help her, that she isn't going to be completely out on a limb if she makes a wrong decision. Do we need to give status to this aspect by adding another objective "Seek help from appropriate resources?" The course presents material and equipment resources What about other kinds of resources, particularly for instruction? Or do you feel this would be covered sufficiently elsewhere?

3. Content.--OK, unless you want to pursue above suggestions. I do have a few suggestions or comments for your consideration:

   A. Vision Screening.--Do you differentiate between vision screening findings and an eye report? Today a school nurse, or a lay volunteer from PAB or Junior League or a remedial reading teacher armed with a telebinocular can give a classroom teacher a visual acuity and "diagnosis." You assume the teacher has available to her an eye report. Despite your cautioning on educational decision making based exclusively on diagnosis, perhaps the teacher will be further misled by information from screening! (And especially in rural areas with limited medical staff.)

   B. Teacher Attitudes and Parental Attitudes.--and child's own attitudes seem properly stressed. I'd like to see reference

to peer group attitudes and how some children can become favorably disposed toward themselves or to the use of appropriate materials or equipment because of the interest and enthusiasm of their fellow students.

C. Sources of Materials.--Should you not also include in your listing "state IMC's or repositories?" Many states are developing these now.

D. Criteria for Selection of Materials --Does size include bulk and weight? What about things that are too small to see - would a model help or confuse? Or did you deliberately avoid this general issue?

E. Criteria - Print.--In type size and style do you speak to type spacing? What about binding, durability? What about dirty pages that cut down on contrast? What about books delivered unbound?

F. Environmental Factors.--Don't forget the dirty chalkboards which also reduce contrast.

G. Do you want to bring out somewhere the legal responsibility of school districts to provide for their children? I don't think we should convey the idea only that VH children can be successful and that the teacher or district is being kind or tolerant or altruistic or thrifty by taking these youngsters into their system! Perhaps a suggestion of the VH child's legal right and the district's legal responsibility should be included in the presentation. This is not in the outline - although you have brought these points out in the chapters I didn't review.

H. Do you need any section devoted to how regular class teachers work with the itinerant teacher, with O & M personnel?

I. Did you speak to PROGNOSIS as well as DIAGNOSIS? Many people are thrown by the "PROGNOSIS - POOR" statement in eye reports as they don't know what this means

4. Test.--Quite good. I especially like those questions which present a hypothetical child and demand a solution. Only one suggestion for 2-c, since we no longer have Supervisor of Special Ed. and this was written for Pennsylvania especially, suggest you change to "Special Education Director."

I think the content is covered well. You wouldn't want it any longer, and I think you hit the high spots.

5. To me the only test that would tell if the teacher had really mastered the contents would be how well he would respond to a real live VH child in his classroom! It's like writing objectives for a federal project; one finally learns how to write them acceptably,

but actually translating into a dynamic educational program is something else. I think the test at least THEORETICALLY tests the teacher's mastery of objectives. Why don't you do a POST DOCTORAL project on those who take the course and then try to apply their skills?

APPENDIX J-2

COMMENT SHEET

Evaluator 02

1. Rationale.--Excellently presented. The rationale is excellently presented. However, I would wish that it could be expanded to include city teachers whose service from trained personnel may be limited because of time factor and also all teachers who may be the first to identify a visually handicapped child or to prevent some child from being labeled as visually handicapped who is not.

   Of particular concern to me are the children whose doctors or parents do not wish them "labeled" or given large print with the result the child suffers educationally or at the other extreme, the child who corrects to almost normal vision but whose parents can only accept the vision uncorrected with the result that the teacher is persuaded to make special adjustments.

   In addition, should the rationale be expanded to teach the difference between vision and perception?

2. Purpose and Objectives.--Certainly met. Are there appropriate school personnel though to whom a teacher may make referrals to state or private agencies for support services other than educational materials, who can advise on long term career planning? For many visually handicapped students, an educational plan is inadequate unless there is support from outside agencies.

3. Course Outline.--Content more than covers purpose

   a. Visual Acuity Measurement - Do you find Allen Care measurement or optometric, both of which must be adjusted.

   b. Definition - Partial sight acuity definition of 20/70 is eliminating many whose visual functioning is lower but acuity higher. This definition needs to be broadened. How about 20/50 high, high myopes, cataracts, or beginning of degenerative diseases? The functional definition is excellent and the summary is well taken.

   c. Injuries - Scratched by branch is unbelievably high in reporting.

d. Low Vision Aids -
    1. Factors limiting use -
        a. Movement distortion with distance telescopic aids
        b Motivation of child
        c. Acceptance by peers

An excellent course outline.

4. Final Exam.--Well prepared. It does test on course material and requires thinking as well as memorization.

I note that the course outline does not include some categories of children who might be considered visually handicapped. Perhaps they are mentioned in the material.

Temporary consideration might be given to the following: Child with patched eye, amblyopic eye, may be 20/70 or less The smart patched eye child solves his problem by removing patch or changing it to the other eye, both of which defeat the purpose but keep him seeing.

The recently enucleated or severely injured eye may constitute an educational problem temporarily until adjustment is accomplished. It might be that the teacher trained in visually handicapped problems would be able through understanding to prevent future emotional problems.

I hope that the above comments are adequate. It was with considerable interest that I perused the prepared material and I was impressed with the amount of valuable information that has been included in the course. It is my hope that this material can be shared with other areas of the country.

Thank you for allowing me to see the material. I wish I could take the course.

APPENDIX J-3

COMMENT SHEET

Evaluator 03

1. Rationale --Does indeed seem logical. Should the following be mentioned, in this section or elsewhere?
   length of course
   hours of credit
   who eligible (wish there could be a modified version of such a course, especially for parents!)

2. Purpose and Objectives.--Is "manage the instruction" the best term in this section - is "effectively teach" more positive (or something similar)? This terminology recurs in Handbook also (e.g., p. 11).

   Could "positive communication with parents" be mentioned, somehow, within the six good points which serve as central theme throughout all aspects of this program?

   Could "relating to available appropriate resource people" be added, suitably, to this section? (See also Handbook, p. 2.)

   Generally, purpose and objectives do meet the need presented in the rationale.

3. Course Outline.--Concerning course outline, in particular, may I suggest several specifics or raise several questions:

   Chap. I re:[1]

A.-1.	What does this mean? Does it indicate gearing the course to students' needs?
B.-	"deal effectively" or "effectively teach"?
D.-5.a	Add " . . . and relevant local resource personnel"?
E.	Could involvement of appropriate resource personnel be meaningfully added to one of the existing categories?

---

[1]The items identified in the course outline by this evaluator cannot all be located in the abbreviated course outline reported in Appendix C-3 because this evaluator examined a more detailed course outline to make her comments.

Chap. II re:
A.-2.b. Would improvement of functional vision thru developmental use be well added here?
B.-3. Would 'E' added here reiterate the above?
-4. Should orthoptist be added here as 'd'?

Chap. III re:
C.- Could "social" be fittingly added here as #4?

Chap. IV re:
D.-6. above weighed in terms of readability for individual youngster?

Chap. V re:
Before A. Testing should there be a brief presentation of other evaluation procedures of weight - homework, oral participation?

Should there be mention of involvement with parents of visually impaired children?

Inasmuch as mobility is an area calling often for special helps should more be mentioned in this regard - and does Pennsylvania have relevant resource people available?

In answer to the specific question re: #3, the course content does relate to the expressed purpose and objectives.

4. and 5. Final Exam.--It does seem to cover the course content. May I suggest the following:

Chap. 4, question No. 3 - Could this be broadened to reflect the Printing House's many other functions and available materials? (This would call for more such information in the course itself.)

Chap. 5, questions no. 5 and 6 - More of this kind of question would seem to me to be especially valuable.

Other Comments.--

Is it possible to request feedback re: course's practicality after students have put their knowledge to work for a 1/2 to a year period?

Are there sufficient teachers already involved with visually impaired youngsters to allow a "big brother" sort of arrangement for a year's time, once a student completes the course?

Concerning Handbook.--

It seems to me its content quite well relates to the purposes and objectives of CARE 4. In particular regard to question 5 (of evaluation form) concerning attitudes, it might be beneficial to periodically mention where appropriate the words "as with children, generally." (Much of what is touched upon in the Handbook is true, certainly, not just re: visually impaired children, but perhaps it bears saying more frequently.)

Should there be specific suggestions herein re: how the teacher can manage the extra time involved when a visually impaired student is in the class (e.g., volunteer help, student 'buddy' system)?

Should more space be devoted to:

references (e.g., new book edited by B. Lowenfild?)
visual functioning (e.g., assessment of APH materials)
mannerisms
explanation of terms re: vision (p. 22)
visual aids
interpretation of one eye record in further detail (pp. 41, 42)
mobility
social needs

How is it determined into whose class a visually impaired child will go?

APPENDIX K

STUDENT-CONTROLLED OPTIONS TO BRANCH

Chapter Location		Number of Students Choosing to Branch
CARE 4-1		
ba25a	Would you like additional information about the history of educational programs for blind children?	6
CARE 4-2		
cal0a	Would you like to read a technical explanation of the construction of the Snellen Chart?	6
cd03a	Would you like to review CARE 1, Chapter 14?	1
ce38a	Would you like the definitions of any of these words: direction, diffusion, radiant energy?	2
ce49a	Do you know the definition of refractive medium?	6
ce64b	Do you want to check the definition of 'diverge'?	1
ce70b	Do you want to check the definition of 'converge'?	1
ce97b	Would you like some more information about cataract, glaucoma, and nystagmus?	2
cf05a	Would you like to review any causes of loss of vision?	2

Chapter Location		Number of Students Choosing to Branch
CARE 4-4		
ecØ2b	Would you like to hear more about larg type and type size?	4
ecØ4a	Would you like to hear more about the work done at APH?	7
ec26a	Do you want to review any of the pieces of equipment?	0
ec33b	Do you want the address of any of the three regional instructional materials centers in Pennsylvania?	5

APPENDIX L

ON-LINE COMMENTS MADE BY FIELD-TEST STUDENTS

VZWC CARE4
If an attempt is being made to demonstrate the lack of an auditory input, you are succeeding . . . The sound portion is almost completely inaudible.

VZWC CC40M
Prior frame was very confusing

VWAT LINKER
The audio portion for Chapter I was inconsistant in quality - sometimes it seemed as if the speaker was too far away from the mike and sometimes he seemed to be too close to it.

VZWC CARE4
Re audio portions of this CARE4 lesson, the messages are garbled, low volume, and also seem inappropriate to the subject being shown on the CRT and viewer. I suggest that they be debugged real fast since this course, while short, is more confusing than CARE1.

DA03A
RE DA 03. . . . Solve is ambiguous. . . . . I may solve mentally, or I may solve physically. . It's a matter of semantics. . Solve varies in whatever context it is put into.

VZWC EC41A
Why ask me to answer if you are going to give the answer anyway. I assumed all of the criteria were important, I chose the two I (you did ask me) felt was most important for the girl.

VZWC FC08C
After having gone through Amy's problems once, I figured I could progress without all the steps. I am caught in a loop. Help Help Help

VZWC HA09A
RE HA09 . . . Computer does not accept some of the answers which were given. . i.e. . . felt marker. Floyd mentioned this . . . Special consideration . . . map . . . Please check your program to see if the other answers might no be put into it.

VZWC C12
Sorry about that.

C13
Re last question . . . Average achievement as to ability.

C4A
Please note that the subject's vocabulary is limited. Congenital = prenatal . . . Accident = injury . . . Tumor = neoplasm . . . Disease was used in the general term i.e., collectively = diseases.

C5
Your question referred to refractive parts of the eye. Both the cornea and the lens are refractive agents in the eye. There is no, repeat no, reference to the relative refractive powers of these units in either text or handbook. My answer was predicated on the optical values of both units. As a professional photographer I made an educated guess as to the power of both and assumed the power of the thicker was more powerful. A possibility also was that it was in the program, but the tapes were fouled up and I may have missed it. This foul-up was reported to computer during the lessons.

E2B
Re previous question. . . . This happens to be a sore point with me. I can get a hell of a lot more by going thru my principal than some of our junior directors. I question the validity of your querry. . . . It depends on circumstances

VZSS E5
My answer automatically accepted as the cursor moved off the screen. I wasn't finished and would have finished it by saying varying light conditions.

VZWC E5
Re previous question . . . Your use of an exclusive vocabulary has fouled me up. Only one line was permitted in the answer. . . . Not stated in original question. . . . I assumed I'd be permitted to continue on the next line. I began by referring to the continual adjustment due to the focusing of the device. I began to try to point out the narrow range with the device but got cut off.

VZWC E6
On the last question regarding the limits of the magnifying glass, I proceeded to give the answers gives a limited field and it has a fixed focus. When I went to push the return button, the answers appeared Will I get credit for my answers.

VZSS E7A
Slate and stylus (your answer) are the same as stylus and slate (my answer).

VZWC E7A
Third choice was difficult to see. Slide is of poor quality. Also, fourth, was correct term a phonograph - talking book?

VZSS F6
Why is B the best answer? It seems to me that using the tape recorder might be a quieter and more convenient method than the typewriter.

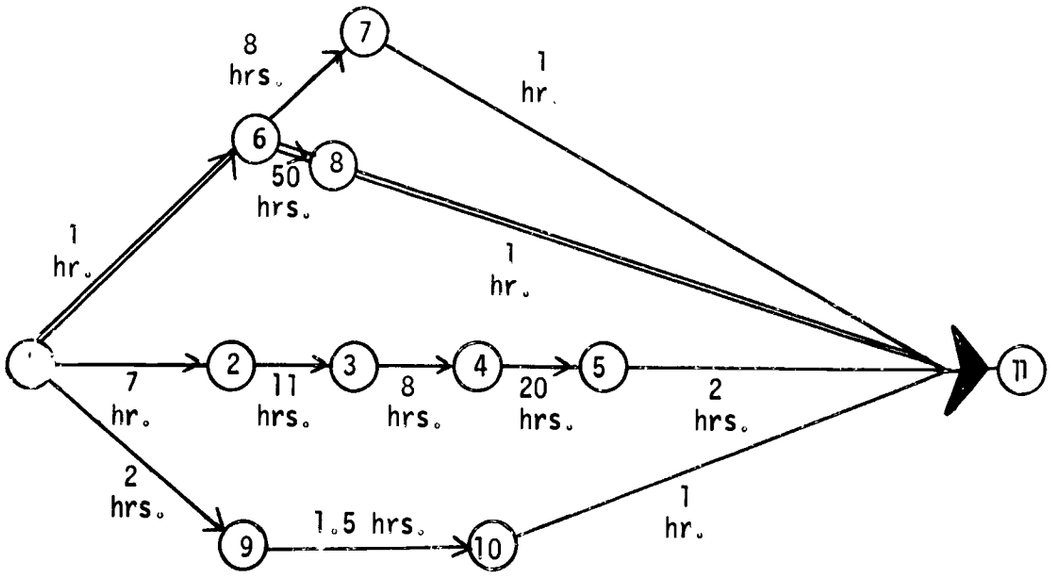
VZWC G2
Re G2 . . . Same difference.

JA
Please review your programming and the audio portions of your course. The audio was extremely difficult to comprehend at times. Tape hardware program. Also please consider the semantic variations that all of us have when taking these tests. Realistically, you cannot include all possible arswers. But try to have a broader acceptance pattern. The workbook was rough . . . in all meanings of the word. It needs work, both on content and presentation. You really should review it. I would be willing to help you as a lay-teacher. I have experience in writing, editing, and communications.
VZWC

*END

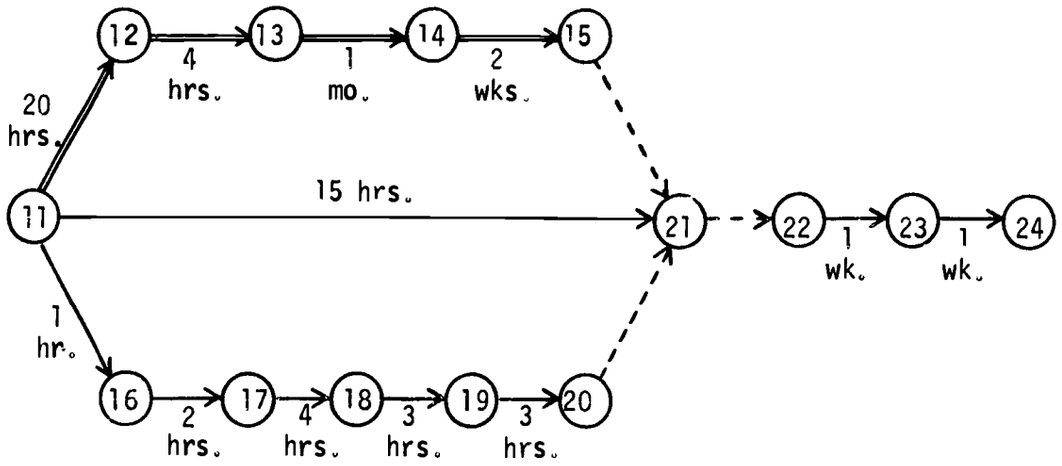
APPENDIX M

FLOWCHART OF EVENTS AT CAI LABORATORY



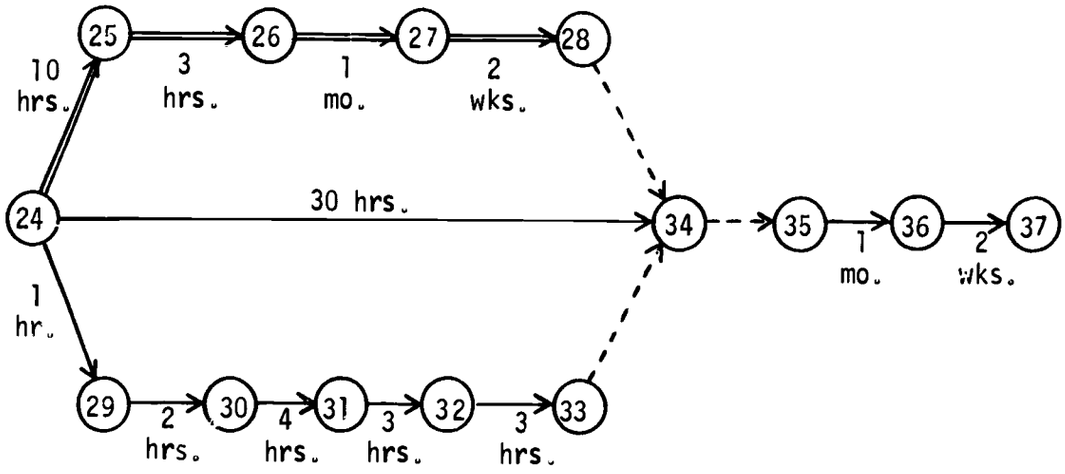
Event Identification

1. Authored material submitted to programer
2. Authored material prepared for keypunching
3. Authored material keypunched
4. Card deck assembled and listed
5. Initial debugging completed
6. Image planning forms sent to graphic artist
7. Slide processing completed
8. Image preparation completed
9. Audio messages edited
10. Audio messages typed
11. Author review completed



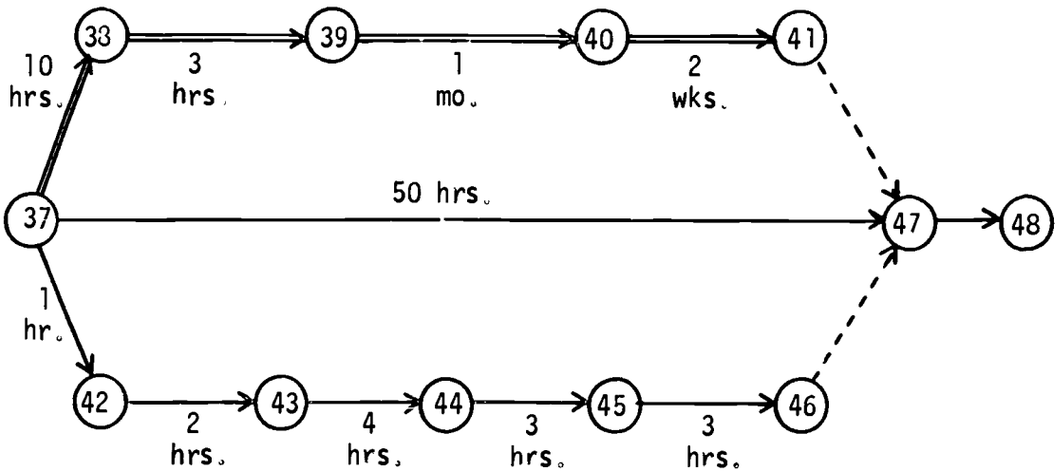
Event Identification (Continued)

11. Author review completed
12. First revision of images completed
13. Images photographed
14. Answer print received
15. Image copies received
16. First revision audio messages typed
17. Audio messages recorded
18. Student audio tape completed
19. Audio recordings debugged
20. Audio tape copies made
21. Program revisions and debugging completed
22. Students scheduled - 1st group
23. Students complete trial run
24. Author review of student records and comments completed



Event Identification (Continued)

24. Author review of student records and comments completed
25. Second revision of images completed
26. Images photographed (or errata noted)
27. Answer print completed
28. Copies of image reel received
29. Second revision of audio prepared
30. Audio messages recorded
31. Student audio tapes completed
32. Audio messages debugged
33. Audio tape copies made
34. Program revisions and debugging completed
35. Students scheduled - 2nd group
36. Students complete trial run
37. Author review of student records and comments completed



Event Identification (Continued)

37. Author review of student records and comments completed
38. Final revisions of images completed
39. Final revisions of images photographed
40. Final answer print approved
41. Image copies received
42. Final version of audio text prepared
43. Final version of audio messages recorded
44. Student audio tapes completed
45. Audio debugging completed
46. Audio tape copies made
47. Program revisions and debugging completed
48. Preparation of course completed