Technical Report 387

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ON-LINE AUTHORING AIDS FOR INSTRUCTIONAL DESIGN

Russel E. Schulz, Nancy Hibbits, Harold Wagner and Robert J. Seidel
Human Resources Research Organization

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The purpose of the research was to conduct a development and feasibility demonstration of on-line, query-based authoring aids for selected blocks of the Interservice Procedures for Instructional Systems Development (IPISD) model. The model indicates techniques and procedures for the development and conduct of interservice training. The blocks selected from the IPISD model for this demonstration were Block II.2, Develop Tests, and Block III.4, Develop Instruction. The research was designed to provide authoring aids ("How to do it" guidance) for developmental activities identified in the blocks.

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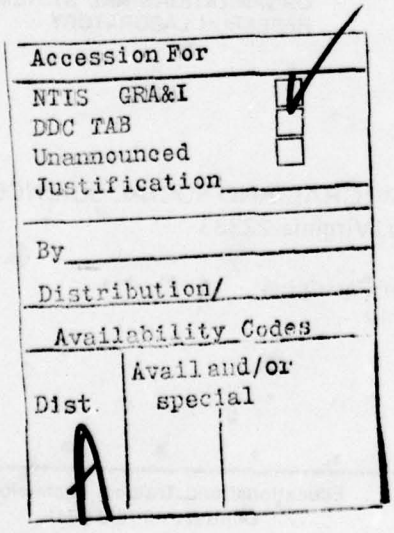

FOREWORD

The Computer-Based Educational Technology Team of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) performs research and development in eares of educational technology that apply to military training. Of interest are computer-based instructional delivery systems that focus on developing the accompanying instructional courseware in the most efficient and cost-effective manner possible. Development and implementation of such systems will help solve the problem of training individuals to produce good courseware in a reasonable time, at an acceptable cost.

This Technical Report describes a development and feasibility demonstration of two author aids designed to assist individuals in developing tests and instruction. The project was funded jointly by ARI and the Defense Advanced Research Projects Agency (DARPA). To accomplish this research, ARI's resources were augmented by contract DAHC 19-76-C-0041 with the Human Resources Research Organization, an organization selected as having unique capabilities for research and development in this area.

Personnel at the U.S. Army Engineer School (USAES), Fort Belvoir, Va., provided guidance and assistance throughout the project: Dr. Everett Rompf, Mr. Jack Ainsworth, LTC Ernest Larson, MAJ John Harvey, MAJ Ramile R. Rebello, 1LT D. Bunn, SFC Alton J. Blanchard, and SFC Leon M. Loomis. In addition, Dr. James Kraatz, PLATO Services Organization, Computer-Based Educational Research Laboratory, University of Illinois at Urbana, and Ms. Beverly Hunter and Mr. Richard Rosenblatt of HumRRO also contributed to the research effort.

The entire research work unit area is responsive to the requirements of TDT&E Project 2Q762717A764, "Educational and Training Technology," the 1977 ARI Work Program.

JOSEPH ZEIDNER
Technical Director

ON-LINE AUTHORING AIDS FOR INSTRUCTIONAL DESIGN

BRIEF

Requirement:

The purpose was to examine the feasibility of providing "how to do it" guidance (authoring aids) for the instructional design and development tasks identified by the Interservice Procedures for Instructional Systems Development (IPISD) model. The usefulness of the IPISD model depends on authoring aids which enable training personnel to translate IPISD procedures into instructional products. The authoring aids developed by this research should be useful for computer-based and off-line instruction and be generalizable to differing subject matter areas.

Procedure:

Authoring aids were constructed, implemented, and tested. The authoring aids were developed to be used on the PLATO IV Computer-Assisted Instruction (CAI) system. The first step produced flowcharts which detailed the steps of the IPISD Blocks II.2 (Develop Tests) and III.4 (Develop Instruction). On-line author aids as well as off-line versions were produced to assist the author in preparing materials for CAI and non-CAI delivery of instruction.

Three levels of evaluation were conducted. An informal evaluation on existing IPISD materials was performed, and a formative evaluation on the newly developed authoring aids. Finally, the instructional materials were evaluated by military authors and administered to U.S. Army Engineer School trainees.

Findings:

The feasibility of on-line aids for implementing IPISD Blocks II.2 (Develop Tests) and III.4 (Develop Instruction) was demonstrated through the evaluations. User acceptance of the aids was high, and the time required for development of test and lesson material has been significantly reduced.

Utilization of Findings:

Based on these findings, the development of authoring aids for additional blocks of the IPISD model was initiated.

ON-LINE AUTHORING AIDS FOR INSTRUCTIONAL DESIGN

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Chapter I

BACKGROUND

The purpose of this chapter is to provide an overview of the state-of-the-art related to instructional systems design and evaluation. Major subjects addressed in this chapter are:

- Systems Approach to Training
- Problems of Implementing Instructional System Development Models
- The Need for Author Aids
- Approaches and Techniques for Evaluating Instruction

SYSTEMS APPROACH TO TRAINING

A revolution in the technology of training within the military and industry began when the systems concept was applied to the development and conduct of training. Even now, after 25 years, the *full* potential of applying the systems approach to improve the effectiveness of instruction, improve on-the-job performance and lower the cost of training has not been realized. Even so, results from applications of the systems approach in terms of improved instruction, increased relevance in what is taught, and lowered costs have been so dramatic that, at present, the systems approach to training has permeated civilian training (and education as well)--training in business and industry, training in the military services, and training in other agencies of the federal government.

Many different names, terms, and variations are or have been used for the systems approach to training. Some of the names are: "systems engineering of training," "curriculum engineering," "systems approach to training," "instructional systems development," "training situation analysis," "modern instructional technology." Even among those using a particular name, there are many divergences in definitions, particulars of technique and procedures, and effectiveness with which the systems approach is applied. Despite such variations, the *common* thrust and orientation of these applications is pre-eminent, especially as they contrast with traditional approaches to training.

The essence of the systems approach to training rests in identifying explicit <u>end states</u> that are to be achieved through training and in defining sets of orderly, objective, and explicit <u>procedures</u> to do that which is necessary to achieve these end states in the most comprehensive, reliable, effective and efficient manner.

The systems approach defines a process which *focuses upon the job* that is ultimately to be performed and *upon the individual* who is to learn

to perform that job. Traditional approaches, by contrast, focus upon *conventional subject matter blocks* that tend to be more of the "school catalog" variety and are, generally, only approximately pertinent to what the student will be doing later.

In addition, most traditional approaches place the burden for information transfer upon the students rather than on the instructional materials. Whether the instruction is rapid or slow, complex or dull, the student must adapt. By contrast, in the systems approach, it is feasible to engineer flexibility into the instruction and, so, to adapt the instructional system to individual differences among the students. Special consideration is given to:

- Evaluation of the needs of each individual student.
- The nature of instructional content to be imparted.
- The instructional decision rules that mediate between student needs and instructional content.

The systems approach is just what the name implies: a systematic process for specifying the desired products of training and selecting what will be taught, how it will be taught, what the presentation mechanism will be, and evaluating the effects of each phase of the process. It focuses on student performance as a determinant of content. Its proper application can hardly fail to improve instruction where only incidental attention has been given to these functions. Thus, in the systems approach setting, unconventional clusters of instructional material may be used for a uniform (usually small) group of students, each of whom is being prepared to perform the same job. Major efficiency is achieved by directing instruction *precisely* to the student and to what the student will use on the job, thereby assuring relevance and efficiency, precluding oversights, and adapting instruction to the individual.

During the past 20 years, many attempts have been made to codify a definitive technology for the systems approach to training. Early efforts in this area included those by HumRRO on behalf of the U.S. Army in the early 1950s and the development of the USAF personnel subsystem approach in the mid-1950s. The HumRRO model, for example [1,2,3,4], is a seven-step process which starts with the development of a man-machine system analysis model. From that, a job model is developed which then leads to both the specification of knowledge and skills required for adequate performance of the job, and the proficiency test development. The proficiency test measures the ability of the student to perform actual job tasks, thereby assessing the job proficiency of the student. From the specification of skills and knowledge, one may determine the instructional objectives, which is to say, those specific requirements for an instructional program. Once the instructional objectives have been determined, then a training program can be constructed. The seventh step is the evaluation of the training program.

One of the more notable of recent systems approach efforts is the Interservice Procedures for Instructional Systems Development (IPISD) Model [5,6,7,8,9]. This model was prepared by the Center for Educational

Technology at Florida State University under contract with the Interservice Committee for Instructional Systems and Development, involving the Army, Navy, Air Force and the Marine Corps. The IPISD contains standardized rationale, terminology, and basic concepts of instructional systems. These have evolved by developing and recording the results of efforts in theoretical and guidance materials required for actually performing instructional systems development. Prior to this effort, the Air Force had undertaken a large activity to develop, define, and record a definitive technology for instructional systems development [10], and the Army had embarked on an ambitious five-year program to systems engineer all of its training courses [11]. Some of the development of the systems approach to training has gone on outside the Services, particularly in industry [12,13,14]. In addition, Mager [15] and others such as Glaser [16], Ammerman [17], Krathwohl [18], Bloom [19], Melching [20], Gagne [21], Esbensen [22], Bond [23], and Butts [24], to mention only a few, have made significant contributions to systems approach models through their research in the development of behavioral objectives and sequencing of instruction. In the Navy, much of the work dealing with the systems approach has been carried out by USNTEC with reference to simulation (e.g., [25,26]). In addition, the Navy has initiated several major efforts related to training systems design of a more general nature [27, 28,29].

The IPISD model shows promise as a useful tool in instructional system development activities and is presently undergoing preliminary field evaluation. The model consists of five major phases which can be conceived under the ADDIC rubric:

A analyze

D design

D develop

I implement

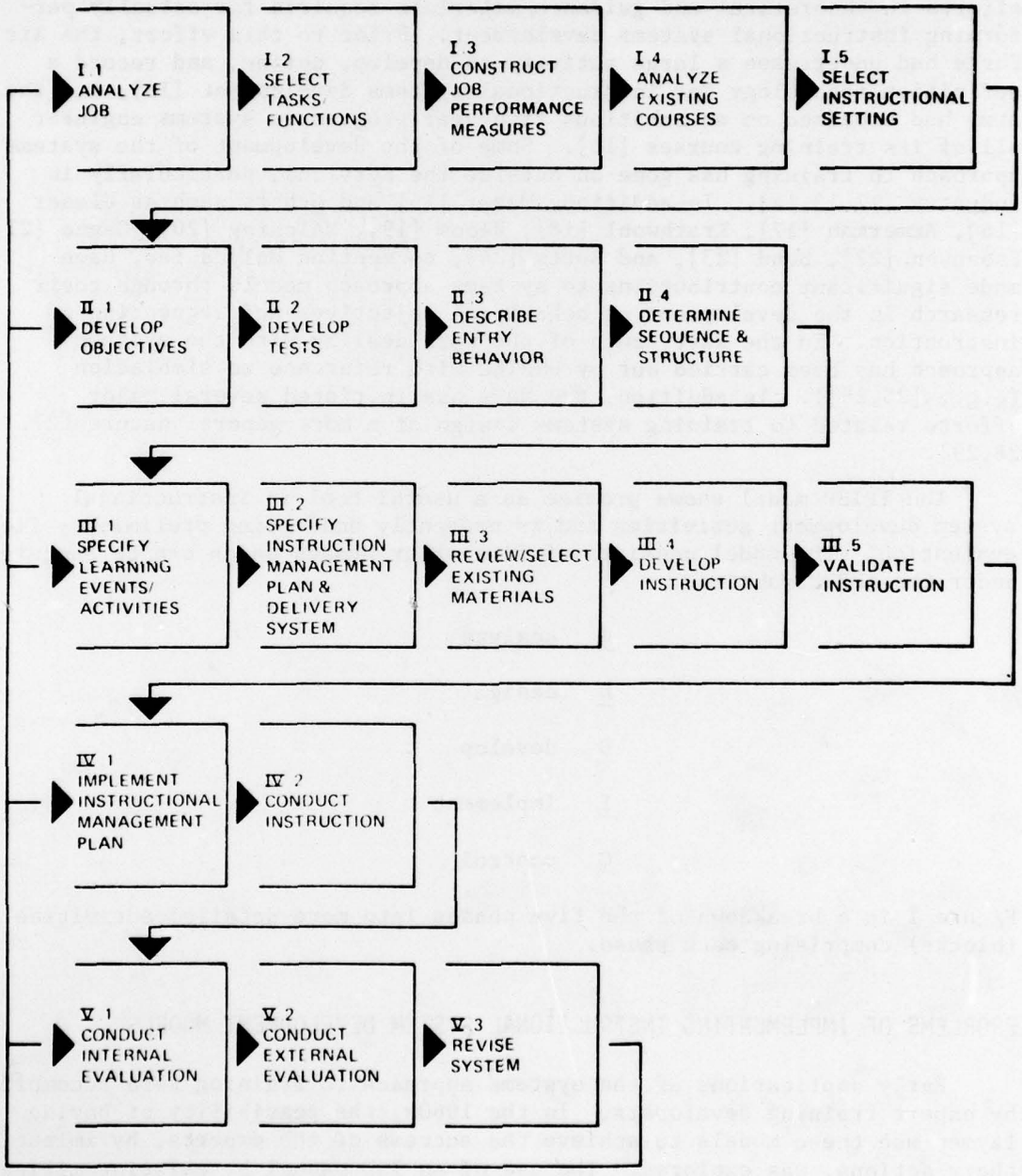
C control

Figure 1 is a breakdown of the five phases into more detailed activities (blocks) comprising each phase.

PROBLEMS OF IMPLEMENTING INSTRUCTIONAL SYSTEM DEVELOPMENT MODELS

Early applications of the systems approach to training were accomplished by expert training developers. In the 1960s, the possibility of having laymen use these models to achieve the success of the experts, by imitating their actions, was explored. The use of an ISD manual by existing military personnel with little or no experience in training program design may cost a fraction of the cost of hiring or contracting experts to do the development. Even so, the cost/effectiveness of the model will still depend on the effectiveness of the model, or tools, in enabling laymen to produce effective instruction.

THE BLOCKS IN EACH PHASE ARE:



Detailed Breakdown of Activities to be Performed in Each Phase
(TRADOC PAM 350-30, Executive Summary and Model, August 1975)

Figure 1

In the past few years, problems with attempts at implementing ISD models by laymen have surfaced. Montmerlo [30] conducted a comprehensive review of ISD state-of-art and problems of implementation. His conclusion was that "available ISD-type methodologies will not allow the layman to be as successful as the expert." (The particular IPISD manuals with which we are concerned, however, were not a part of this review.)

Montmerlo cites the paper by Ricketson, Schulz and Wright [31] as the "most significant article concerning the problems of ISD," because it represents "the only empirical evaluation of an ISD-type methodology." Ricketson, Schulz, and Wright studied the CONARC REG 350-100-1 and its implementation by Army instructional developers. Although IPISD is intended to be a considerable improvement over 350-100-1, many of the same problems do apply. For example, Ricketson, et al., found that "High rates of personnel turnover within some curriculum development groups have resulted in a general reduction of systems engineering program productivity." Assuming this to be a continuing reality in military instructional development, the need becomes evident to provide authoring aids which can be quickly learned by new developers. The study found, among other things, that developers tended to develop training programs that employed the same techniques with which they had been taught, since they did not have the ability to assess other training techniques and equipment.

IPISD and other ISD manuals are intended to have general applicability. However, it has been clearly recognized by many experts that the same methodologies cannot be applied to the universe of training problems. The literature on task analysis, for example, contains a number of articles on the impossibility of using the same method for all tasks [32,33,34]. The IPISD Executive Summary & Model [9] also emphasizes the need for different methodologies in the statement, "The extent that one used the interview method, the observation method, or the occupational survey method depends on the nature of the job being analyzed, the job data already available, and the availability of analyses resources." [9]

While the "what to do" may remain relatively constant across training problems, the "how to do it" may vary enormously. This again is why the instructional systems designer needs a wealth of aids to refer to in dealing with a specific training problem in a specific subject area. While the IPISD manuals do provide far more references to the literature than previous manuals did, they do not provide specific "how to do it" guidance for specific design and development tasks. [9, p. 124]

Another major problem area of ISD implementation in general is the management of the instructional development process. For example, when a change is made in the conditions of a particular test item, this has many ramifications backward and forward in the ISD process. The management of these changes, including the communication among various members of the IPISD team, is complex and usually requires some management aids. Discussions with training staff at Ft. Belvoir provided us with practical evidence that it is in the area of management of the ISD process that major problems continue to be found.

Other problems of using IPISD relate to the background skills of the team leader and of the members of the development team. This is pointed out in the IPISD Executive Summary [9], in the Montmerlo study [30], and in many other sources [35,36,37].

The IPISD model is advanced over other systems approach models in providing guidance to the training manager. However, the IPISD manuals are not presently intended to provide specific procedures for every instructional situation that can be encountered. Some situations are now covered only by the general principles underlying the Model. If IPISD is to have a "fair chance" of being accepted by training managers, it is essential that tools and author aids be developed that will permit training personnel to readily and effectively translate recommended IPISD procedures into meaningful instructional products. This rationale forms the basis for the initiation of the present project.

THE NEED FOR AUTHOR AIDS

Author aids are any products used in accomplishing one or more steps of the IPISD procedures. Under this definition, thousands of guidebooks, research studies, texts, professional articles, and technical reports could be considered as aids. If an instructional system designer were familiar with the full range of aids available, he would in fact be an expert in the field of IPISD and therefore not be a subject of our concern. The problem for the author (any member of the development team), is to know what aids to use when, to know they exist, to have access to them in a timely way, and to have some facility and judgment in their application.

In this effort two of the blocks of the IPISD model were selected for evaluation. Block II.2, Develop Tests, and Block III.4, Develop Instruction. The first block, II.2, was required in the RFQ. Our choice of Block III.4 is based on a number of mutually supportive general and specific reasons. Many leading instructional technologists and designers have concluded from their experience that the Development Phase of instructional preparation is *the* significant component of the systematic approach to producing quality instruction. It is expensive, time consuming, critical, and requires specialized capabilities. Van Pelt and Rich [38], for example, speak from experience in the Army training environment: "There is no question that much time is wasted by writers casting about for a reasonable set of guidelines to follow that will result in lessons requiring a minimum of editing and revision." For the Navy, Aagard and Braby [39] have emphasized the need for an algorithmic approach to translate basic learning events into instructionally meaningful task categories ". . . in a manner that emphasizes the flow of events and the combining and sequencing of learning guidelines in the design of a training program. . ." (p. 7). In the civilian sector, Lipson [40] has stressed the need for ". . . increased investment in development of instructional materials." The "homemade" variety doesn't have ". . . the qualities of craftsmanship, artistry, nor the proper incorporation of what is known about effective instructional design to be widely used." Industrial developers of CAI (Simonsen and Renshaw [41]) have stressed that ". . .

the cost of lesson preparation actually more than doubles the projected cost of an hour of CAI and cannot be ignored." Recent analyses (formal and informal) by the Training and Evaluation Group (TAEG)[1] support this assertion for the general case of individualized instruction that involves a systematic approach to the development of materials.

On a specific and practical basis we have learned from the Curriculum Development Personnel at the USAES that they have experienced the most difficulty in using IPISD with Block III.4, Develop Instruction. A comparison of test construction to general development of instruction suggests that in developing tests (IPISD Block II.2), authors need help in performing such activities as the following:

- Developing test items that actually test the Terminal Learning Objectives (TLO), Learning Objectives (LO), and Lesson Steps (LS).
- Constructing hands-on scorable units of Skill Qualification Tests (SQTs).
- Developing scoring procedures.
- Writing test items that will help identify bad instruction.
- Devising test items that will support remediation strategies.
- Generating test items and alternative forms of items.
- Managing the test development process, e.g., have all TLOs been tested?
- Obtaining reliability measures on test items.
- Determining the validity of test items.

In Block III.4, Develop Instruction, a variety of aids are needed. Some of the activities and decisions which require support include:

- Ensuring reading level is appropriate to the audience.
- Deciding what kind of drill and practice is needed, and how much, for a given task.
- Deciding how the student will be able to obtain additional help.
- Determining the nature, frequency, and type of feedback to provide to the student during the instruction.

---

[1] Personnel Communication, Dr. Richard Braby of the Training and Evaluation Group (TAEG).

As an overriding concern, aids are needed to help reduce the time it takes to develop quality instruction and tests, and to make the development process as efficient as possible.

A wide variety of aids exist. Recently Logan [42] completed a survey of existing tools/procedures which could be used by instructional developers in conjunction with the IPISD. The results of this survey indicated that aids exist for a number of IPISD components. Unfortunately, a considerable technical background and level of expertise is required for their use. Thus, even when aids are available, there remains the problem of using them without imposing an undue burden on the author.

The existence of these aids testifies to the recognition that they are needed. However, in the case of author aids it is not the variety and quantity in the universe that counts. What matters is that the appropriate aid be available, easy to use and accessible at the right time and place.

The majority of existing materials are more of the "what to do" nature than the "how to do it" variety. There are a number of general resource guidelines already available to aid systematic development of instruction. The following discussion of these resources is illustrative and not intended to be exhaustive of the field. Because they are general, many of these handbooks, manuals, etc., are difficult to categorize in terms of specific single phases of IPISD. However, many examples can be categorized as giving guidance primarily in Analysis, Design, Development, Implementation, or Control. For instance, Harless [43] emphasizes the importance of "front-end analysis" to solve human performance problems. For his target audience, primarily management personnel, he recommends defining the problem, investigating its characteristics and studying alternative solutions and their costs before making any decisions. McKnight's work [44] on tailoring military training by systems and job analysis provides another useful resource for the Analysis Phase. The recently produced Marine Corps training guide for task analysis [45] is another such aid.

Mager's techniques [46] are classic as aids to stiuplating precise instructional objectives and thus fit into the Design phase of IPISD. The TAEG approach to categorizing instructional tasks according to particular learning algorithms [39] can in some instances be useful for design purposes.

The brief book by Pipe [47] for beginners falls between Design and Development. It describes the systematic procedures necessary to begin writing programs. He neglects the details such as frame writing or program format, concentrating on the "practical" issues of steps that precede writing, testing programs, and avoiding pitfalls. Drumheller's handbook [48] is even broader. In his guide of curriculum design for individualized instruction he has highlighted the need for materials to "have built-in comprehensiveness." His systems approach provides guidelines in the form of a detailed model for curriculum design. It includes defining objectives, analyzing sub-objectives and integrating them into the learning experiences. Wong and Raulerson's [49] guide spans all the steps of IPISD in brief but they spend more time and give more detailed

aid for Design and Development. In the latter, they provide guidance for media selection based on variations in stimulus requirements of the learning tasks. Their selection guide is useful, and while not apparently theoretically derived from learning principles as is Briggs' approach [50], it may be more helpful to the layman. As with most such selection guides, the user still must choose from two or three potentially equivalent alternatives. Wong and Raulerson's model [49] is based in general on a strict sequential view of learning.

A number of published texts are available as aids for various parts of the Development Phase of IPISD. Markle [51] has discussed the construction, format, and sequencing of the frames in her texts, both of which are programmed.Sperry [52] with its Instructional Program Development Workbook, has developed and used comprehensive plans for a workshop (along with a workbook) on instructional program development. Its structure follows the philosophy of mathetics that includes demonstration, prompt, and release exercises. Espech and Williams [53] in their Handbook for authors of programmed instruction describe the process of constructing programs with major emphasis on editing, testing, and analysis. The finished product is then assured of being a "packaged change of behavior." Hawkridge, Campeau, and Trickett [54] provide a rather unique resource to help the evaluator prepare his reports. While it is written towards a school system audience, its clear, concise approach should make it usable in a military context. More recently, and still under development, Hillelsohn is employing a programmed instruction approach to creating and managing computer-based learning materials [55]. This effort is expected to provide an additional means for implementing several components of the IPISD model.

The most relevant example for the Army as an aid to Implementation of instruction is the military training manual, FM 21-6 [56]. Its format is readable and comprehensive, replete with examples for the instructors.

Not a great deal of useful materials is available for the Control phase per se. However, Cogan's case study approach [57] is illustrative of such aids which could be a useful resource to training managers.

Having noted some of the available resources, certain *caveats* are in order. Rather than providing actual help in performing the authoring work, or even detailed "how to do it" guidance, most of the existing author aids may serve simply to reinforce or broaden the guidance provided in IPISD manuals. Aagard and Braby [39] very carefully note the practical limitations of the use for their algorithms and guidelines to general approaches. "The task categories and related guidelines are not at a level that will accommodate any training setting." Briggs' handbook [50] may also serve such a broad guidance function. Care should be exercised in the selection of aids to be integrated with IPISD, so that IPISD authors are not confronted with a confusion of different yet similar models, sets of jargon, procedures or forms. Existing general manuals differ from one another in that they:

- Include different steps or different names for steps.
- Include different methods of accomplishing each step.
- Provide different levels of specificity in the detail included under each step.
- Provide different formats for reporting the work accomplished under each step.

Thus, to provide the most efficient aids to IPISD developers, the guidance found in some of these manuals and guidebooks needs to be translated and integrated into the IPISD framework, rather than referred to in its source form.

One example of a useful "how to do it" guide is the Guidebook for Developing Criterion-Referenced Tests [58]. To make the guidance in this book readily accessible and useful to the IPISD author, the ideas need to be integrated into the IPISD framework. Another important aid in the testing area is the recent Manual for Developing Skill Qualification [59] and the Procedures for Validating Skill Qualification Tests [60].

In some cases, the author needs actual assistance in performing an activity, rather than simply how to do it information. For example, automated readability indices can take some of the workload from the author.

Some aids are specific to a particular method or theory of instruction. The layman author needs some basis for using that particular approach or method, and needs to know that it is one of several alternatives. Thus, for example, Markle's [51] texts might be relevant and useful to an author who has decided to follow her particular approach to programmed instruction. Alternatively, Sperry's comprehensive plans for a workshop and workbook [52] on instructional program development as noted earlier follows the philosophy of mathetics.

In the more specialized areas of computer-based instructional development, an array of automated aids have been produced. The TICCIT project [61], for example, uses highly structured forms for text preparation, and highly proceduralized production techniques for authoring teams. Similarly, Project IMPACT [62-68] developed standard formatting aids for authors, sophisticated techniques for logic and text separation, instructional management, etc. Again, these aids are highly specific to a particular instructional strategy or method and (particularly in the case of TICCIT) frequently constrained by system hardware and software constraints.

The array of automated aids for authors of computer-based materials includes: special programming languages, test item generators, scoring algorithms, recordkeeping facilities, objectives data banks, text editors, graphics aids, student response analysis algorithms, data analysis routines, statistical subroutine packages.

Among the major problems for users of computer-administered instruction (CAI) is the high cost of developing quality instructional material. The problem is exacerbated by the fact that new CAI programmers frequently require several months of training before they are able to produce quality instruction within an acceptable time frame. These individuals view their role as that of subject-matter experts and educators rather than programmers. To satisfy this audience, authoring aids are needed that will permit educators to rapidly develop quality instruction without extensive CAI language training.

As a first step in meeting this need, and a forerunner of the present research, HumRRO completed the development of sets of author aids called MONIFORMS [67,68]. These aids assist an author in generating question-and-answer type practice items. The author interacts with the computer which leads the author step-by-step in the creation of items, answers, feedback, remediation, etc. The resulting practice items can then become part of either an on-line or off-line course of instruction. The computer dialog can also be used off-line in the form of a checklist for the author.

MONIFORMS were developed specifically for the PLATO IV system TUTOR language. However, the concept of programming templates which permit authors with limited programming experience to create test and lesson materials has wider application. While MONIFORMS are a valuable first step, there still existed a need for more advanced author aids. Preliminary study at HumRRO indicated the feasibility of developing author aids which through interrogation of the course author would automatically convert lesson content and structure into executable program code. Therefore, the author would require no previous programming experience and thus make the aids much easier to use. This concept formed the basis of the approach for the current effort.

In summary, with respect to authoring aids:

1. There exists a very rich array of a wide variety of materials, handbooks, guides, and automated aids which could serve to help in the IPISD process.

2. There exists a very real need for these aids.

3. The selection of specific assistance to be integrated into the framework of IPISD is a task that is yet to be completed.

EVALUATION

In the previous sections, we have discussed the need for specific aids or tools which can assist authors to apply the IPISD process in the preparation of instruction. In developing and tailoring aids for authors, we are in effect developing instruction--for authors. Once any instructional product is under development, a continuous process of evaluation and

revision needs to take place. This evaluative process should also be applied to the development of author aids--an approach we have taken in the present research effort. The following discussion of evaluation provides background and rationale for our approach to evaluation.

Evaluation Defined

Evaluation is the process of delineating, obtaining, and providing useful information in judging decision alternatives [69]. It is an action-related process which has as its major characteristic the determination of value, worth, or merit. The evaluation process is conceived as continuing rather than as having a discrete beginning or ending. Evaluation should facilitate the continuous improvement of a program. It should stimulate, not stifle, instructional development.

Evaluation procedures may be categorized as formative or summative [79]. Formative evaluation is that process which validates instruction during on-going initial program development. The results of this evaluation are acted upon immediately in program modification. In other words, the practice of conducting tryouts of draft materials during program development, followed by measures which provide an assessment of the materials which lead to their revision is referred to as formative evaluation. Formative evaluation is performed for the purpose of diagnosing and correcting the weaknesses of a program.

Anyone involved in the revision of instruction may be engaged in formative evaluation (in the loosest sense of the term). What is presumably being done is being done because the developer or someone else has judged the existing course as unsatisfactory. As new materials are developed, they are constantly being "evaluated" as better or worse than that which already exists. However, it is a formal program of formative evaluation employing various assessment techniques which is the keystone of the IPISD process and which provides the link between course content and course improvement. By explicitly stating objectives and criteria, one can properly determine if the program is achieving its goals, or if goals are to be modified.

Summative evaluation is performed for the purpose of assessing a fully implemented training program with respect to its ability to produce graduates who can perform to minimum standards of performance. Also, the evaluation can determine whether or not efficient and effective use was made of educational resources. Summative evaluation should occur after instructional development, improvement, and stabilization of operational and administrative activities. This may vary from one training program to another. In some cases, training objectives may not be measurable at the desired time of evaluation because they are either too costly to measure or are long-term objectives.

Results of a summative evaluation, while of interest to the developer, are of primary concern to those who will decide whether or not a program is to be continued or adopted. Summative evaluation, therefore, provides the basis for policy decisions that do not necessarily concern revision of the program or product [71,72].

The differences between formative and summative evaluations are mainly in their purposes and the timing of their application. Formative evaluation is continuous in nature and serves to refine a given program through an iterative feedback process; summative evaluation produces final judgments concerning the degree to which program objectives and goals have been attained. The information obtained from a summative evaluation allows the user to judge whether a program meets his needs, whether it should be widely disseminated, and if alternatives exist, which are to be preferred.

The discussion which follows will concentrate primarily upon formative evaluation as the purpose of the effort reported herein was to evaluate author aids in their initial development stages.

Evaluation Models

The formal distinction between formative and summative evaluation is attributed to Scriven [70]. However, the purposes for which such evaluation data are used have been discussed for many years in the training and education literature. Cronbach [73] stated that "the greater service evaluation can perform is to identify aspects of the course where revision is desirable." Early models of the systems approach to training development contain quality control components which emphasize the need for feedback for program improvement. Smith [74] described the purpose of a quality control system, ". . . a means for continuous monitoring of the quality of the graduates and for improving the training when it is deficient."

Quality control procedures are needed both at the school and in the field. Information from both locations must be "fed back" so that the instructional program can be appropriately adjusted. Schools require two types of feedback information. The first type assesses the ability of a course graduate to perform acceptably those tasks which the instructional program claims to teach. This type of information assesses the ability of the instructional program to teach well whatever it is that it claims to teach. In most instances, this assessment can be made at the school.

A second type of feedback information deals with the discrepancies between the course graduate performances and field requirements. "Relevancy control" information assesses whether or not the instructional program teaches the appropriate subjects or tasks, and whether or not the student can transfer these capabilities to the field. Also, this feedback should provide information dealing with changing field requirements and with more precise descriptions of job activities.

Baker and Alkin [75] point out that the evaluative process was an integral part of programmed instruction development which antedated the surge of interest in formative evaluation during the past decade.

Recent models of the formative evaluative process include those of Stake [76], Scriven [77], Stufflebeam, et al. [69], Sanders and Cunningham [78], and Rippey [79]. Scriven [77] feels that it is best if formative evaluation is performed by someone other than the developer. Scriven calls his approach "goal free evaluation" which calls for the evaluator

to assess the actual effects of the program. The evaluator operates without knowledge of the purposes, goals, or objectives of the program developers. Another model is described by Stake [76] as "responsive evaluation" which calls for the evaluator to be external to an instructional development activity, and therefore to have a certain independence and objectivity that is presumed not to be present in an internal evaluator. The Stake model provides a process evaluation strategy which contains a two-stage procedure: the first determines congruence between what is intended and what is actually observed (that is, discrepancies from program specifications), and the second with making sure the program has the type and quality of components implied by its objectives.

Less dependence is placed on the external evaluator by Stufflebeam [69]. As this model emphasizes the need for evaluation data to serve decision-making purposes in a timely manner, it permits the evaluator to be part of the development team. The "process" evaluation component calls for provision of feedback continuously during program implementation. In a similar framework, Sanders and Cunningham [78] identify four stages of the formative process. The first is called the predevelopmental stage, which seeks to identify needs. The second stage is called evaluation of objectives in which one develops, revises, and clarifies objectives. The third stage is called interim evaluation, and seeks to evaluate each piece of the instruction as it is developed. The final stage is called product evaluation, in which the program as a whole is evaluated, after which it may be recycled for further development.

Churchman, et al. [80] discuss the question of whether to use internal or external formative evaluators. They make the point (with which we agree) that in practice the formative evaluator will become so involved in the program that the objectivity expected from an external evaluator will be of little significance during the formative process.

Transactional Evaluation (Rippey [79]; Seidel [81]) differs from other evaluation models in that it focuses on the effects of perceptions of project team members and the user population. Its usefulness in formative evaluation comes from its emphasis on making explicit the relationships, roles, problems and possible solutions as perceived by developers and potential users of the instruction. The formal involvement of these people in clarifying the goals and objectives of a given program contribute to improvement during its early formative stages.

Formative Evaluation Techniques

The same measurement techniques and procedures may be employed in formative and summative evaluation. It is the purpose to which the evaluative effort is put and the time when it occurs that distinguishes between the two types of evaluations.

The application of experimental design to evaluation problems conflicts with the principle that evaluation should facilitate the continual improvement of a program. Experimental design prevents rather than promotes changes in the treatment because treatments cannot be altered in process if the data

about differences between treatments are to be unequivocal [82]. The experimental design type of evaluation is useful for making summative decisions but almost useless as a device for making decisions during the planning and implementation of a project [23].

In formative evaluation, the developer is looking for what the researcher often takes great pains to avoid. Instruction changes as a function of his activity, both as it is being developed and as it is implemented in pilot or field tests. The summative evaluator, on the other hand, as does the researcher, goes to great lengths to hold the program constant.

The choice of design for a formative evaluation is a complicated decision depending upon a number of considerations: cost, utility, practicality, generalizability, etc. Campbell and Stanley [83] have discussed the major considerations in the choice of a design. The evaluator needs to be concerned with replicability in that if the effect of instruction cannot be reliably established, then, of course, decisions about how to make it better are meaningless.

The most frequently used design in instructional evaluations is the single group pre-test/post-test design [84]. In this quasi-experimental design, a single group of students is first tested to determine how much of the criteria behavior they possess, then are administered the instruction, then tested again. If learning gains are demonstrated, the product developer concludes he has a successful product. The problem with such a design is that it allows many other plausible rival explanations for the observed results. In addition, a very serious limitation is the unreliability of change scores [85].

Pre- and post-testing is usually considered inadequate for formative purposes. Continuous monitoring permits correcting problems as they occur, tends to increase the aspects of the program that are included in the evaluation, and consequently improves the usefulness of the evaluation itself.

One problem with monitoring is in collecting data representative of the performance of the program such that it is typical of the full range of the intended usage of the system. This collection of performance data needs to be done without disturbing the performance of the system being monitored, which is difficult. Another problem is assimilating and interpreting the results. It is easy to collect massive amounts of confusing data unless one establishes monitoring experiments with clear hypotheses in mind [86].

The IPISD guidance [87] recommends such tryouts, as follows: "If the student who tries out the instruction experiences difficulties, it may be profitable to again test out the instruction, after revisions, on another student. Beyond practical considerations of time there is really no limit to the amount of pre-test tryouts that can be conducted until the instruction is successful."

If the task of the formative evaluator is to monitor programs in order to provide evaluation data leading to improved instruction, then it is not surprising that the focus of most research on formative evaluation has been at the data-acquisition/evaluation-utilization juncture [75].

One interesting research question relates to the selection of subjects as a data source for various formative evaluation efforts. There are those (including IPISD) which recommend that formative evaluation data are obtained from single learners in linear fashion with repeated tryouts. Essentially this technique consists of placing the author with a student as he/she uses the materials. Ideally, the student will help the author locate ambiguities, errors of sequence, and the like, and allow the author to test his assumptions concerning the thinking processes which will be employed by students using the materials [78].

An unpublished study by Robeck (as reported by Baker an Alkin [75]) tested the feasibility of using a single student as the data source for formative evaluation leading to the revision of an instructional program. The study demonstrated that observation of a single student is an economical method for significantly improving instruction. Aside from this study, very little research on this technique has been performed. The present state of knowledge consists of a number of conflicting "tips" on how to implement the procedures. Some recommend that high ability students be used, others recommended low ability. Some sources argue that students can only clean up semantic and syntactic errors, while others insist that the student can make more substantive suggestions concerning sequence, intended prerequisites, etc. At present, even a simple experiment comparing the quality of instructional products which have and have not used individual student tryouts as part of the development has not yet been done.

As was stated earlier, a variety of techniques can be used for formative evaluation. The purpose for which the information is gathered determines whether it is formative or summative. The ultimate criterion of an instructional program, however, is a change in the behavior of students. Determination of whether or not that purpose was met requires a demonstration of such changes. The IPISD guidance states that one needs to examine in detail the responses of the learners on criterion tests [87]. A combination of tests, observations, interviews, and affective measures is required to amass the data necessary for the formative evaluation and improvement of instruction. The specific techniques and approach used in our project to evaluate the author aids will be discussed in Chapter IV of this report.

Chapter II

PURPOSE

The purpose of the research effort described herein was to conduct a development and feasibility demonstration of on-line, query-based author aids. The research was designed to include author aids for Blocks II.2 (Develop Tests) and III.4 (Develop Instruction) of the Interservice Procedures for Instructional Systems Development (IPISD).

Specifically, the activities of the project were to result in author aids which:

- Are suitable for creation of both on-line and off-line instruction.
- Are generalizable for differing subject matter areas.
- Are documented in a flowchart form to permit timely conversion as appropriate to other CAI systems.

The utility of the author aids developed was to be evaluated and revised as necessary with military authors/instructors preparing operationally relevant instructional material.

Chapter III

APPROACH

The goal of the project was to construct, implement and provide a feasibility test of on-line authoring aids which can be integrated with the IPISD model. In order to attain the objectives of this project, the approach taken was:

- User-oriented
- Guided by the IPISD model
- Multi-level in its parallel development/evaluation activities.

A cooperative working relationship was established with instructional and curriculum development personnel of the U.S. Army Engineer School (USAES), Ft. Belvoir, Virginia. Input from USAES personnel was an important influence in the selection of author aids which would help the USAES instructional development team to implement the IPISD.

Author aids to be developed in this project were presented on the PLATO IV computer-assisted instruction (CAI) system. During the course of the project, four PLATO IV terminals were located in the HumRRO laboratory, Alexandria, Virginia. In addition, 8 terminals located at Ft. Belvoir, Virginia, were also available during the project.

The Engineer Non-Commissioned Office Advanced (ENCOA) course was selected for this project in consultation with USAES curriculum development and training personnel and with the agreement of ARI. Arrangements were made to permit participation of four instructors (2 NCOs and 2 Officers) who teach this course.[1] The ENCOA course covers a wide range of technical ("hard") and soft skills. It was thought that if authoring aids were developed which would be useful for handling instruction and testing of hard skills (e.g., straightforward mechanical work) as well as soft skills such as problem-solving, the set of authoring aids would be more applicable to other courses and other schools than if just the hard skills were chosen for the targeted materials. Therefore, the subject matter selected for this project was a nine-hour block of instruction from the ENCOA course, covering such items as field fortifications emplacement construction, U.S./foreign mine warfare doctrine, and protective mining. The work involved in this section of the course includes computational problem-solving, as well as procedural tasks. School personnel had defined training objectives as a result of previously applied systems engineering principles.

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[1] One Officer was transferred from the USAES during the course of the project. Therefore, only three instructors participated in the research effort.

The IPISD model was a compatible and useful guide in designing the technical approach for the proposed project. Each of the first three major procedural Phases--Analyze, Design, and Develop--were pertinent to the activities undertaken in this project. The targeted "students" in this case were the authors and the instructional focus was the author aid.

The multi-level nature of the project should be considered here. HumRRO personnel developed and evaluated author aids. These author aids were then used by USAES instructors to develop and validate instruction. Thus, iterative, parallel activities occurred at different levels in the project. Guiding all these efforts was the IPISD model itself--in particular the first three procedural Phases. For example, the approach to author aid development and validation drew its guidance specifically from IPISD Blocks III.4 and III.5.

Initially, a set of detailed flowcharts were constructed to describe information elements and features required by instructional developers in performing the steps of IPISD Blocks II.2 (Develop Tests) and III.4 (Develop Instruction). The flowcharts were designed to be sufficiently detailed and annotated for ready adaptation to any system (i.e., relatively hardware or software independent).

Inasmuch as the PLATO IV system was considered a research vehicle only, care was taken to maximize hardware or software independence of the aids. On-line author aids as well as off-line versions were supplied to assist the author in preparing instructional and test materials for either CAI or non-CAI delivery of instruction.

The multi-level nature of the research activities is clearly demonstrated by the three levels of evaluation undertaken in the project. The first level was an informal evaluation of existing IPISD guidance, procedures and author aids. HumRRO staff, as users of this guidance, were the primary source of evaluation data at this level.

Level 2 was directed toward a formative evaluation of new author aids and procedures developed specifically for on-line application to IPISD Blocks II.2 and III.4. Level 3 evaluation assessed the adequacy of the instructional materials created by the military authors. These materials were then administered to U.S. Army Engineer School trainees who provided an additional data source.

Revision activities occurred continuously throughout the period of project performance. The purpose of these revisions was to assure maximum utility of the flowcharts and author aids in implementing the IPISD process. The test items and lesson material were not revised as a basis of trainee data, because of time limitations, but these data were incorporated as part of the research conclusion.

The project activities were divided into four major Tasks. These were:

Task 1. Analysis and Determination of Required Author Aid Elements

Task 2. Conversion of Flowcharts to Interactive Program

Task 3. Evaluation of the Programmed Materials

Task 4. Revisions

The activities and accomplishments in each of the Tasks are described in the following chapter.

Chapter IV

PROJECT ACTIVITIES AND ACCOMPLISHMENTS

TASK 1. ANALYSIS AND DETERMINATION OF REQUIRED AUTHOR AID ELEMENTS

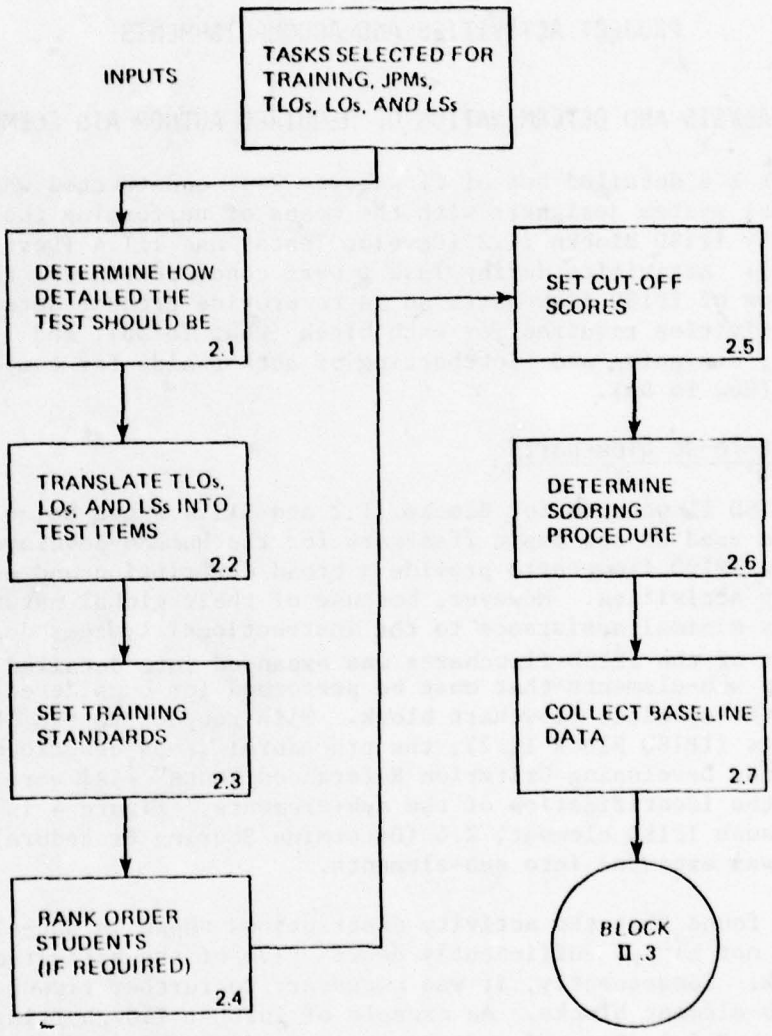
In Task 1 a detailed set of flowcharts was constructed which provide instructional system designers with the means of performing the procedures called for by IPISD Blocks II.2 (Develop Tests) and III.4 (Develop Instruction). Activities during Task 1 were conducted in two Phases: (1) expansion of IPISD flowcharts so as to provide greater detail of the specific activities required for each block (What To Do), and (2) selecting, identifying, designing and flowcharting of author aids for completing the activities (How To Do).

Develop What-To-Do Flowcharts

The IPISD flowcharts for Blocks II.2 and III.4 shown below in Figures 2 and 3 were used as the basic framework for the HumRRO-developed flowcharts. The IPISD flowcharts provide a broad description and sequencing of necessary activities. However, because of their global nature, they provide only minimal assistance to the instructional systems designer. Each element of the IPISD flowcharts was expanded into detailed step-by-step sub-elements that must be performed (or considered) in completing the specific flowchart block. With respect to the IPISD activity, Develop Tests (IPISD Block II.2), the procedural steps described in the "Guidebook for Developing Criterion Referenced Tests" [58] were used heavily in the identification of the sub-elements. Figure 4 is an example of how one such IPISD element, 2.6 (Determine Scoring Procedure) from Block II.2 was expanded into sub-elements.

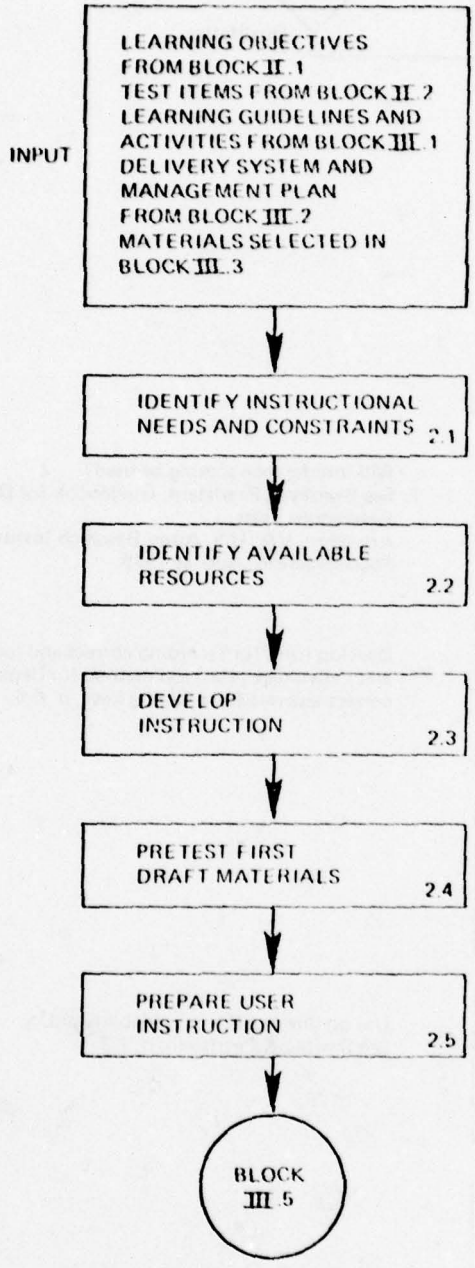
It was found that the activity descriptions shown in sub-element blocks were not always sufficiently descriptive of the activities required by the block. Consequently, it was necessary to further flowchart several of these sub-element blocks. An example of further flowcharting of sub-element block 2.6.1 (Determine Qualitative Scoring Procedures) is shown in Figure 5. The blocks in italics refer to blocks already flowcharted in IPISD. All other blocks are HumRRO flowcharts. Blocks outlined in boldface are blocks for which author aids were developed in the project. A check mark above a block indicates that existing author aids have been identified for that block. The narrative on the right of the flowchart further clarifies the block and lists any references to existing author aids.

The product which resulted from the Phase 1 activities is itself a valuable author aid for instructional system designers. It provides a step-by-step enunciation of activities that must be performed. The revised



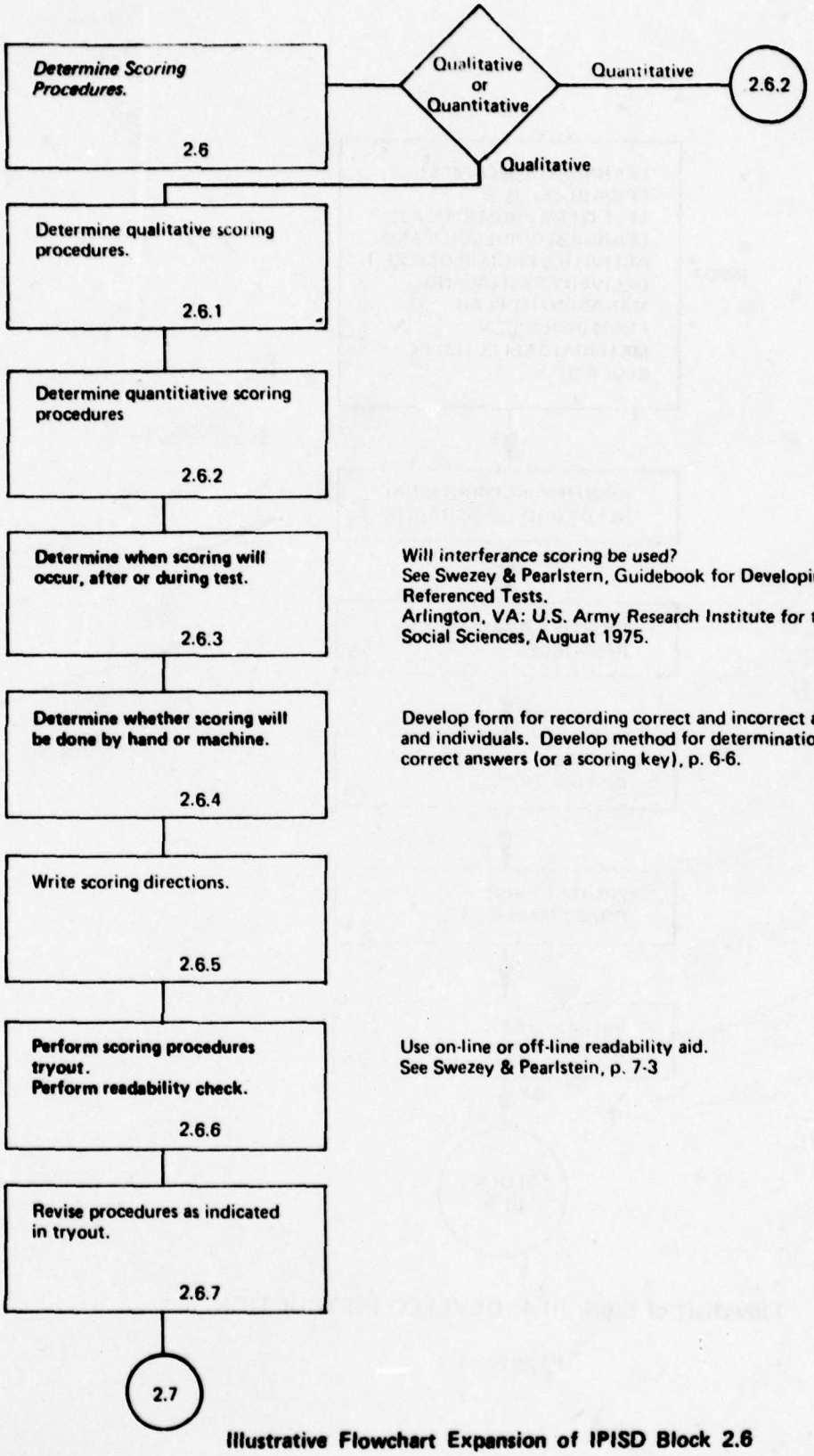
Flowchart of Block II.2: DEVELOP TESTS

Figure 2



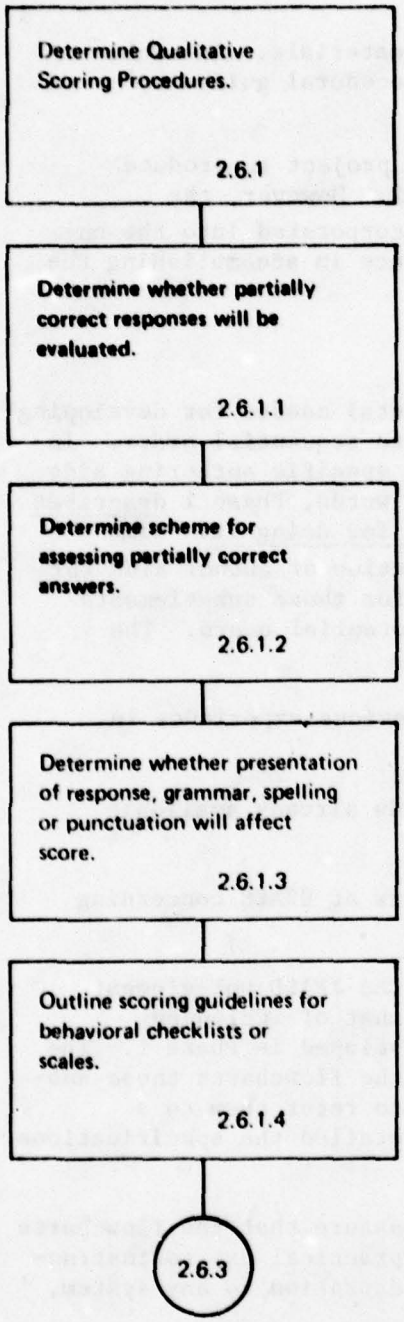
Flowchart of Block III.4: DEVELOP INSTRUCTION

Figure 3



Illustrative Flowchart Expansion of IPISD Block 2.6

Figure 4



Illustrative Flowchart Expansion of Block 2.6.1

Figure 5

and expanded flowcharts were produced as off-line materials. As such, they can be converted to checklists and used as procedural guides by designers of instruction.

It was not feasible within the limits of this project to produce the fully expanded flowcharts on the PLATO terminal. However, the information contained in many of the blocks was incorporated into the on-line author aids and as such provide on-line guidance in accomplishing the objectives of each block.

Identify and Reference How-To-Do-It Author Aids

In Phase I the detailed activities (sub-elements) needed for developing tests and instruction were defined and arranged into sequential order. In Phase 2 each sub-element was examined to determine specific authoring aids desirable to accomplish the sub-element. In other words, Phase 1 describes what must be done, and Phase 2 defines author aids for doing it. Time constraints did not permit the development or selection of author aids for every sub-element. Therefore, aids were provided for those sub-elements which were identified as of highest priority for potential users. The selection was based on such factors as:

1. Available HumRRO expertise gained from previous experience in author aid development;

2. A review of the literature to identify aids already available for use; and

3. Opinions of instructional systems designers at USAES concerning aids they considered would be helpful to them.

After identifying the author aids needed for the IPISD sub-element blocks, the next step accomplished in Phase 2 was that of including references to the author aids in the flowcharts developed in Phase 1. The purpose of this step was to identify for users of the flowcharts those sub-elements for which author aids were available and to refer them to a reference (hardcopy or on-line) which more fully detailed the specifications of the aid.

Throughout Phases 1 and 2, care was taken to assure that the flowcharts were sufficiently detailed and annotated to be of practical use to instructional system designers and would readily permit adaptation to any system, i.e., be hardware or software independent.

Task 1 activities resulted in an Interim Report and Guide to the Use of Flowcharts [88]. This report contains flowcharts providing detailed guidance on the procedural steps necessary for implementing IPISD Blocks II.2 and III.4, and identifies sub-elements of these blocks for which author aids were developed. In addition, the Interim Report includes a guide to the use of flowcharts which we felt is necessary inasmuch as many authors may not be familiar with a flowchart format.

The flowcharts prepared in Task 1 are of value from three standpoints: (1) They are useful as tools for instructional systems designers in the implementation of the IPISD process; (2) they may be used as a model for detailing the processes covered in other IPISD Blocks in terms of level of detail, style, and format; and (3) they may be used in the preparation of on-line author aids on any CAI system.

TASK 2. CONVERSION OF FLOWCHARTS TO INTERACTIVE PROGRAM

In Task 2, author aids identified in Task 1 were developed for presentation on the PLATO IV computer-assisted instruction (CAI) system. Inasmuch as the PLATO IV system was considered a research vehicle only, care was taken to insure that the author aids developed could be readily modified to be hardware or software independent. Where possible the author aids were also created so as to have application for "off-line" use.

In the context of the present project, an instructional system developer (author) may be working on-line in an interactive mode with a computer. In this case, he is termed an "on-line author." If an author is not working directly with a computer, he is referred to as an "off-line author." Even authors who are developing CAI materials work in both off-line and on-line modes. For example, some authors use preprinted CRT layout sheets to write their text, and then have clerks key the text into the computer. Currently authors of most military instruction typically work off-line, although they may have access to computer support for such things as test scoring, statistical item analysis, or other aids.

Author aids were developed to assist the on-line author in preparing instructional and test materials for both CAI and non-CAI delivery of instruction. CAI was the principal mode used in this research because the CAI mode provides opportunity for ease of gathering and analyzing data regarding both student and author activities. Off-line versions of these aids will assist off-line authors in preparing both CAI and non-CAI materials.

PLATO lessons "inquiry1" and "inquiry2" can be thought of as master author aids. These lessons incorporate the individual author aids identified in Task 1. Lesson "inquiry1" deals with lesson development (IPISD Block III.4), and "inquiry2" with test development (IPISD Block II.2).[1] Individual author aids for inquiry1 and 2 can be roughly categorized in four different classes which are discussed below. The four categories for each master author aid are:

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[1]These lessons were available on the University of Illinois PLATO IV CAI system at the time this effort was completed.

Lesson "inquiry1" (Lesson Development)

1. Tutorial author aids for Lesson Development
2. Author aids for management of the lesson development process
3. Author aids for lesson content development
4. Author aids controlling within lesson branching

Lesson "inquiry2" (Test Development)

1. Tutorial author aids for Test Development
2. Author aids for management of the test development process
3. Author aids for test development (e.g., test instructions and test items)
4. Author aids for post-test reporting of results, review and remediation actions.

Lesson Development (Lesson "inquiry1")

1. Tutorial Author Aids. This series of author aids provide instructional system designers (authors) with guidance in the preparation of lesson materials. On-line the guidance is automatically presented at appropriate points during the lesson development process. In addition to the forced presentation, authors may review any specific guideline as desired. The guidelines are available in both on-line and off-line versions. Specific guidelines included in this series of author aids are:

- Instructional Sequencing Rules
- Guidelines for the Preparation of Terminal Learning Objectives
- Guidelines for Reducing Reading Difficulty Level
- Guidelines for the Preparation of Text Material
- Guidelines for the Use of Practice Question Formats (General)
- Guidelines for the Preparation of Multiple-Choice Practice Questions
- Guidelines for the Preparation of True-False Practice Questions
- Guidelines for the Preparation of Constructed Response Practice Questions

The "off-line" version of these author aids will be of use for all instructional modes.

2. Author Aids for the Management of the Lesson Development Process

- *Sequencing of Instruction*

Instructional content is, of course, based on Terminal Learning Objectives (TLOs), Learning Objectives (LOs), and Learning Steps (LSs). However, how these are sequenced in the instruction may very well determine whether an instructional module is effective or ineffective. (A module as here defined begins with an LO or LS and is usually followed by 5-10 frames of text and practice questions which teach the LO or LS.) To assist authors in the creation of modules and the sequencing of instruction, worksheets have been prepared for off-line creation of LOs, LSs, text

frames and various types of practice questions. These worksheets can be used for most instructional modes but are particularly suited for CAI and programmed instruction.

- *Learning Objectives (LO) and Learning Steps (LS) Management*

Learning Objectives (LOs) and Learning Steps (LSs) are the backbone of the IPISD process. They dictate the content of both instructional material and test items. The instructional system designer must attend to them carefully to insure they are represented in the instruction and test situation. As described above (Sequencing of Instruction) each module of instruction begins with an LO or LS. The author is required to input the LO or LS prior to inputting instruction for a given module. During the preparation of the instruction for a module, the associated LO or LS is available to the author as a continual reminder of the instruction to be addressed. A by-product in the CAI version that is available to students studying a particular module of instruction is the option to access the LO or LS statement underlying the instructional module (see Student Controlled Branching Author Aid below.) The "off-line" version of this author aid will be of use for all instructional modes.

- *Reading Difficulty Index*

When preparing any instructional material it is essential for the author to consider the intended audience for the material [89-97]. Therefore, an author aid was prepared for use on the PLATO system that automatically computes the reading difficulty of text material, question stems, and feedbacks provided the student as the material is inputted into the system.[1] In using the aid, authors specify the reading ability level of the intended audience and if this level is exceeded the computer so informs the author who can then revise the material to a lower reading level. An off-line version provides the formula and identifies the components required for computing the reading difficulty index. Obviously, this author aid is far stronger in its on-line version since the author is not required to compute the index. However, it can be used manually in off-line instructional modes.

3. Author Aids for Lesson Content Development

- *Text Creation and Editing*

This author aid will be most powerful for development of CAI materials. In CAI form it permits authors to create CAI executable textual material without a knowledge of the programming language required by the system. The text may be placed at the author's option any place on the screen and permits revision after initial creation. It incorporates other author aids such as the reading difficulty index (described earlier).

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[1]Available in Appendix A.

- *Practice Item Creation*

This is actually a series of several author aids which allows creation of practice questions. The author aids do not require a knowledge by authors of a computer programming language. The aids are of primary value in a CAI or PI mode. Detailed characteristics of each of these author aids are shown in Tables 1, 2 and 3.

4. Author Aids Controlling Within-Lesson Branching

- *Author-Directed Branching*

Today, in many instructional modes such as CAI, PI and other forms of self-paced instruction, students frequently must demonstrate a mastery of current instruction before being allowed to go on to new instruction. Based on their performance, some students may be required to review certain portions of the instructional material while others will go through the instruction without forced review. That is, students are branched depending upon their particular needs. This process requires that student performance be continuously monitored. Author aids have been provided to assist authors in these efforts. Data collection aids for practice questions provide continuous student monitoring. Other aids provide guidance to the author on how to use monitoring information (e.g., the number of attempts a student is permitted at a practice question, the conditions under which the student is required to review instruction, etc.). These aids have primary application in self-paced modes of instruction.

- *Student-Directed Branching*

Students themselves, frequently know when they need additional assistance and should have the opportunity of accessing this assistance whenever they desire. However, they must be able to identify what assistance is available and the means for accessing it. This series of author aids provides students the options of accessing auxiliary information, returning to previously studied material[1] and, if permitted by the author, of branching to the end-of-lesson test from anyplace in the lesson. These aids make use of aids already developed for other purposes. For example, the management and sequencing aids provide specific statements of TLOs, LOs and LSs associated with each instructional module. The student-directed branching aids permit the student to temporarily branch to these statements whenever desired. The author aids provided for student-directed branching will have wide application independent of the instructional mode used.

Test Development (Lesson "inquiry2")

1. Tutorial Author Aids. This series of author aids is similar to those discussed in the tutorial author aids for lesson development. These aids, however, provide both on-line and off-line guidance in the various

[1] That is, back-page, return to beginning of lesson or beginning of module.

Table 1. CHARACTERISTICS OF PRACTICE QUESTION AUTHOR AID (MULTIPLE CHOICE)

- Question stem has maximum length of six 50-character lines.
- Three-six answer alternatives (including correct answer) permitted.
- Each answer alternative has maximum length of two 40-character lines.
- Correct answer position randomly selected. (Author may select other position if desired.)
- Author "cued" if answer alternatives differ in length by more than ± 20 characters. (Author has option of revising.)
- Author specifies one-three attempts student permitted on question.
- Author can create correct answer congratulatory message. Maximum of five 40-character lines.
- Incorrect answer feedback messages may be specific to response given, or general feedbacks which may be different for different attempts. Incorrect answer feedbacks are limited to five 40-character lines.
- Correct answer given student if number of permitted attempts reached without student correctly answering the question.
- Reading difficulty of question stem and feedback messages automatically computed. If desired reading level exceeded, author has the option to revise material.

Table 2. CHARACTERISTICS OF PRACTICE QUESTION AUTHOR AID (TRUE-FALSE)

- Question may be a maximum of six 50-character lines.
- Author specifies one or two attempts student permitted on question.
- Author can create correct answer congratulatory message. Maximum of five 40-character lines.
- Incorrect answer feedback message provided if two attempts permitted. Messages may be a maximum of five 40-character lines.
- Correct answer given student if number of permitted attempts reached without student correctly answering question.
- Reading difficulty of question and feedback messages automatically computed. If desired reading level exceeded, author has the option to revise material.

Table 3. CHARACTERISTICS OF PRACTICE QUESTION AUTHOR AID (CONSTRUCTED REPONSE)

- Question may be a maximum of six 50-character lines.
- Author specifies one-three attempts student permitted on question.
- Student response analyzed for one-four correct or partially correct answers.
- Student response analyzed for one-four anticipated incorrect answers.
- One-four congratulatory messages permitted depending upon number of correct or partially correct answers specified by author. Messages may be a maximum of five 40-character lines.
- One-four wrong answer messages permitted depending upon number of incorrect answers specified. Messages may be a maximum of five 40-character lines.
- Author has option of permitting misspelling of answer; words in answer to be out of order; extra words in answer; and disregarding the capitalization of answer.
- Correct answer given student if number of permitted attempts reached without student correctly answering the question.
- Reading difficulty of question and feedback messages automatically computed. If desired reading level exceeded, author has option to revise material.

facets of test development. Like the lesson development tutorial author aids, they are automatically presented to authors at appropriate points during the test development process and are available for review at any time. Specific guidelines included in this series of author aids are.

- Guidelines for using "inquiry2" author aids
- Guidelines for the Preparation of Terminal Learning Objectives
- Guidelines for Writing Test Instructions
- Guidelines for Reducing Reading Difficulty Level
- Guidelines for the Preparation of Multiple-Choice Test Items
- Guidelines for the Preparation of True-False Test Items
- Guidelines for the Preparation of Constructed Response Test Items
- Guidelines for Assigning Scores to Test Items
- Guidelines for Post-Test student review of test items and Remediation Strategies

2. Author Aids for Management of the Test Development Process

- *Sequencing of Test Items*

Worksheets are provided to authors for off-line creation of TLOs, LOs, LS test instructions, and test items. These aids permit authors to organize and sequence their test items prior to input into the computer. The worksheets are useful for all modes of instructional delivery.

- *Terminal Learning Objectives (TLO), Learning Objectives (LO), and Learning Step (LS) Management*

This author aid is somewhat different from the corresponding aid used for creating TLOs, etc., in the lesson development process. Instructional system designers (authors) input all TLOs, etc., into the computer in the sequence in which they wish to cover them in the test. (See sequencing of Test Items above.) The author aid then maintains records of which TLO, etc., has been addressed in the test and in the on-line version. The computer "cues" the author as to the TLO they should next address. The off-line version of this author aid will be of use for all instructional modes.

- *Reading Difficulty Index*

This author aid is identical to the one discussed earlier in the Author Aids for Management of the Lesson Development Process.

3. Author Aids for Test Development

- *Creation of Test Instructions and Editing*

This author aid is similar to the text creation author aid previously described. The aid will be most useful for development of

student instructions for computer-administered tests. It can also be used for on-line development of instructions for other instructional modes such as programmed texts, etc. The use of the author aid does not require a knowledge of the programming language required by the system. The aid also permits revisions to be made to the instructions after initial creation.

- *Test Item Creation*

A series of author aids was developed to be used for creation of representative types of multiple-choice, constructed response and true-false test items. They are similar to the practice question author aids (see Tables 1, 2 and 3) except that they do not provide correct and incorrect response feedbacks, nor a variable number of permitted attempts.

- *Timing of the Test*

This author aid permits authors to establish, if desired, a time limit for individual items in the test or a time limit for the entire test. In the CAI version of this author aid, the computer maintains a record of elapsed time and takes appropriate action based on the elapsed time. This author aid is most useful in a CAI mode.

- *Test Item Scoring*

Test item scoring author aids are provided to assist test developers in establishing test scoring procedures. These aids include such considerations as: setting cut-off scores, differential weighting of various answers to a test item (i.e., correct, partially correct, and incorrect answers), and/or differential weighting of different test items. Off-line versions of these aids consist of guides, checklists, etc. On-line versions are similar but are prepared in a "query" format. The aids are useful for test scoring for most instructional modes.

4. Author Aids for Reporting of Results, Review and Remediation Actions

- *Reporting of Results*

Subsequent to test item scoring (discussed above) authors can establish the minimum passing score required. This author aid then scores the test and automatically reports to students their obtained score and the minimum score required for passing. The aid is most powerful in a CAI format but may be also used in other self-paced modes of instruction.

- *Post-Test Review of Test Items Missed*

These author aids permit the test developer different student review options for test items missed. For example, if the student passes the test with less than a perfect score, the author may elect to show the student the correct answer to items missed. Or, in the case of students who fail the test, the author may elect to: (1) show the students test items missed without providing the correct answers, (2) show test items

missed and include the correct answers, or (3) not permit a review of items missed. This author aid is primarily of use in a CAI or programmed text mode.

- *Remediation Actions*

This is a series of author aids which permit the author to select the type of action that will be taken if a student fails the test. The actions possible in these aids are as follows:

(a) Re-administration of instructional lesson followed by re-administration of test items previously missed.

(b) Re-administration of instructional lesson followed by re-administration of entire test.

(c) Immediate re-administration of test items previously missed. (No re-administration of instructional lesson.)

(d) Immediate re-administration of entire test. (No re-administration of instructional lesson.)

(e) Re-administration of test items missed. Give student option of reviewing instructional lesson first.

(f) Re-administration of entire test. Give student option of reviewing instructional lesson first.

(g) No re-administration of instructional lesson or test--student is finished with lesson or goes to new lesson.

In the on-line version of these author aids, failing students are automatically branched as directed by the author. Therefore, these aids are most powerful in a CAI format. However, the principles underlying the aids can be employed in any instructional mode.

TASK 3. EVALUATION

Three levels of evaluation were undertaken in this project. The first level was an informal evaluation of existing IPISD guidance, procedures and author aids. Six HumRRO personnel with technical expertise in systems engineering procedures judged the ease and effectiveness with which selected IPISD procedures and guidelines could be used to develop instruction. Where appropriate, these author aids were referenced in the flowcharts developed in Task 1.

The second level of evaluation was a comprehensive formative evaluation of the new author aids and procedures developed for application to IPISD Blocks II.2 and III.4. Three instructors from the ENCOA course [one officer and two NCOs (E8)] served as study participants and as a data source for evaluation. These instructors used the aids to create test items and lesson material. Evaluation data were gathered as the authors developed their

instructional material. Formative evaluation of the author aids was accomplished by examining author performance and acceptance of the aids. Critical weaknesses in the aids (i.e., those which impeded the progress of the authors) were remedied immediately upon diagnosis of the problems.

In the third evaluation level, the adequacy of the instruction created by the military authors was assessed. This instruction was administered to U.S. Army Engineer School trainees who provided the data for evaluation. The ultimate criterion of instruction is evidence of desired changes in trainee behavior (i.e., Does it "teach?"). In order for the author's developmental activities to be adequately assessed, trainee performance and attitude data were collected.

In the intial stages of the second level formative evaluation, HumRRO staff functioned as "test item developers" and/or "preparers of lesson material." Their role in this study was to find errors and faults in the directions, requirements, procedures, etc., of the author aids. We then used these data to make needed revisions of the author aids.

Once the author aids were considered ready for application to actual course content, the three USAES authors were given training in using the aids. A brief 15-minute familiarization/training period in using PLATO preceded each individual's involvement in the project. They received instruction in signing on and off to the system (which included signing into the appropriate HumRRO lesson). A brief (approximately 5 minutes) orientation to the PLATO keyboard was then presented to each author. This included: use of the edit keys; editing techniques; and use of the help sequence keys (e.g., HELP, BACK, NEXT, etc.). Descriptions of system crashes, transmission errors, and other system abnormalities were provided along with instructions on how to proceed under these circumstances. The authors were then permitted to practice with the keyboard before they started inputting their lesson/text materials, and all of them chose to do so.

Following familiarization training on PLATO, the three USAES instructors/authors were given a brief explanation of their role as authors and then training in the use of the author aids. Project staff members provided the training in a one-on-one, tutorial mode.

Following training in the use of aids, instructors prepared and input on-line in the PLATO system test items and lesson material. Each of the instructors developed a lesson and the related test items in their content specialty as part of a 2-3 hour block of different, but related, subject matter from the Engineer NCO Advanced (ENCOA) course. Table 4 lists the subject-matter blocks selected for this project.

The ENCOA course had undergone systems engineering and USAES personnel provided a set of well-defined terminal learning objectives. Test items were prepared which reflected these objectives. An additional advantage to the ENCOA course was that both NCO and Officer instructors were available as authors. Hence, the utility of the aids could be evaluated across a wide range of background skills and experience.

Table 4. ENCOA LESSONS AUTHORED ON PLATO USING INQUIRY AIDS

Lesson	Author	Time to Create Lesson	Completion Time in Current Course	Average Completion Time in CAI Version (minutes)
Field Fortifications Emplacement Construction	NCO-1	48.5 hrs.	4 hrs.	94.3 (N = 9)
US/Foreign Mine Warfare Doctrine	Officer	41 hrs.	2 hrs.	60.2 (N = 11)
Protective Mining	NCO-2	35 hrs	3 hrs.	38.6 (N = 9)
TOTAL		124 hrs.	9 hrs.	191.1 minutes (or) 3.22 hrs.

Although each author was required to input his material into the computer, a HumRRO staff member was present to assist him in the process on a one-to-one basis. No instructor needed to know the TUTOR language or have previous TUTOR experience because the INQUIRY author aids were designed so that code was automatically generated.

Data collection, to a large extent, resulted from direct observations of the authors creating and inputting their instruction and from structured interviews with the authors. We gathered user acceptance data, and information on various areas of difficulty that the authors experienced while using the aids.

The authors using the INQUIRY system were encouraged to comment at any time on their progress. Monitors were present at every inputting session to note any problems encountered or comments made by the authors. These comments were used later to make changes in the system so that it was easier to use. After the authors inputted all of their material, they received a questionnaire asking their opinions of CAI and the INQUIRY system. In addition to interview/questionnaire data, performance data were collected. Such items as the time to create a given frame of text or test item on-line, the number of times a piece of text had to be re-input, errors in attempts to apply a particular aid, calls for help from the monitor, etc., were recorded.

In the third evaluation level, we assessed the instruction created by the authors using the INQUIRY aids. To the extent feasible, student-identified areas of difficulty in the instruction were associated with the use of particular author aids. In this way, we tried to determine whether a poorly designed aid led to unclear instruction or to problems with the tests.

Twenty-two students[1] went through the lesson material for about 2-3 hours each to assess the quality of the instruction created with the author aids. All students received preliminary training on using PLATO. As all the students could not go through all the instruction and testing within the time allotted by USAES for this project, only two of the three lessons were presented on a random basis to each student.

Presentation of lesson content occurred on-line, as did the administration of the post-tests based on the TLOs. In addition to collecting cognitive data regarding student performance, exit questionnaires were administered to obtain information regarding opinions of the clarity of the instructional material, problems encountered in the practice and test items, and attitudes toward the CAI instructional experience.

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[1] Prerequisites for selecting students were that they be NCOs who have entry qualifications for the ENCOA course, but have not been exposed to the material covered in these lessons.

Findings

1. Instruction and Test Development. The tutorial aids were presented to each author prior to inputting. In no instance did the authors seek to reread these aids which presented guidance on test and lesson development. Thus, it cannot be concluded whether or not these guidelines were useful to the authors. It appears that more emphasis on the applicability and value of the aids is required in order for authors to pay attention to this guidance. This may involve a considerable change in their presentation format.

As a result of the initial formative evaluation, the authors were able to prepare test and lesson material with minimal difficulty. In developing almost 360 frames of instruction and testing, a total of 65 problems were experienced by the authors as recorded by the monitors. Over 25% (18) of these problems were trivial errors caused by the author pushing the wrong key. Fourteen instances were due to unclear INQUIRY instructions, which were remedied as soon as possible after they were noted. Twenty-one problems were due to "bugs" in the INQUIRY program which were eliminated as soon as their diagnosis was confirmed. Six problems were noted as due to PLATO system crashes and transmission errors. Six other problems arose from miscellaneous reasons. Thus, most of the instructional and test development activity undertaken by the authors occurred smoothly and without undue difficulty.

2. Time. The blocks of instruction from the ENCOA course which were put on-line are traditionally taught in 9 hours. The average completion time was under 3 1/4 hours for this instruction including taking the associated tests. (See Table 4)

The time to prepare the test items and lesson materials using the INQUIRY system of author aids varied little from one author to another. Times ranged from 35 hours for one NCO (15 hours on-line), 41 hours for the Officer (14.5 hours on-line), to 48.5 for the remaining NCO (18.5 hours on-line).

3. Readability Index. This author aid provided information if the reading grade level was surpassed for each text frame or test item. However, it was rarely used. That is, no matter what the index showed, the authors chose to ignore it. About 220 text frames of instruction were produced in this study. More then 50% (126) exceeded the pre-specified reading levels. However, only 1 frame of instruction was revised by the author as a result of this information. This was most likely due either to a lack of confidence in the measure's validity, or to a lack of perception on the part of the authors regarding the criticality of reading level, or a combination of both. In any event, no changes have been made to this aid yet. However, we believe that there are at least two possible changes needed. First, authors should be given more instruction in the usefulness of this aid together with more practice. Second, the options available in the INQUIRY system to override this aid should be removed entirely or severely constrained (i.e., within 1 grade level on either side of the pre-specified one).

4. Multiple-Choice Items. As authors prepared multiple-choice practice and test items, a pre-programmed INQUIRY aid assigned the correct answer alternative on a random basis. Authors were given the option to change the designation of the correct answer alternative, and approximately half the time exercised this option. Authors were, thus, indicating their preference for retaining control over the manner in which they created instruction.

Another author aid compared the lengths of answer alternatives and indicated when they were unequal. This occurred in about half the items. However, authors unanimously disregarded this information and left the alternatives as they were. It appears that more restrictions on the author aid are needed in order for these author aids to be used.

5. Constructed Response Items. In the constructed response format, authors used the following aids:

- The aid which permitted them to define the rigor with which answers would be scored. Authors selected those options which permitted misspellings, extra words, and optional capitalization. However, authors did not permit the words in the answer to be out of order.

- Authors made full use of the various aids available for preparing response feedbacks and varied between providing trainees specific as well as general feedbacks to both anticipated and unanticipated answers. The most positive reaction by students was to the explanatory feedbacks presented after each response to practice questions. The INQUIRY author aids for presenting response feedbacks were used frequently by the authors and, if possible, should be incorporated in off-line instruction (e.g., using the guidance for preparing feedbacks in PI texts).

- Authors were able to use the INQUIRY aids to specify anticipated correct and incorrect answers. However, there appeared to be a problem with anticipating all the answers which were given by the trainees.

The student attitude questionnaire data indicated a strong negative reaction to the constructed response questions provided by all the authors both as practice and as test items. Student performance data supported this result, as most difficulties were encountered when responding to constructed response questions (both during learning and test taking). These results appear to be due to those instances in which a "correct" answer as given by the student is considered to be incorrect by the system.

The monitors had observed this problem as authors input their material. The authors could not adequately anticipate all the synonymous correct answers which could be given by the trainees. This problem is particularly critical in CAI, as the evaluator "knows" whether the answer is correct after seeing it. This finding suggests that the guidance for preparing constructed response items be revised to clarify situations where authors should or should not use constructed response questions. That is, constructed response formats should be used only in cases where the number of possible alternate correct answers is small.

6. Student Options. Of the student options, the ability to back up to a previous frame (BACK) was considered helpful by almost all of the trainees in all three lessons. The other three options were: HELP--in which the relevant learning objective was displayed; LAB--in which the student could return to the beginning of the lesson; and DATA--in which the student could go back to the beginning of the module. All three options were rarely used, and so it was not surprising that students were divided in their opinions about their necessity.

TASK 4. REVISIONS

Task 4 activities consisted of making revisions to: (1) flowcharts developed in Task 1 and (2) author aids provided in Task 2. The purpose of the revisions was to assure maximum utility of the flowcharts and author aids in implementing the IPISD process. Revisions constituted a series of activities which spanned almost the entire research period and paralleled all development and evaluation actions in the other Tasks. Information sources upon which revisions were based are as follows:

- As flowcharts were being developed, HumRRO personnel not directly involved in the project provided input as to the clarity, utility and need for revision.

- The expanded flowcharts developed in Task 1 were submitted to instructional system designers at the USAES for review.

- Review of the Interim Report (which contains flowcharts) by the COTR provided additional information for needed revisions.

- As on-line author aids were developed they were initially used by HumRRO personnel to identify "bugs" in the aids which were corrected before wider use was made of them.

- The most important test of the utility of the flowcharts and author aids occurred in Task 3 when authors participating in the research effort used the flowcharts and author aids for developing instructional material. Only minor "bugs" were identified at this stage since the flowcharts and author aids had undergone extensive review and pre-testing. Any problems encountered by the authors in using the flowcharts and author aids were immediately corrected.

- The last information source for flowchart and author aid revision was to occur after the students had been administered the instructional materials developed by the authors. A few such needed revisions were identified as a result of difficulties students had with the instruction that was directly connected with the author aid used for preparing the instruction. Specifically, it was found that the author aids for preparing constructed response practice and test items require additional developmental effort in guiding authors in the identification of what constitutes a correct or incorrect answer. For example, the answer to a question might be 820 meters. However, if the student answered 820 M (which should be an acceptable answer), they were judged as having given an incorrect response.

As a result of the input received from USAES system designers and the COTR, major formatting revisions were made to the flowcharts contained in the Interim Report [88]. The revised flowcharts are shown in Appendices B and C.

Chapter V

RECOMMENDATIONS

The evaluation of the author aids reported in the preceding chapter has demonstrated the feasibility of on-line aids for implementing IPISD Blocks II.2 (Develop Tests) and III.4 (Develop Instruction). User acceptance of the aids is high and the time required for creation of test and lesson material has been significantly reduced. Further developmental effort of on-line author aids appears warranted. Continued development effort should include five major areas which are discussed below. These areas are:

1. Modification of selected current author aids developed in the present project.

2. Development of additional author aids for IPISD Blocks II.2 and III.4.

3. Development of author aids for other blocks of the IPISD model.

4. Conversion of aids presently programmed for PLATO IV CAI to other systems.

5. Author Characteristics.

MODIFICATION OF CURRENT AUTHOR AIDS

There was insufficient time during the project to make all of the modifications that were indicated during formative evaluation. These modifications should be made if the lesson and test development author aids are to be maximally effective. The specific author aids for which we recommend modification are:

(1) Reading Difficulty Index. As was reported in the previous chapter, experimental authors did not revise lesson or test material when the material was written at a reading difficulty level in excess of that intended. Hence, if reading level is critical, the author aid should be modified to force authors to revise material when the reading level is more than one grade above that desired.

(2) Author Aid for Creating Constructed Response Questions. Authors require additional guidance in determining how to use constructed response questions appropriately. When constructed response questions are used, guidance is needed in the selection of the correct answers and alternate forms of the correct answer (e.g., George Washington, Geo. Washington,

President George Washington, etc.). The need for this modification arises from the level 3 evaluation. Students who were administered the experimental lessons and tests had difficulty in answering constructed response questions. Often, students would provide answers which were actually correct but with an answer variation not anticipated by the author. Therefore, their answer would be erroneously judged incorrect. When this happens, it is very frustrating for the student and if it occurs frequently, it reduces the perceived instructional value of the lesson to the student. To remedy this situation, authors should be provided with detailed guidance on the use of constructed response questions as well as guidance on the framing of correct answer variations.

(3) Editing of Test and Lesson Material. With the present author aids all editing must occur only during the creation of text or questions. Once material has been completed there is no provision for further editing. This is a severe weakness of the present author aids. It is possible to revise the author aids so as to permit text and question revision after trial administration of the lesson. However, this is a major effort outside the scope of the current project.

ADDITIONAL AUTHOR AIDS FOR IPISD BLOCKS II.2 AND III.4

Although additional author aids could have been developed, this was outside the current scope of work. Additional aids which are desirable include:

- Author Aid for creation of Matching Questions. (This aid is presently in draft form.)
- Author Aid for creation of Arithmetic Manipulation Questions.
- Author Aid for creation of Multiple Choice Questions with more than one correct answer.

CONVERSION OF INQUIRY AUTHORS AIDS TO A CAI SYSTEM OTHER THAN PLATO IV

As previously stated, the PLATO IV CAI system was considered to be a research vehicle only. The goal was to develop and document on-line author aids that could be programmed on any CAI system. Therefore, a trial conversion of at least selected author aids should be undertaken. This undertaking would determine the extent to which author aids developed on one CAI system could be converted to another CAI system and point out difficulties to be expected in such a conversion. For example, rather than using the TUTOR language, a system-independent language such as PLANIT could be used as a test for the general usefulness of the on-line author aids. Use of flowcharts which supported on-line aid development on PLATO IV could be used for the basis for this effort.

DEVELOPMENT OF AUTHOR AIDS FOR IPISD BLOCKS OTHER THAN II.2 AND III.4

The present research has demonstrated, to a degree, the utility of on-line, query-based author aids in the implementation of IPISD. However, before further work is initiated which is directed toward providing on-line author aids for all applicable Blocks of the IPISD mode, other research is needed. Examples of such research are discussed below. This study does show the benefit of flowcharting to aid the IPISD process, and such efforts should be undertaken for other IPISD blocks.

AUTHOR CHARACTERISTICS

Authoring of CAI lessons requires a certain discipline and level of competence which may not be present in all instructors assigned to this task. Aids are thus needed which constrain the author much more than was done in INQUIRY, in order that useful guidance and techniques can be applied in creating effective instruction. The minimal prerequisites for authoring both on- and off-line materials need to be established as well as the extent to which aids can compensate for variable experience between personnel. If such a study indicates that many individual proficiencies are lacking and cannot be overcome by author aids, then a selection and classification problem would have been uncovered and an assessment of "author" job/duty position requirements is necessitated.

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Appendix A

READABILITY LEVEL FORMULA

Figure the average length of a sentence in number of words. Figure the average word length in number of letters.

1. Multiply the average sentence length by .5.

2. Multiply the average word length by 4.71.

3. Add the products of Steps 1 and 2 together.

4. Subtract 21.43 from the sum obtained in Step 3. This is the readability level of the materials.

Here is the formula:

[(.5 (verage sentence length)) + (4.71 (average word length))] - 21.43

(from Kincaid, 1972)

Appendix B

FLOWCHARTS OF IPISD BLOCK II.2 (DEVELOP TESTS) AND BLOCK III.4 (DEVELOP INSTRUCTION)

GUIDE TO THE USE OF FLOWCHARTS

The IPISD flowcharts for Blocks II.2 and III.4 (see Figures 2 and 3 in Chapter IV) were used as the basic framework for the HumRRO-developed flowcharts. The flowcharts in this appendix expand each of the IPISD flowchart blocks into detailed step-by-step components which must be performed (or considered) in completing the specific flowchart block. (In the appendix IPISD flowchart blocks are noted by italics.)

Flowchart blocks which are shaded are blocks for which author aids were developed in this project. Next to these shaded blocks are indicators specifying whether the aid is on-line and/or off-line. Blocks with an asterisk (*) next to them indicate that existing author aids have been identified. In these cases we provide a reference to the author aid that is to be used at that specific point in the process of developing tests and instruction. For some flowchart blocks supplementary information is presented for clarification of a specific block's activity statement.

For example, Figure B-1 shows the first seven task elements required to prepare multiple-choice test items. The total task elements can be found on pages B-7 thru B-9 of this Appendix.

The first task element in Figure B-1, Establish Testing Conditions for Multiple-Choice Tests (2.2.1.2.2) is the task to be performed. The task elements under this block must be performed, or at least considered when preparing multiple-choice test items. For example, task element a, "set readability level for test," is the first sub-task shown in the figure. The asterisk (*) beside the block indicates the availability of a non-HumRRO author aid. In this case, the readability level set is contingent on the reading level of trainees. Since this block is shaded it is identified as a block for which an author aid was developed in this project. This aid is also designated as both an on-line and off-line author aid. In the computer version of this author aid, the author is specifically queried as to the reading difficulty desired for the entire test. Thereafter, all material input by the author is automatically checked to determine if the desired readability level has been exceeded.

Block b, "set minimum and maximum number of answer alternatives including the correct answer," indicates that author aids were not developed. Block c, "determine if more than one answer is correct," has neither an asterisk, nor is it shaded. This indicates that no off-line author aid has been identified and no aid was developed in this project for this

task element. The comment to the right of the block is intended to further clarify the statement within the block.

Block d, "set time limits if any," is shaded identifying it as requiring development of an author aid in this project. In the computer version of this aid, authors have three options: (1) an untimed test, (2) time limitation for individual test items, and (3) time limitation for entire test. Again, the comment to the right of the block is for further clarification.

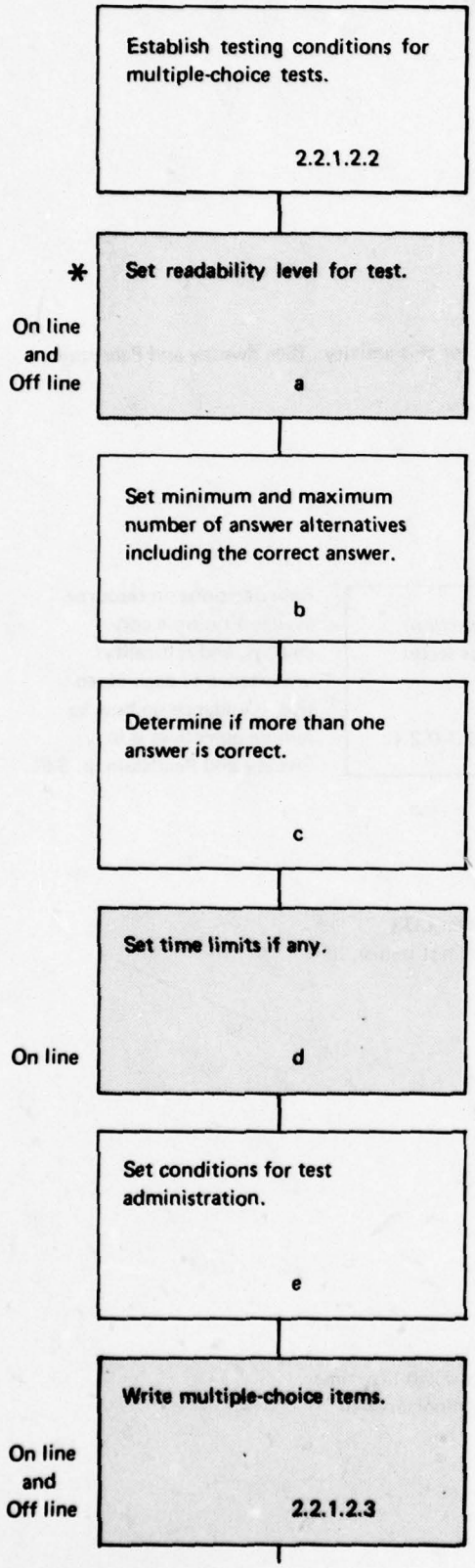
Block e, "set conditions for test administration," has neither available or developed author aids. The comment further clarifies the statement within the block.

This completes the task elements identified as required for establishing testing conditions for multiple-choice test items. The next major task to be performed is the actual writing of the multiple-choice items (2.2.1.2.3). The line coming out of the block indicates that in the actual flowcharts this task's components are continued on subsequent pages.

The flowcharts in this appendix are on the pages listed below.

Block II.2 (Develop Tests) -- Page B-4
Block III.4 (Develop Instruction) -- B-35

Figure B-1. **Flowchart for Establishing Test Conditions for Multiple-Choice Test Items.**



Contingent on reading level of trainees.
See: Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.

Author aid for reducing readability level

That is, is one (or more) answer alternatives correct, in addition to correct answer?

Time limit for each item and entire test.

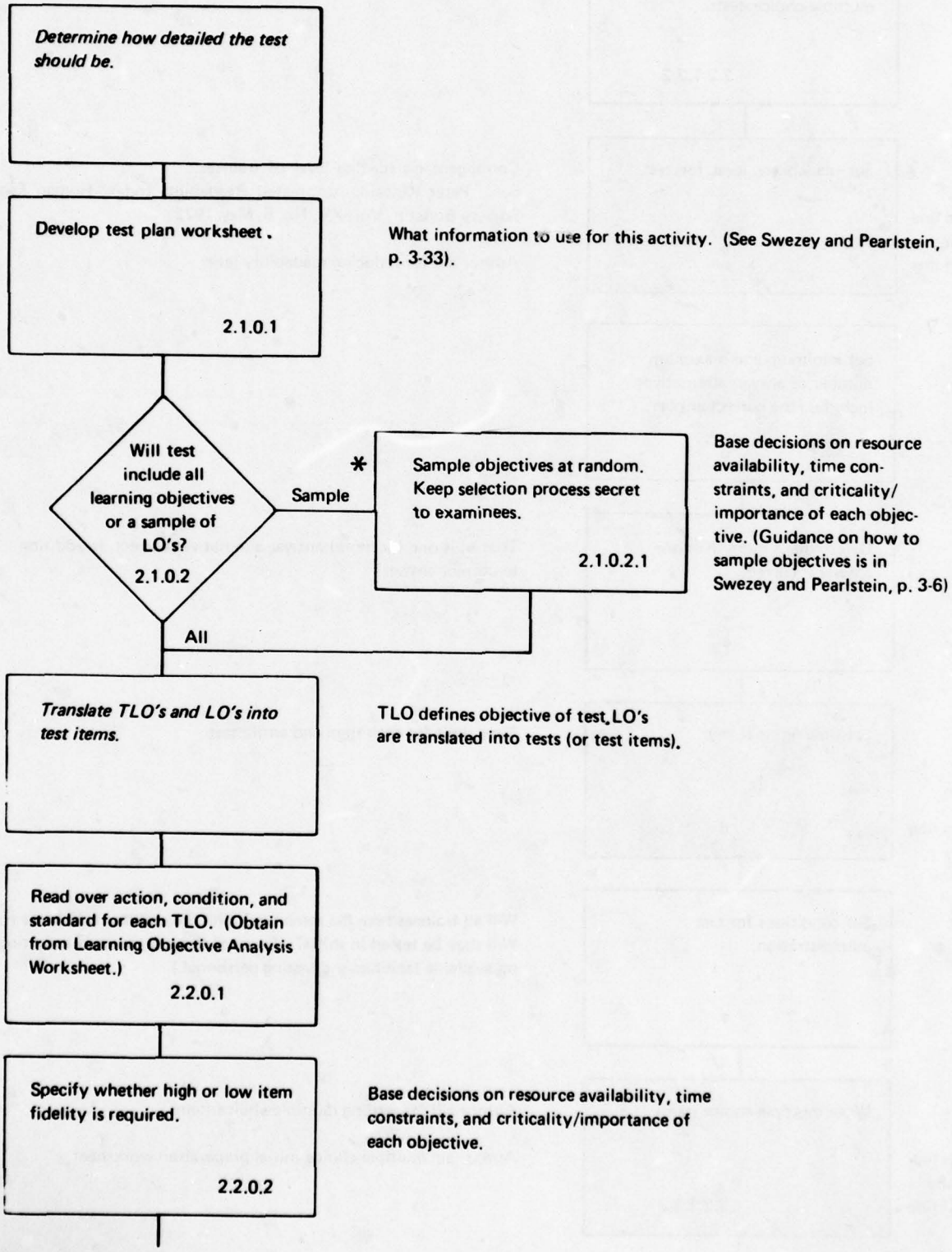
Will all trainees take the same test? Will they all be in the same room? Will they be tested in shifts? (Some of these decisions are contingent on available facilities and testing personnel.)

Author aid for writing multiple-choice items.

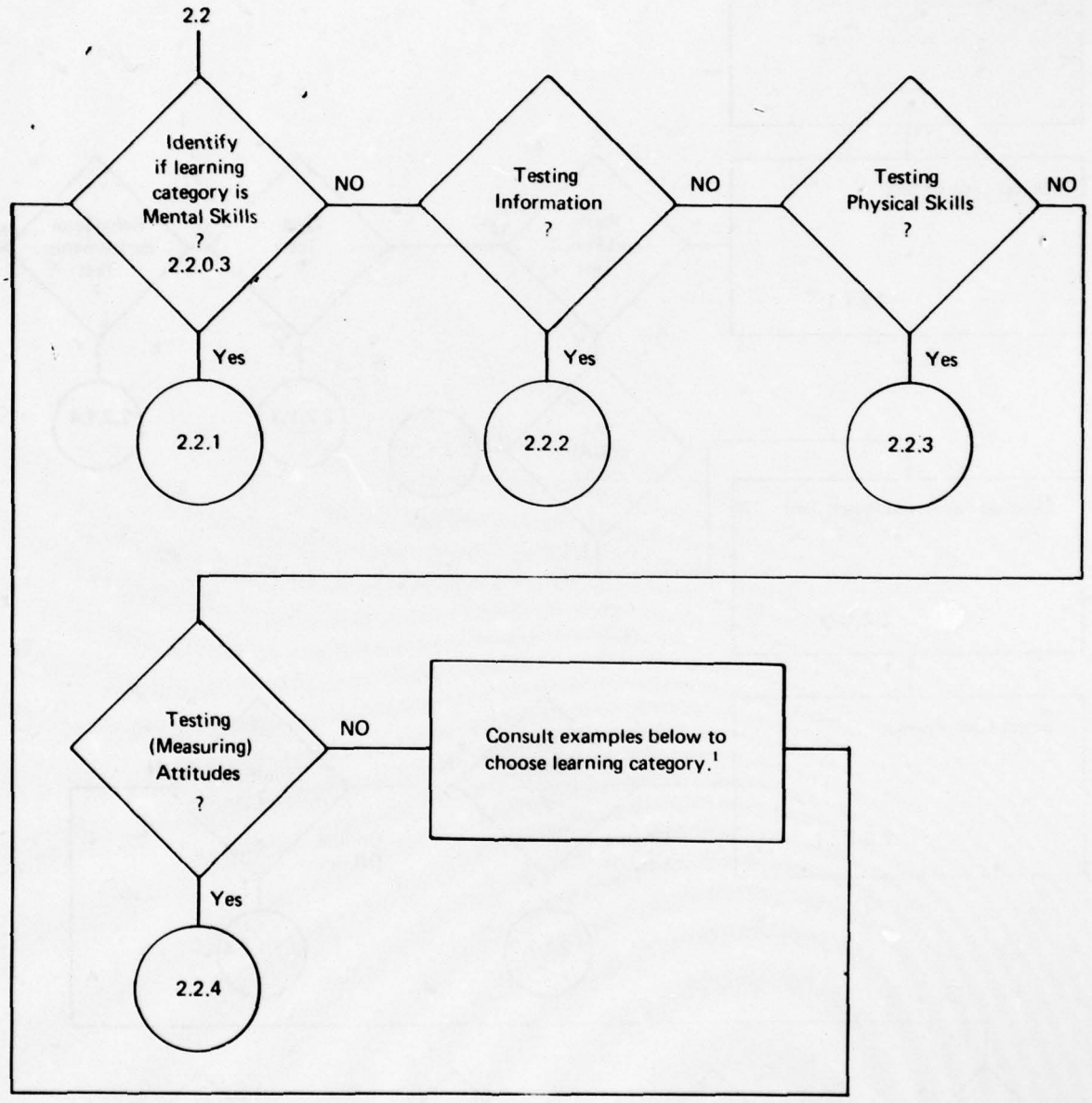
Author aid multiple-choice initial preparation worksheet.

* Non-HumRRO author aid.

II.2 DEVELOP TESTS



* Non-HumRRO author aid.



[1] LEARNING CATEGORIES

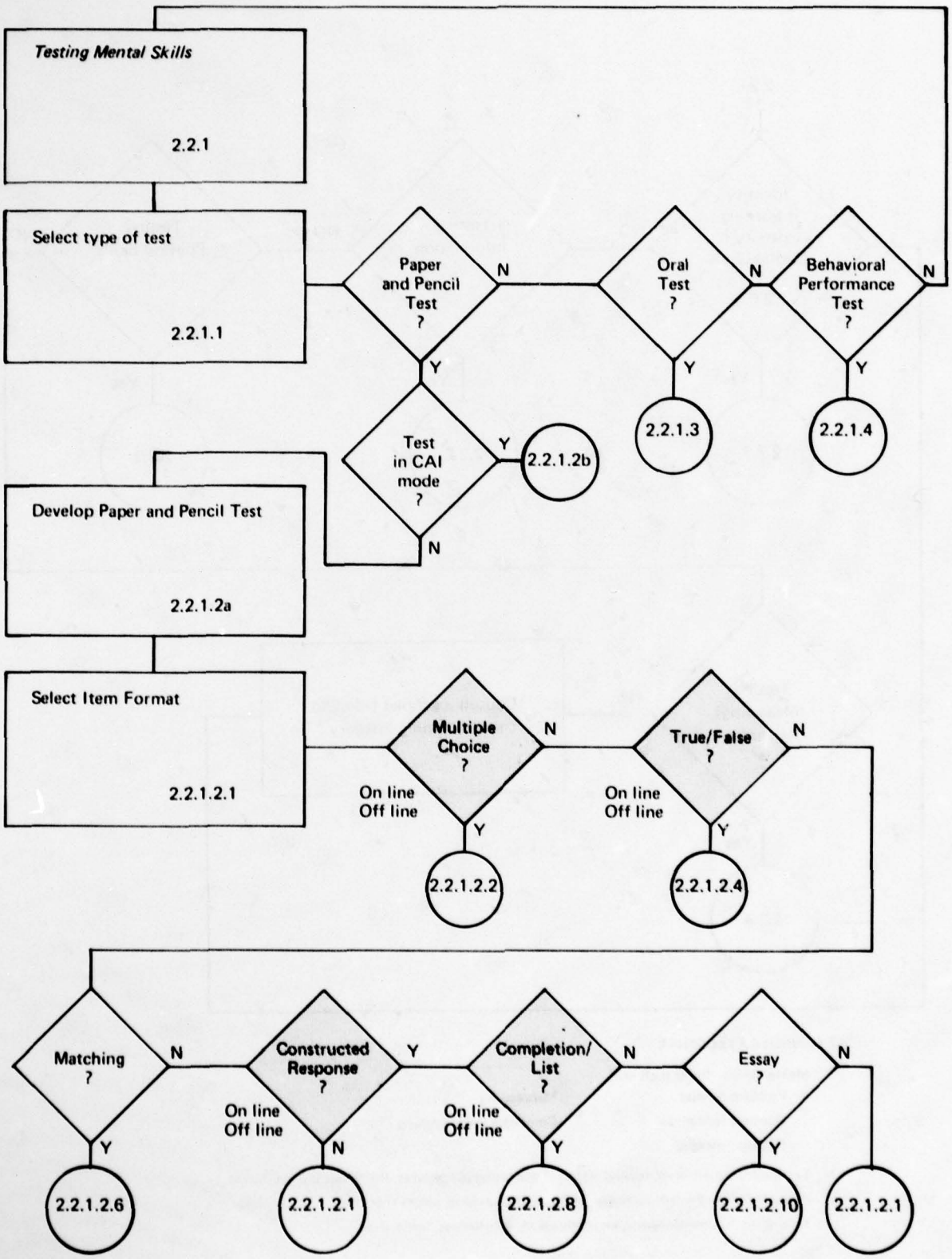
Mental Skills. Skills such as:

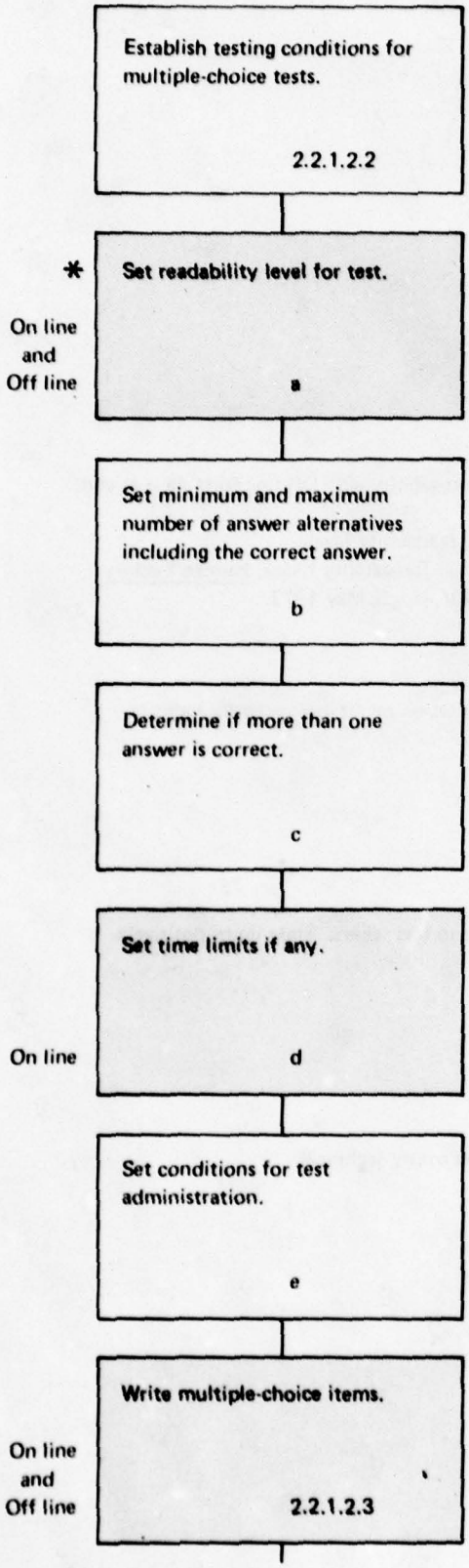
Problem solving	Mapreading
Concept formation	Computer programming
Decision making	

Testing Information—Knowing standard operating procedures, filling out clerical forms

Physical Skills—Perceptual motor skills, such as typing, target shooting

Testing Attitudes—Cooperation, dedication, helpfulness, leadership


Testing Mental Skills
2.2.1
Select type of test
2.2.1.1
Paper and Pencil Test ?
N
Oral Test ?
N
Behavioral Performance Test ?
N
Y
Y
Y
Test in CAI mode ?
Y
2.2.1.2b
N
2.2.1.3
2.2.1.4
Develop Paper and Pencil Test
2.2.1.2a
Select Item Format
2.2.1.2.1
Multiple Choice ?
N
True/False ?
N
On line
Off line
On line
Off line
Y
Y
2.2.1.2.2
2.2.1.2.4
Matching ?
N
Constructed Response ?
Y
Completion/ List ?
N
Essay ?
N
On line
Off line
On line
Off line
Y
N
Y
Y
2.2.1.2.6
2.2.1.2.1
2.2.1.2.8
2.2.1.2.10
2.2.1.2.1



Contingent on reading level of trainees.
See: Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.

Author aid for reducing readability level.

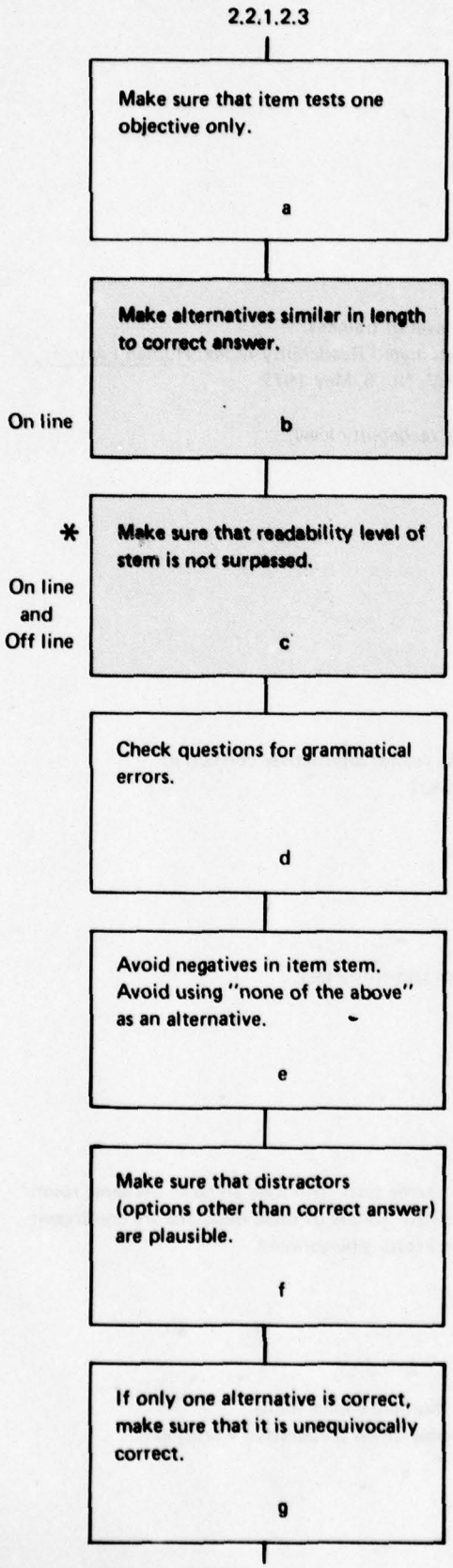
That is, is one (or more) answer alternatives correct, in addition to correct answer?

Time limit for each item and entire test.

Will all trainees take the same test? Will they all be in the same room? Will they be tested in shifts? (Some of these decisions are contingent on available facilities and testing personnel.)

Author aid for writing multiple-choice items.
Author aid multiple-choice initial preparation worksheet.

* Non-HumRRO author aid.



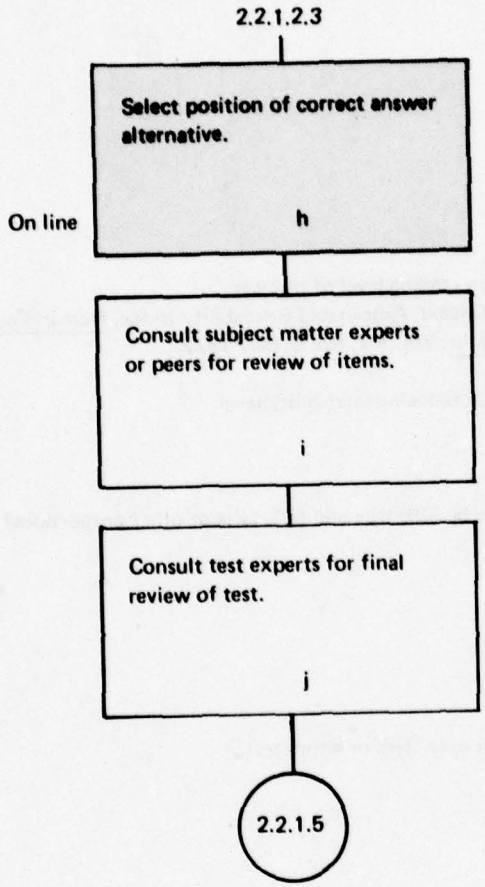
Use on-line or off-line readability aid. Off-line formula is at end of flowchart.
Author aid on reducing readability level.
Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.

Errors or phrasing of question might inadvertently indicate correct answer.

Negatives are confusing to test takers. State items positively.

Do not make distractors overly technical.

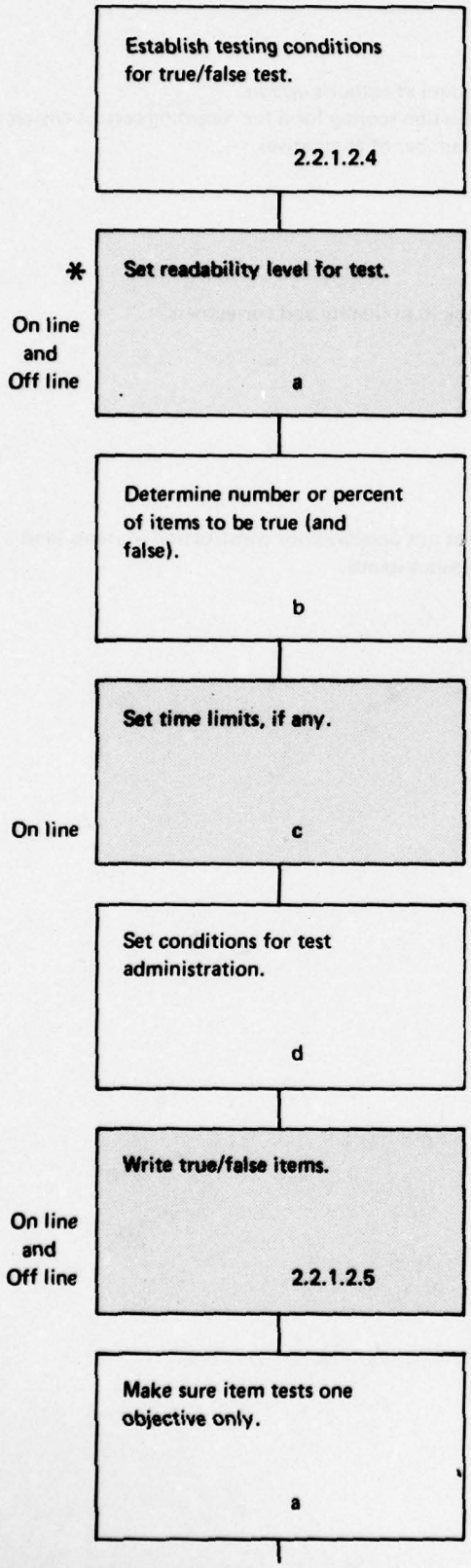
* Non-HumRRO author aid.



Chosen at random at author's option.
Author aid question scoring form for recording correct answer position and number of alternatives.

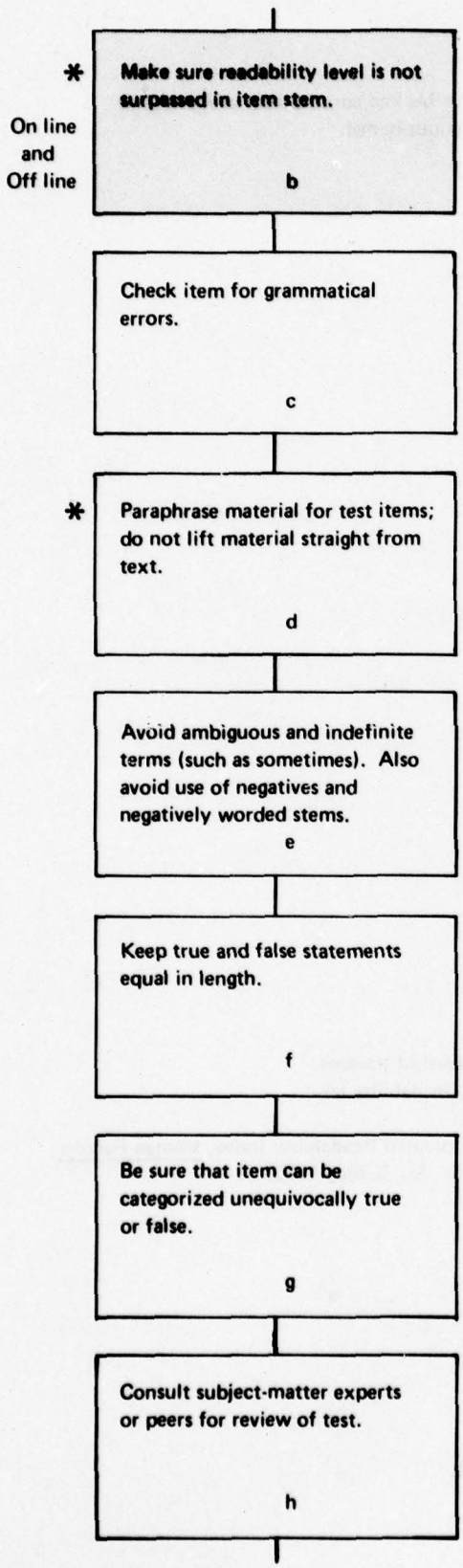
They will check item fidelity and correctness.

They will point out possible poor construction of items (and weak or ambiguous items).



* Non-HumRRO author aid.

2.2.1.2.5



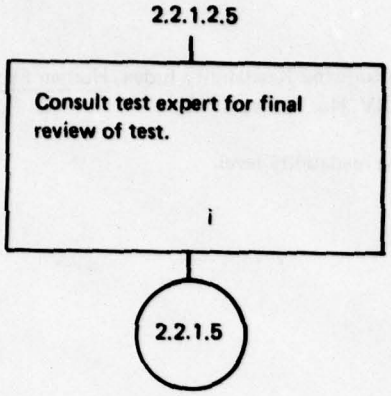
See: Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.

Author aid for reducing readability level.

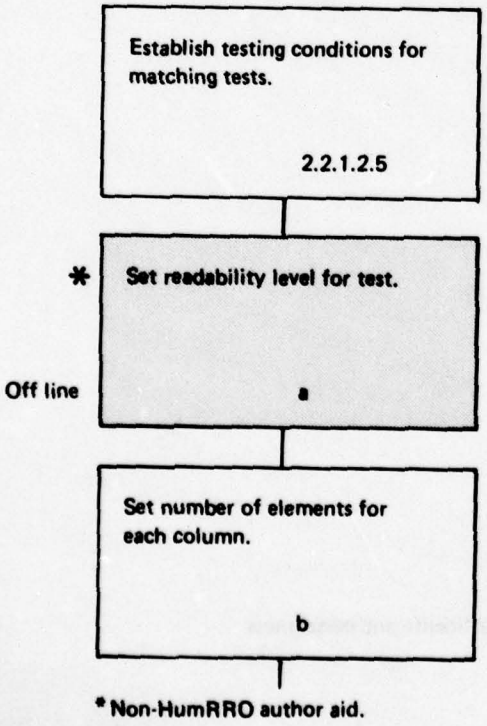
See Stevens and O'Neil (November 1974) for guidance and examples.

They will check test for fidelity and correctness.

* Non-HumRRO author aid.

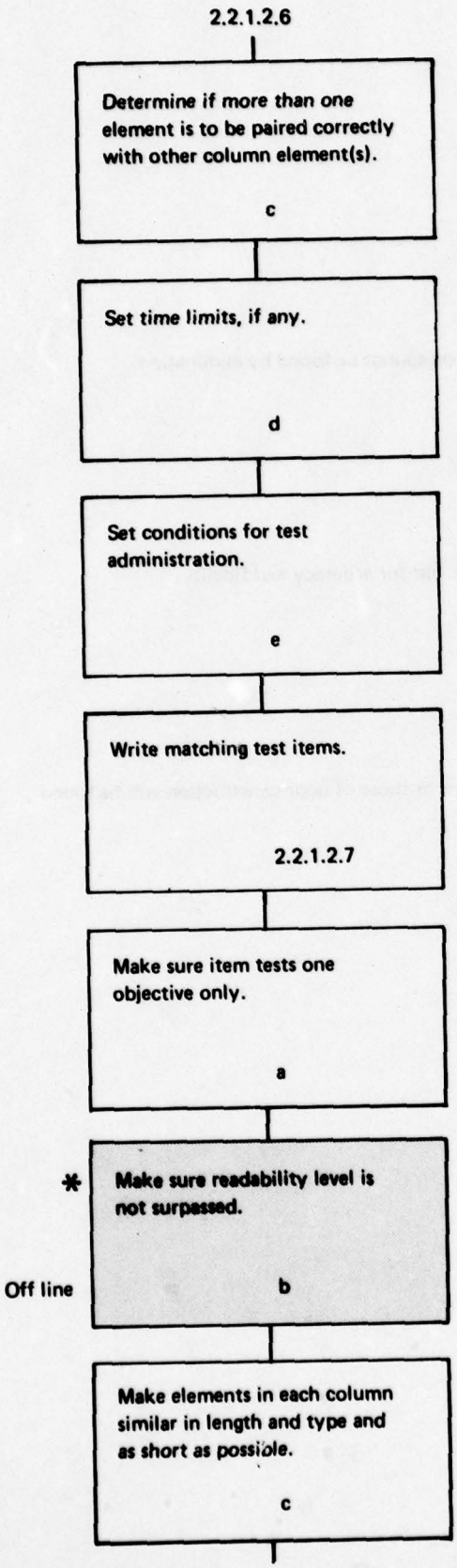


They will point out possible bad construction of items (and look for weak or ambiguous items).



Contingent on reading level of trainees.
Author aid for reducing readability level.

See: Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.



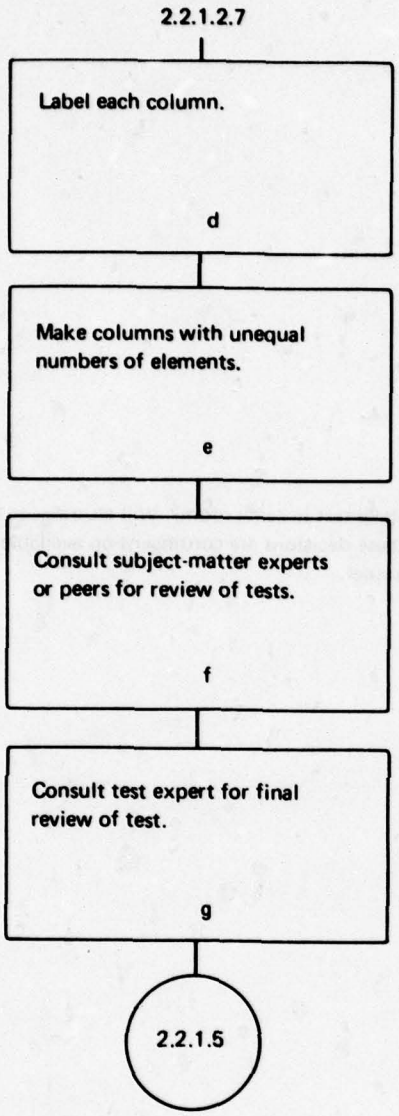
Will all trainees take test in same room? Will all trainees take same test? Some of these decisions are contingent on available facilities and testing personnel.

Author aid for reducing readability level.

See: Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.

Column items should be of similar category (e.g., nouns, verbs).

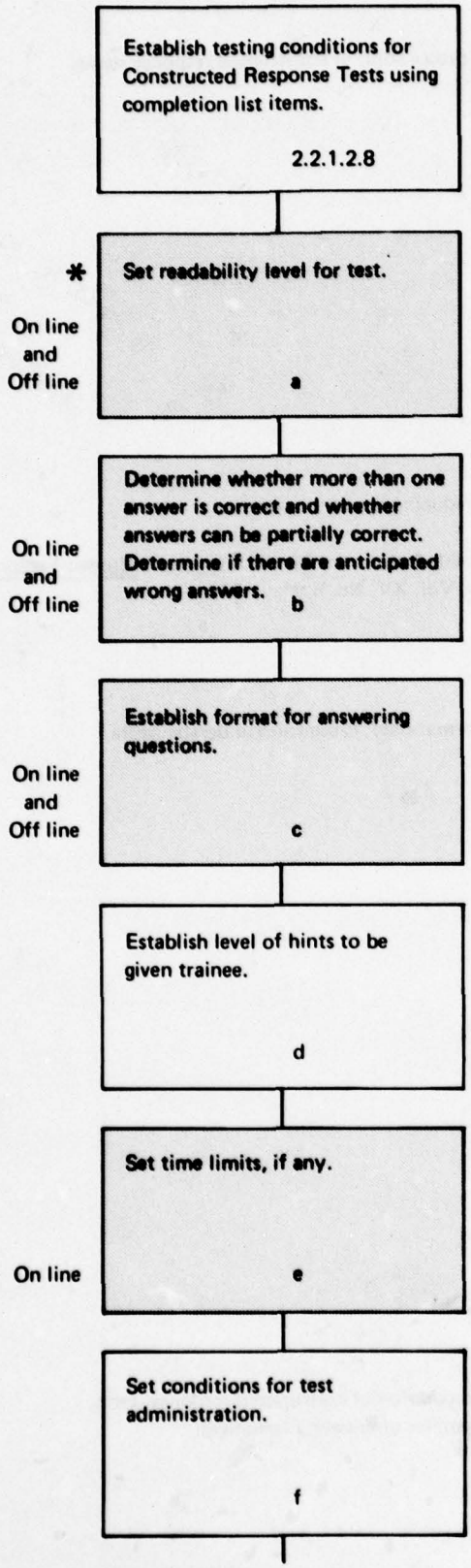
*Non-HumRRO author aid.



This is so answers cannot be found by elimination.

They will check test for accuracy and fidelity.

Ambiguous items or those of poor construction will be found in this review.



*Non-HumRRO author aid.

2.2.1.2.8

On line and Off line

Write completion/list items for Constructed Response Tests.

2.2.1.2.9

Author aid for preparation of constructed response items.

Make sure item tests one objective only.

a

* On line and Off line

Make sure readability level of item is not surpassed.

b

Author aid for reducing readability level.

See: Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.

Check items for grammatical errors.

c

If fill-in-blank format used, is question understandable with blank?

If a numerical response is required, specify units to be used.

d

In completion, omit only key words.

e

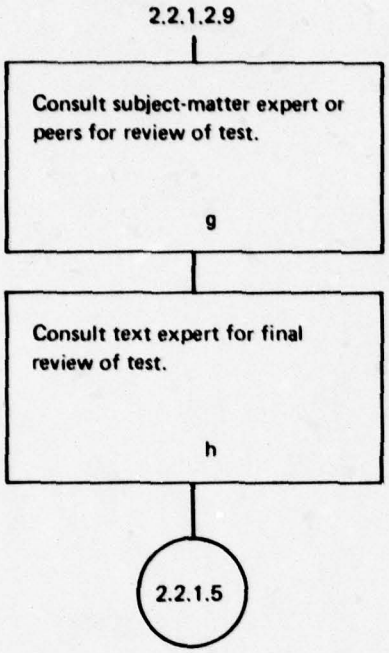
On line and Off line

List possible correct answers. List anticipated incorrect answers.

f

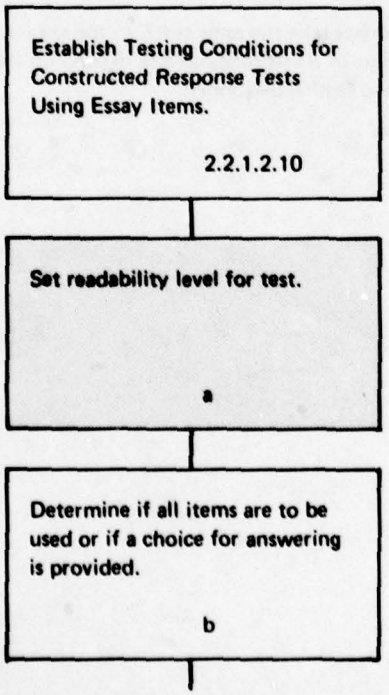
Author aid for preparation of constructed response items. Author aid of examples of answer alternatives.

* Non-HumRRO author aid.



They will look for fidelity and accuracy and may add other correct answer possibilities.

This review will pinpoint poorly constructed items or ambiguous items.

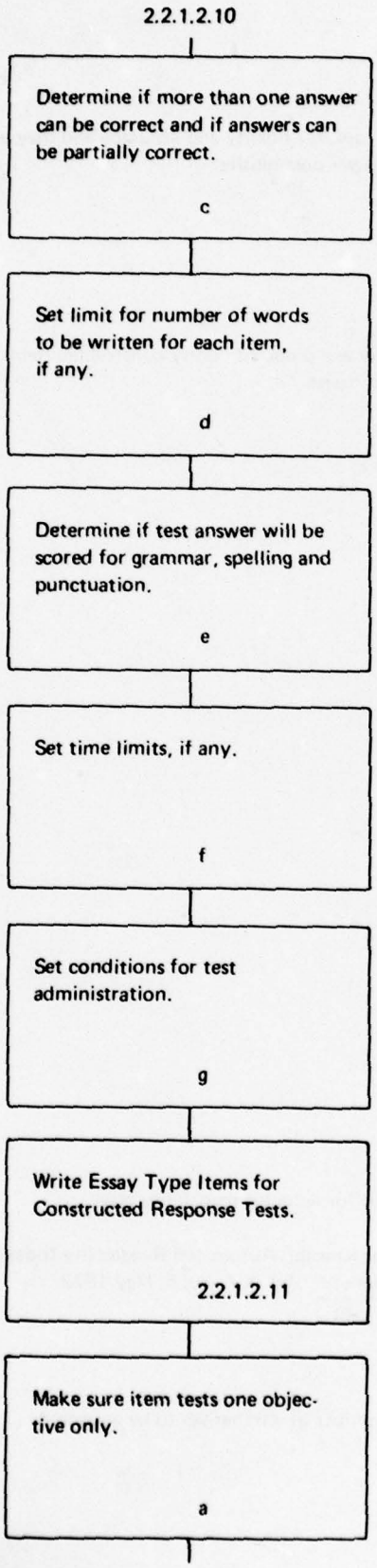


Author aid for reducing readability level.

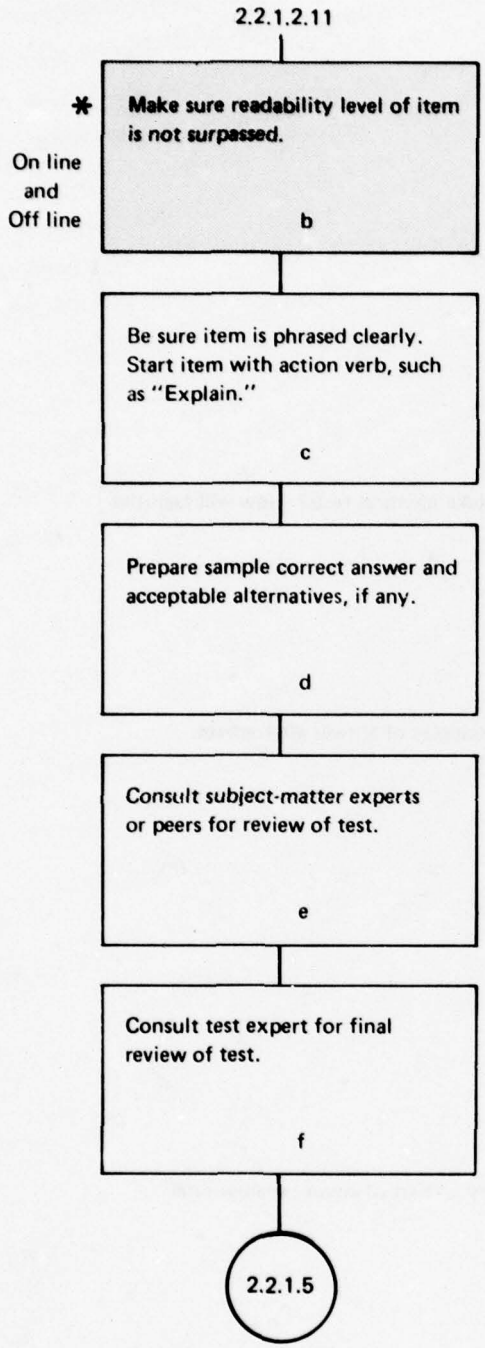
See: Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.

Specify number of alternatives to be answered.

* Non-HumRRO author aid.



Will all trainees take the same test? In the same room? In shifts? Some of these decisions will depend on available facilities and testing personnel.



Author aid for reducing readability level.

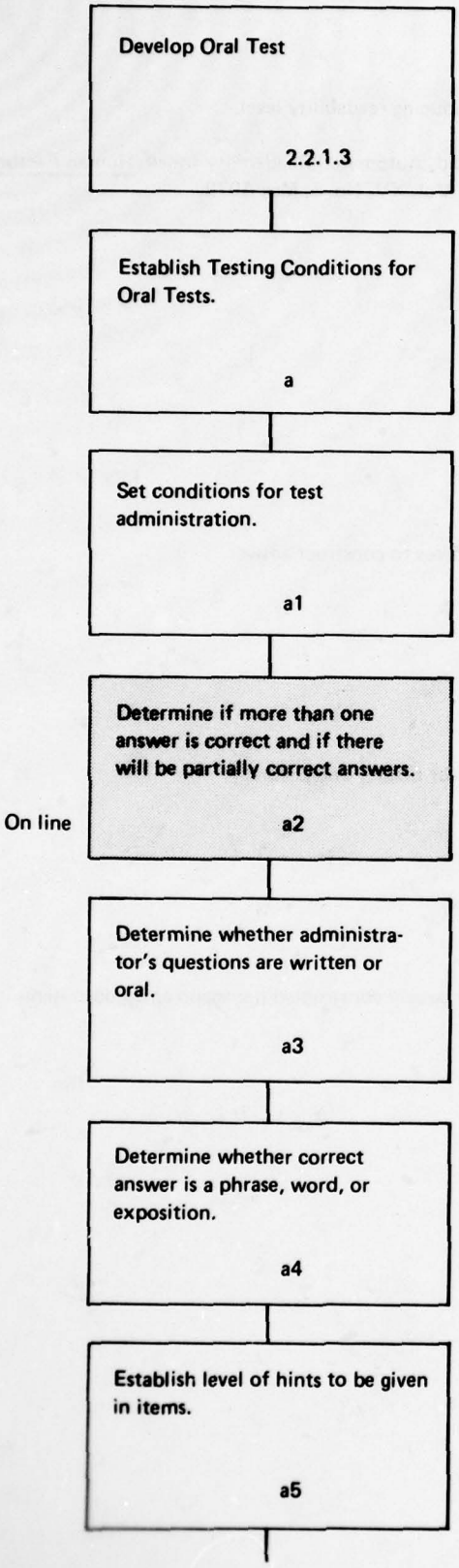
See: Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.

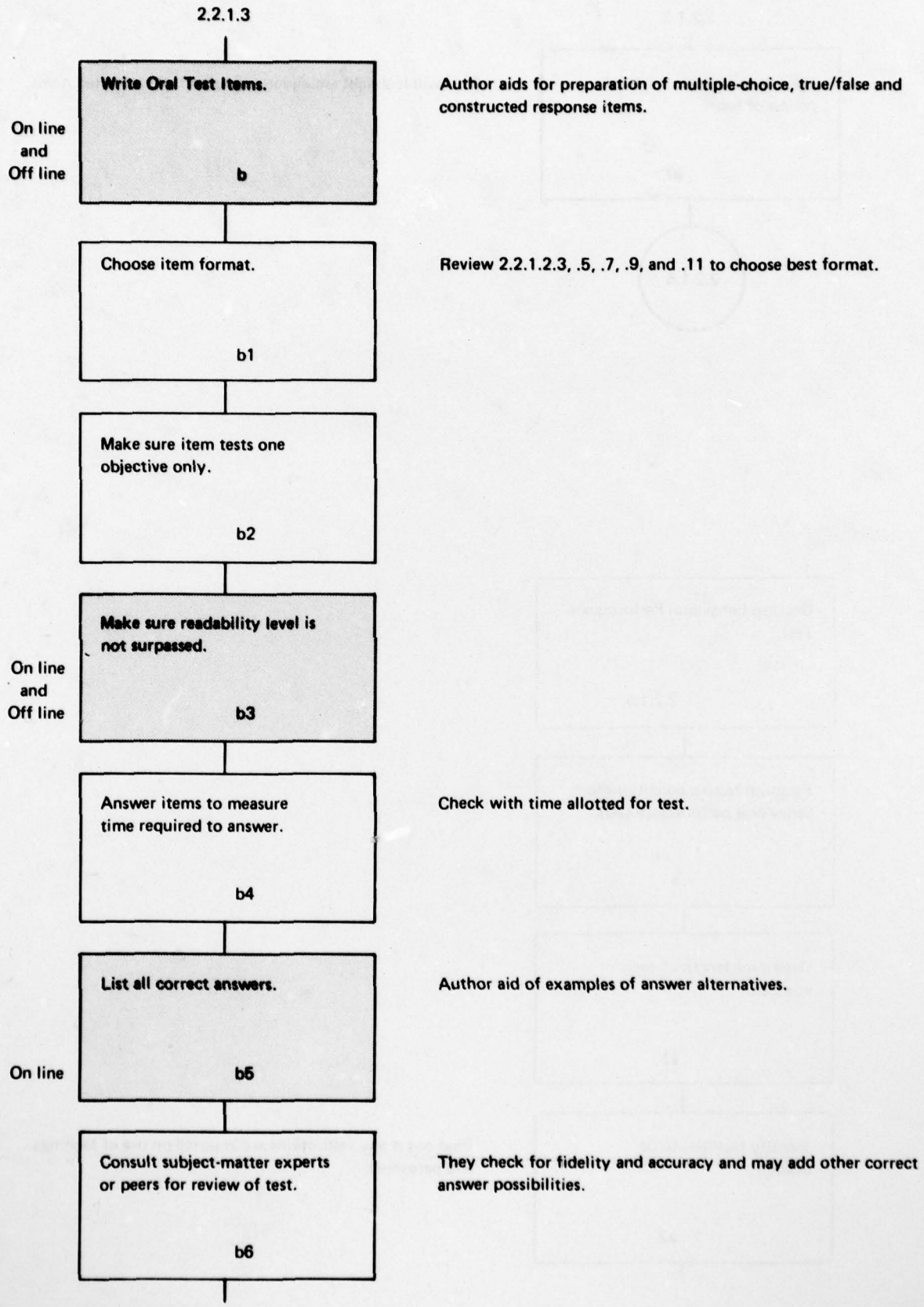
Observe time it takes to construct answer.

They check test for fidelity and accuracy.

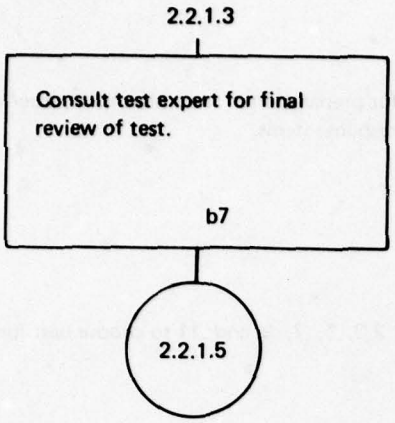
This check is for poorly constructed items and ambiguous items.

* Non-HumRRO author aid.

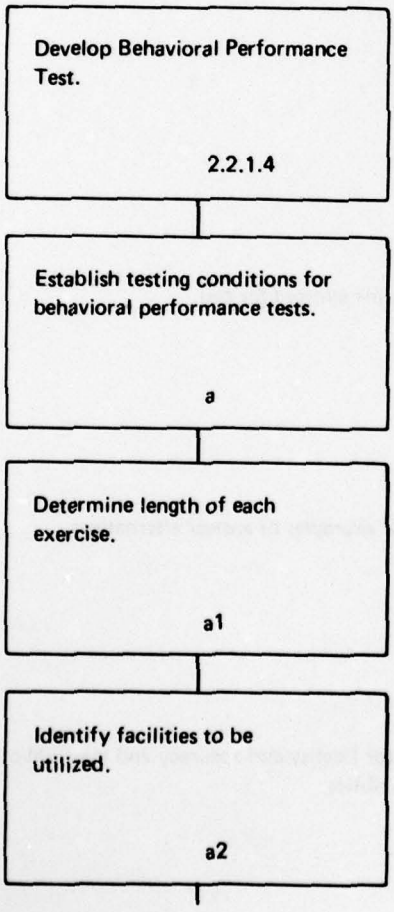

Develop Oral Test
2.2.1.3
Establish Testing Conditions for Oral Tests.
a
Set conditions for test administration.
a1
Will all trainees take identical tests? How will facilities be used?
Determine if more than one answer is correct and if there will be partially correct answers.
a2
On line
Author aid of examples of answer alternatives.
Determine whether administrator's questions are written or oral.
a3
Determine whether correct answer is a phrase, word, or exposition.
a4
Will verbal ability be part of answer evaluation?
Establish level of hints to be given in items.
a5
Are number of components in answer to be delineated? (For example, explain the three parts of an experiment, etc.)



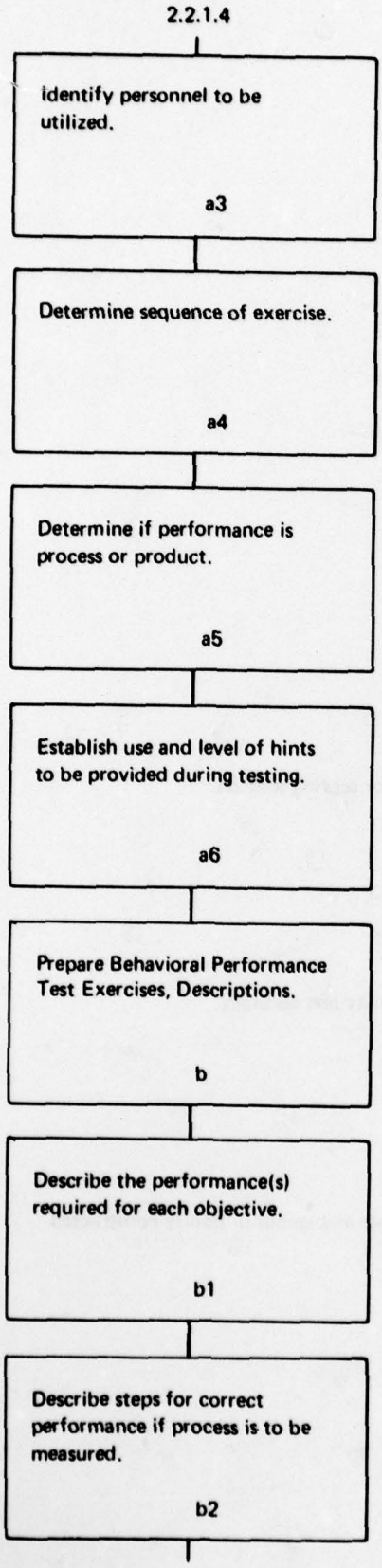
* Non-HumRRO author aid.



This will highlight ambiguous and poorly constructed items.



Find out if any restrictions are imposed on use of facilities and personnel.



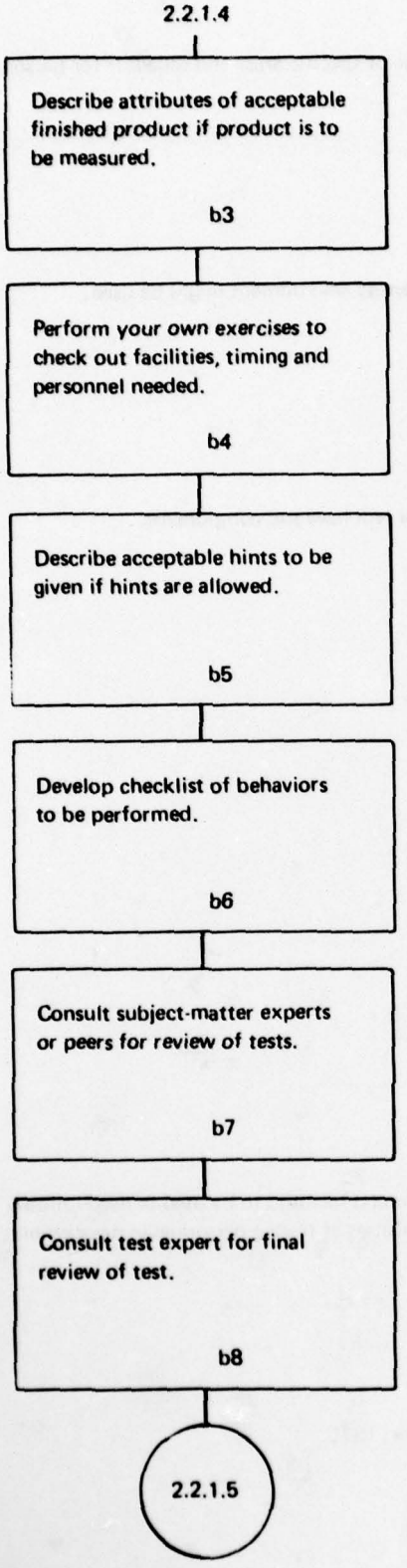
Set up schedule for use of specific areas and schedule for personnel involved in testing.

"County Fair" type testing environment might be used.

If process, the behavior will have sub-components.

Include time restrictions and facilities to be used in descriptions. Describe locations and duties of testing personnel in description.

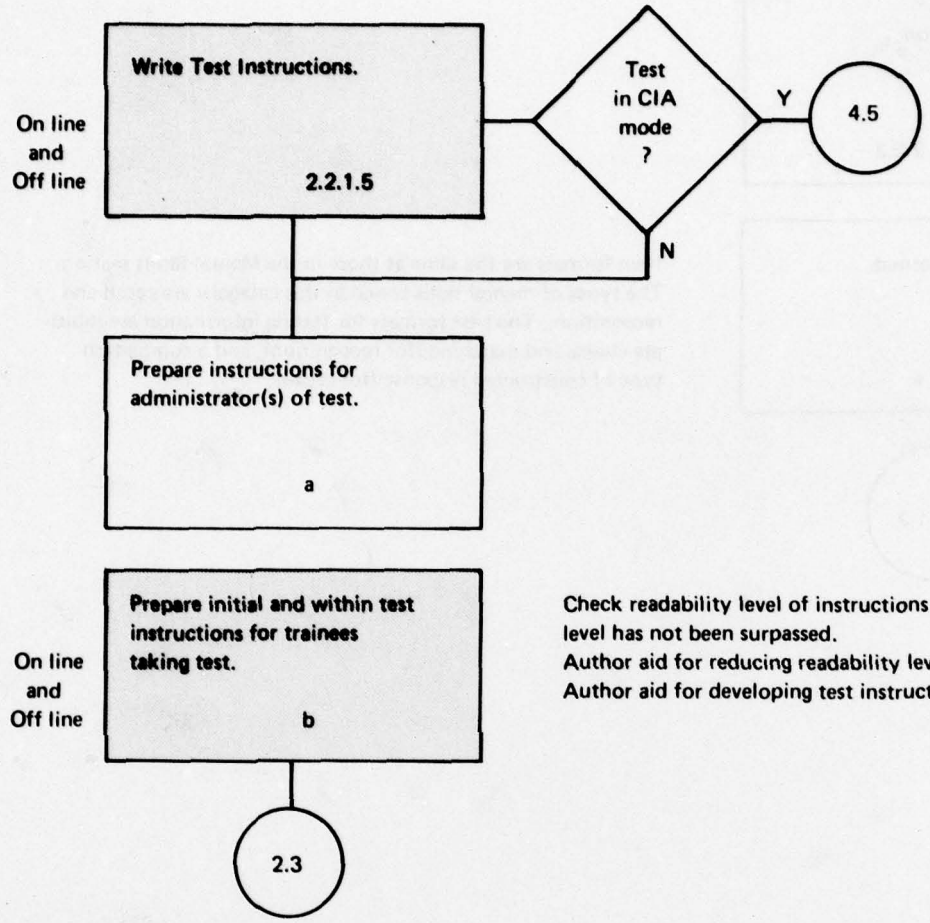
See Vineberg and Taylor, 1975.



This will be necessary for scoring later on.

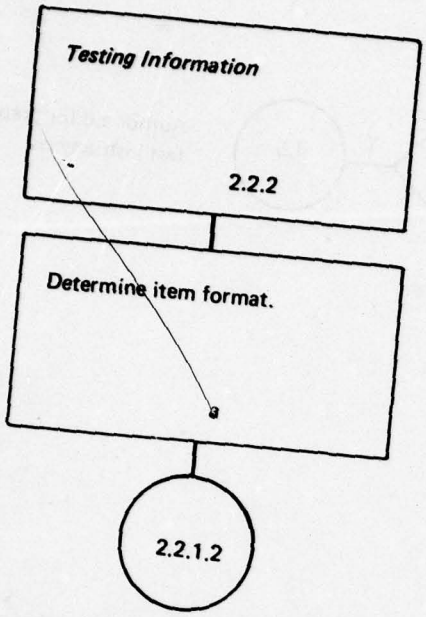
They will check for fidelity and accuracy.

This check will illuminate ambiguous or poorly constructed exercises.

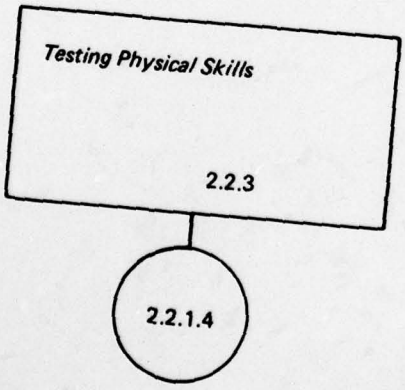


Author aid for preparing test instructions.

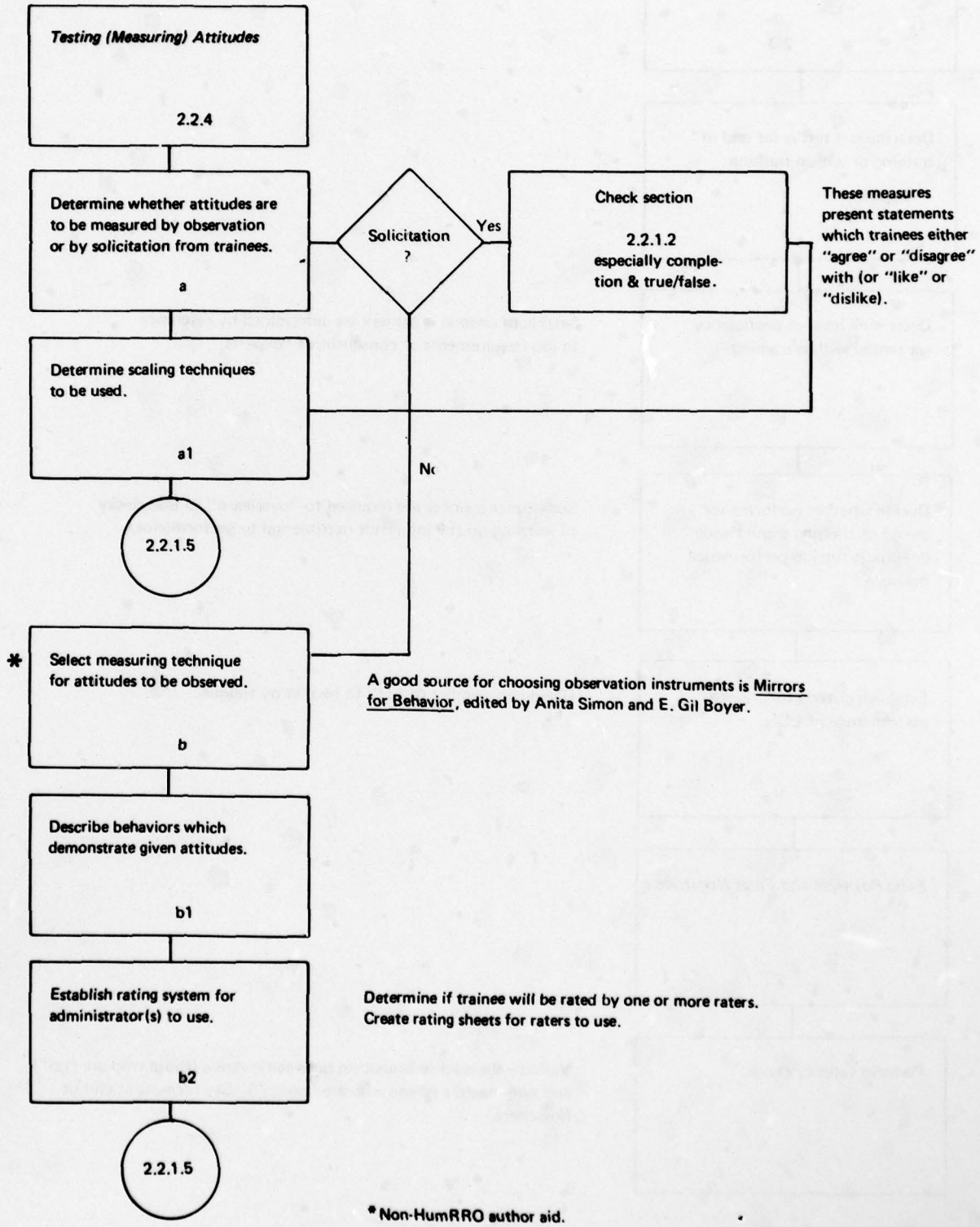
Check readability level of instructions to guarantee that reading level has not been surpassed.
Author aid for reducing readability level.
Author aid for developing test instructions.



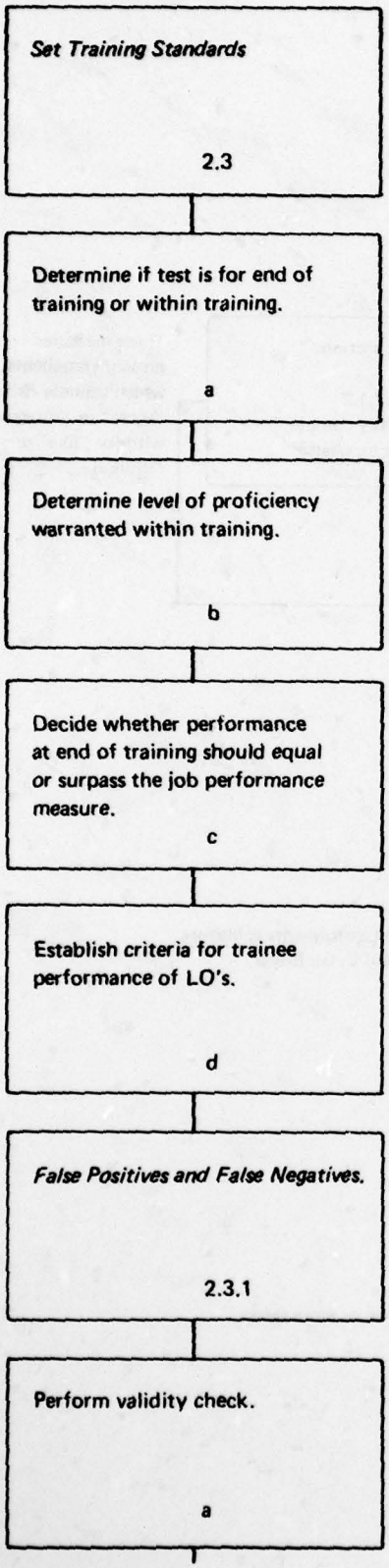
Item formats are the same as those in the Mental Skills section. The types of mental skills tested in this category are recall and recognition. The best formats for testing information are multiple choice and matching (for recognition), and a completion type of constructed response (for recall).

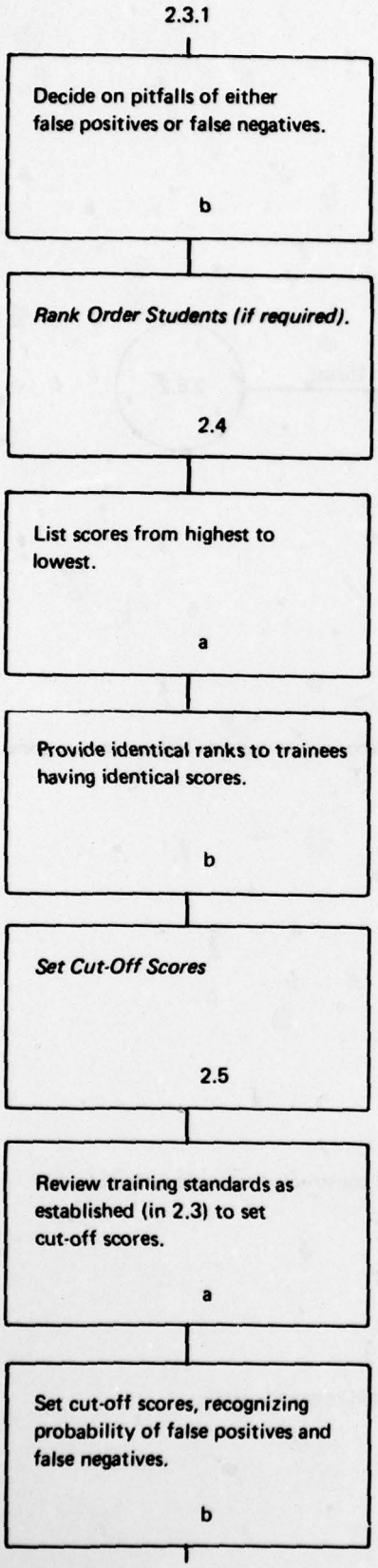


See behavioral performance test development activities.



*Non-HumRRO author aid.


Set Training Standards
2.3
Determine if test is for end of training or within training.
a
Determine level of proficiency warranted within training.
b
Setting of criteria is sometimes determined by reference to job requirements or consensus of "experts."
Decide whether performance at end of training should equal or surpass the job performance measure.
c
Sometimes trainees are required to "overlearn" so that decay of learning on the job is not detrimental to performance.
Establish criteria for trainee performance of LO's.
d
Decide on number of LO's to be met by trainee.
False Positives and False Negatives.
2.3.1
Perform validity check.
a
Validity shows discrimination between masters (those who are "go") and non-masters (those who are "no-go"). See formula at end of flowchart.

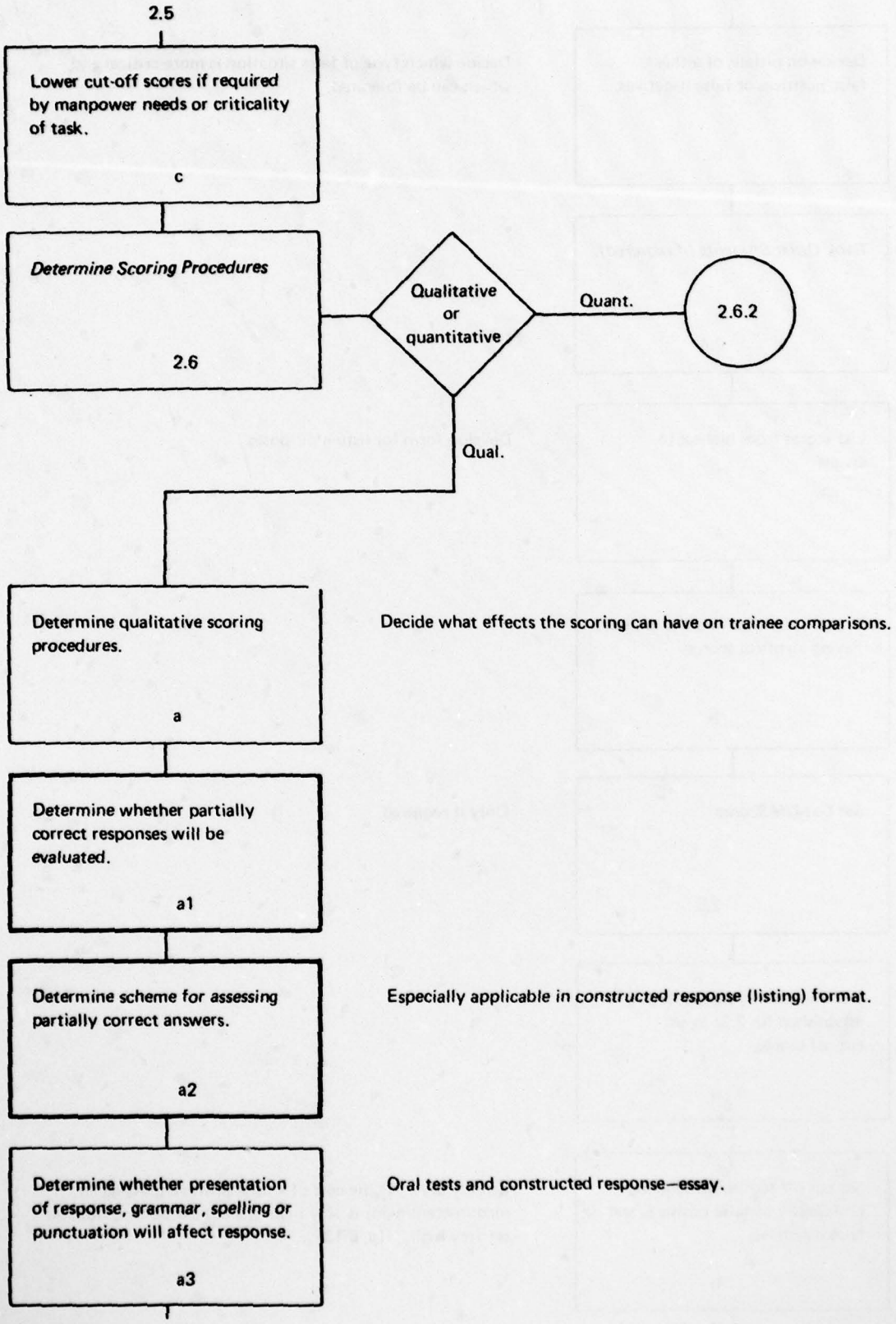


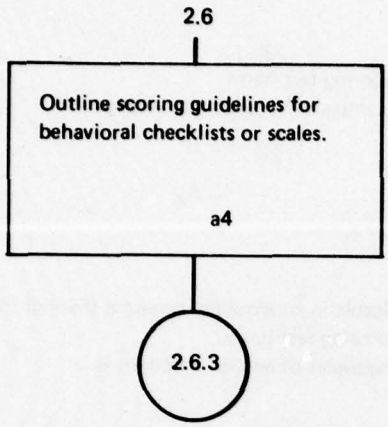
Decide which type of false situation is more critical and which can be tolerated.

Develop form for listing purposes.

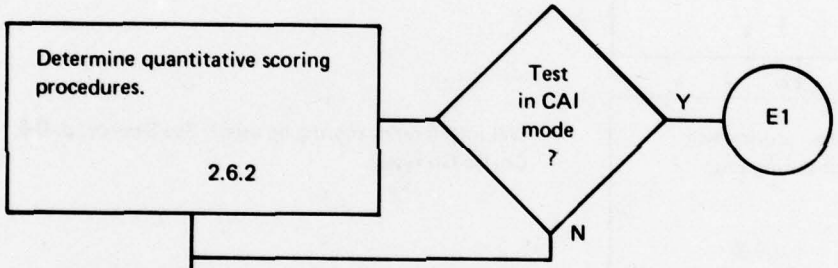
Only if required.

Swezey says, "If the cost of a false positive (passing an incompetent man) is very high, the cut-off point should be set very high." (p. 6-13)


2.5
Lower cut-off scores if required by manpower needs or criticality of task.
c
Determine Scoring Procedures
2.6
Qualitative or quantitative
Quant.
2.6.2
Qual.
Determine qualitative scoring procedures.
a
Decide what effects the scoring can have on trainee comparisons.
Determine whether partially correct responses will be evaluated.
a1
Determine scheme for assessing partially correct answers.
a2
Especially applicable in constructed response (listing) format.
Determine whether presentation of response, grammar, spelling or punctuation will affect response.
a3
Oral tests and constructed response—essay.



Checklist scoring is applicable to "process" types of performance.



On line and Off line

Determine number of points for each response.

a

Author aid for scoring test items.

Determine if responses are to be rank-ordered.

b

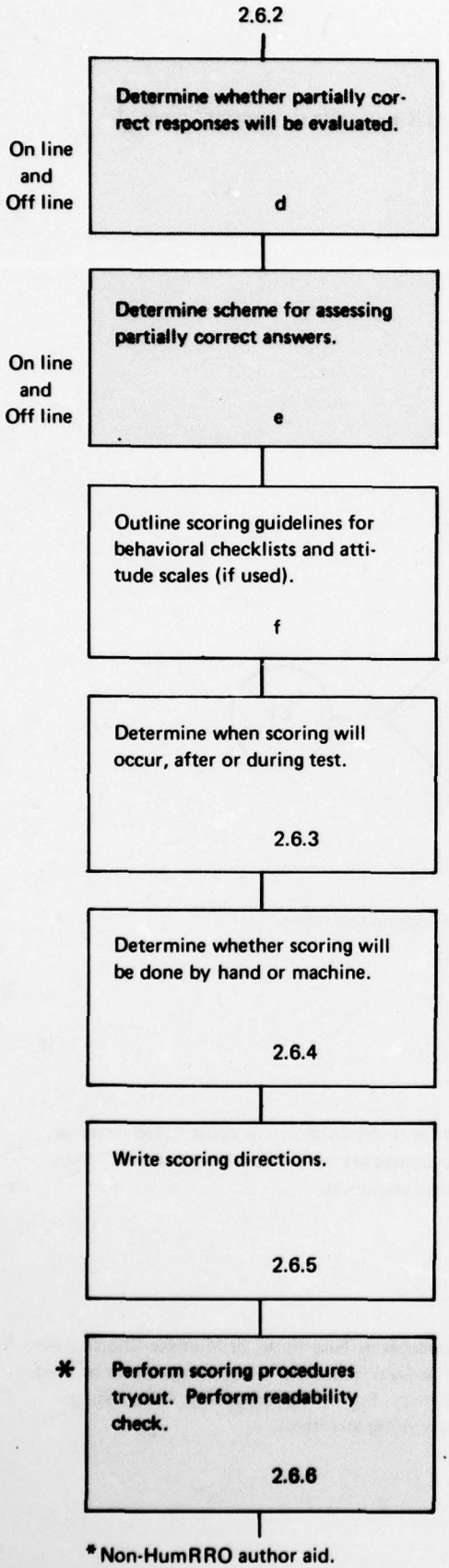
Could be used for multiple-choice or constructed response, where some responses are considered "more correct" than others. Weighted responses?

On line and Off line

Establish penalties for incorrect responses.

c

Especially applicable in Ture/False, or Multiple-Choice where probability of guessing correctly is high. Could also be used in matching format. Formula or correction for guessing. Author aid for scoring test items.



Author aid for scoring test items.
Author aid of examples of answer alternatives.

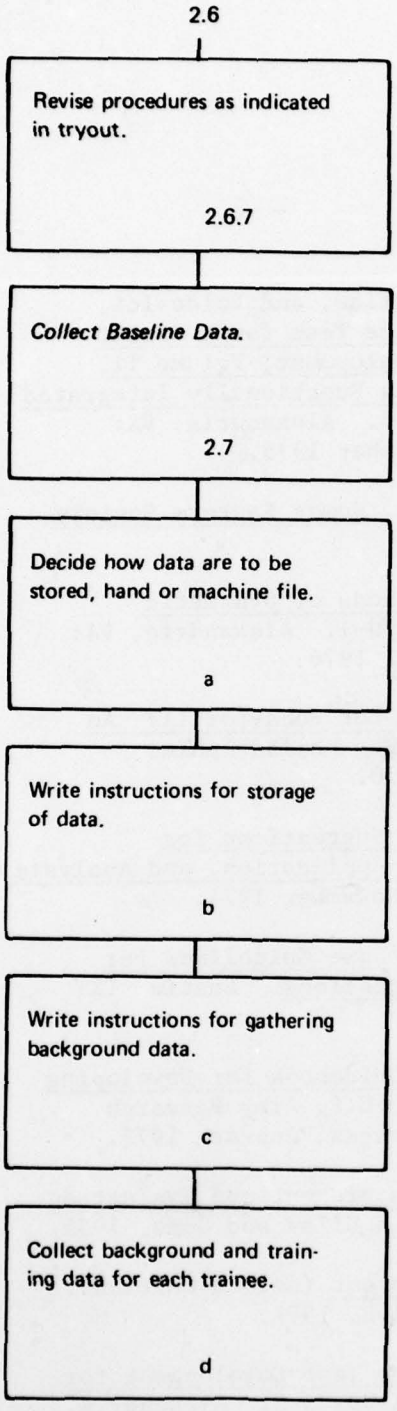
Especially applicable in constructed response (listing) format.
Author aid for scoring test items.
Author aid of examples of answer alternatives.

Will interference scoring be used? See Swezey, p. 6-6.
Go/No-Go type?

Develop form for recording correct and incorrect answers of class and individuals. Develop method for determination of number of correct answers (or a scoring key).

Author aid for reducing readability level.

See: Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.



Usually not test developer's responsibility.

Develop form for intermediate storage of data.

REFERENCES

HARRIS, James H., Campbell, Roy C., Osborn, William, and Boldovici, John. Development of a Model Job Performance Test for a Combat Occupational Specialty. Volume I. Test Development; Volume II. Instructions and Procedures for Conducting a Functionally Integrated Performance Test, Final Report FR-CD(L)075-6. Alexandria, VA: Human Resources Research Organization, November 1975.

KINCAID, J. Peter. Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.

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SIMON, Anita and Boyer, E. Gil (Eds.). Mirrors for Behavior II: An Anthology of Observation Instruments, Vol. B. Philadelphia: Research for BetterSchools, Inc., Spring 1970.

STEVENS, Jane Close and O'Neil, Harold F., Jr. Suggestions for Generating Test Items at the Comprehension, Application, and Analysis Levels. Austin, TX: University of Texas, November 1974.

STEVENS, Jane Close and O'Neil, Harold F., Jr. Some Guidelines for Development and Review of Multiple-Choice Questions. Austin, TX: University of Texas, May 7, 1974.

SWEZEY, Robert W., and Pearlstein, Richard B. Guidebook for Developing Criterion-Referenced Tests. Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences, August 1975.

THORNDIKE, Robert L., and Hagen, Elizabeth. Measurement and Evaluation in Psychology and Education. New York: John Wiley and Sons, 1955.

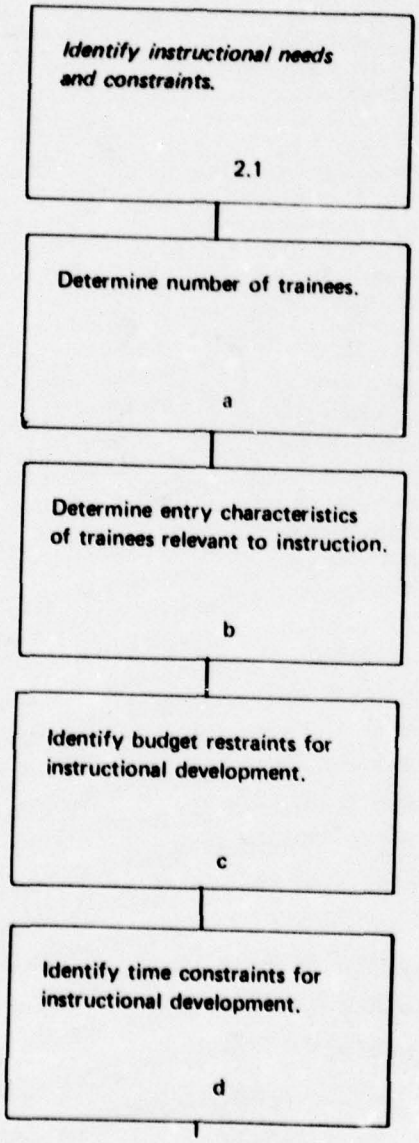
THORNDIKE, Robert L. (Ed.). Educational Measurement (second edition). Washington, DC: American Council on Education, 1971.

VINEBERG, Robert and Taylor, Elaine. Performance Test Development for Skill Qualification Testing, Final Report FR-WD-75-5. Alexandria, VA: Human Resources Research Organization, June 1975.

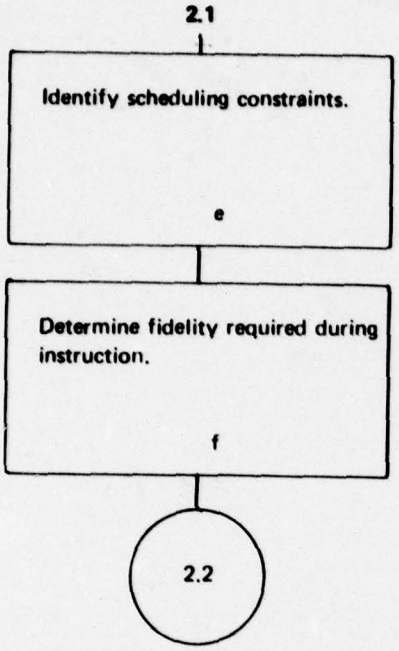
III.4 DEVELOP INSTRUCTION

1.0 *Introduction*

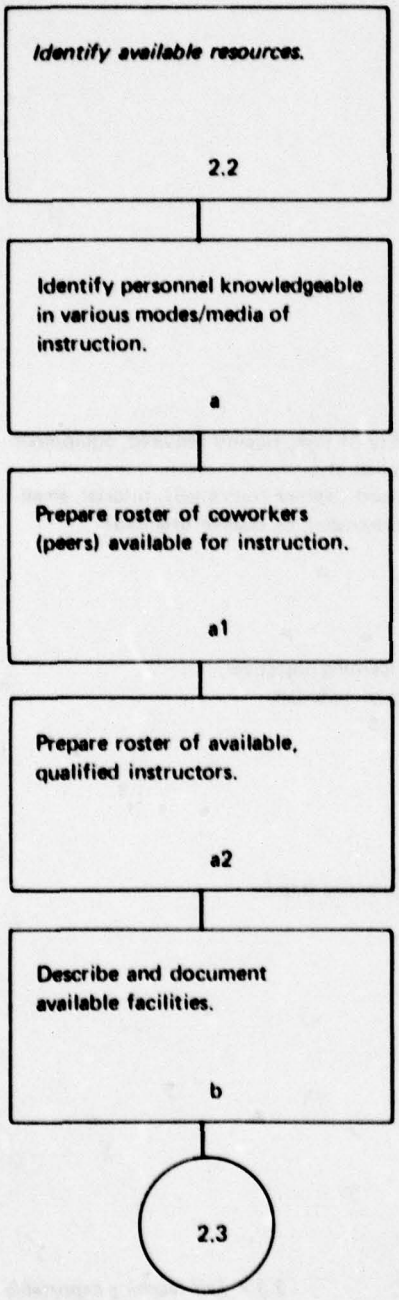
2.0 *Procedures*



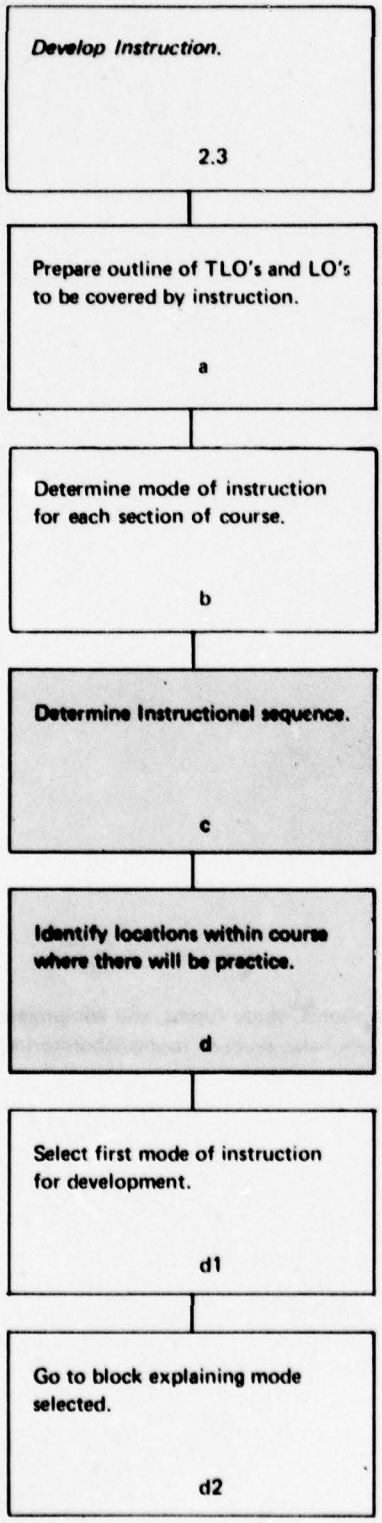
E.g., reading comprehension level.

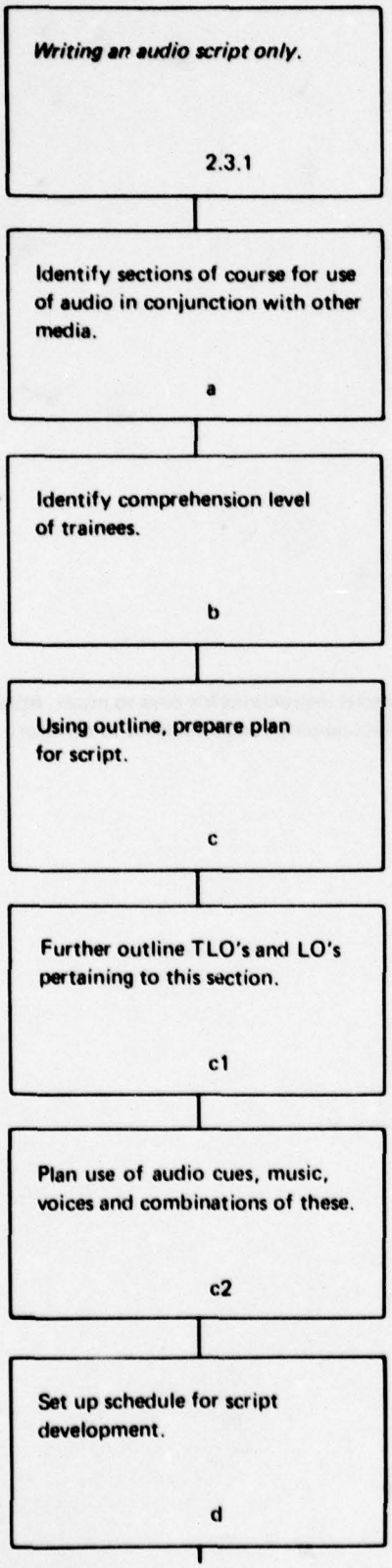

2.1
Identify scheduling constraints.
e
Determine fidelity required during instruction.
f
2.2

See LOAW

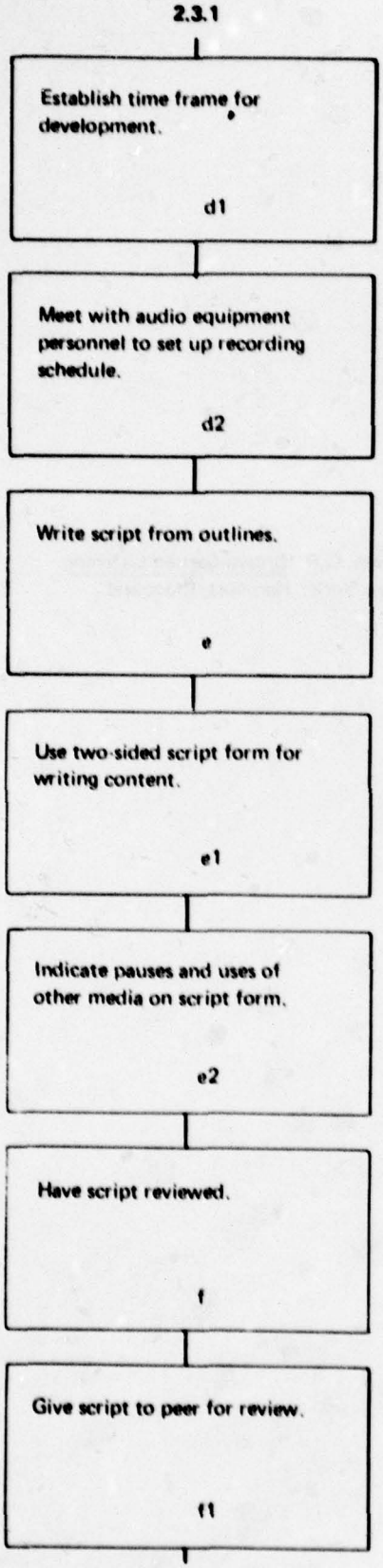


List all library/reference rooms, study rooms, and equipment; classroom and large lecture halls; practice rooms/laboratories, and equipment.

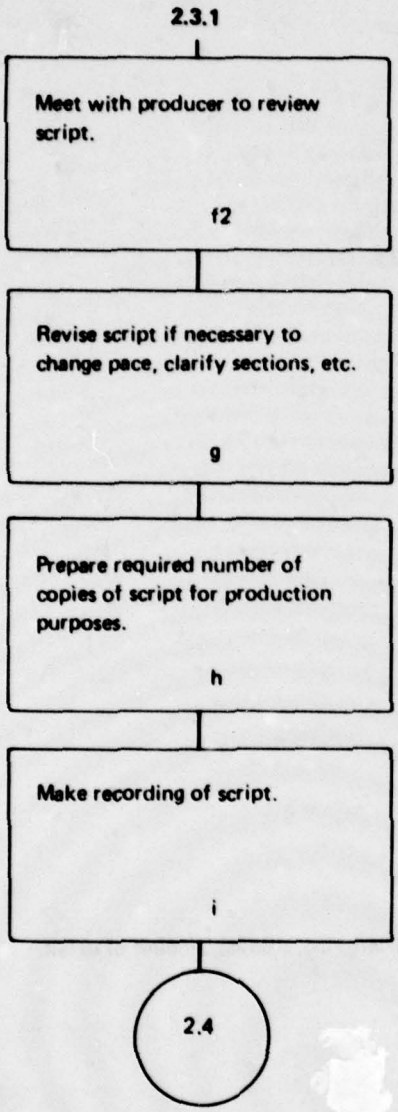

Develop Instruction.
2.3
Prepare outline of TLO's and LO's to be covered by instruction.
a
Determine mode of instruction for each section of course.
b
Base decisions on criticality of task, fidelity required, equipment availability, personnel availability.
Will learning be self-paced (learner controlled), tutorial, small-group or large-group discussion, or teacher oriented?
Determine instructional sequence.
On line and Off line
c
Author aid for preparing learning objectives,
Author aid for sequencing of materials.
Identify locations within course where there will be practice.
On line and Off line
d
Author aid for preparing practice frames.
Select first mode of instruction for development.
d1
Go to block explaining mode selected.
d2
CHOOSE FROM LIST:
2.3.1 Audio script.
2.3.2 Video materials.
2.3.3 Audiovisual materials.
2.3.4 Printed materials.
2.3.5 Programmed instruction.
2.3.6 Platform lectures.
2.3.7 Self-teaching exportable packages (STEPs).
2.3.8 Supplementary instruction.
2.3.9 Adjunct programs.
2.3.10 Job performance aids (JPAs).
2.3.11 Formal OJT.
2.3.12 Other forms of mediated instruction.
2.3.13 CAI.

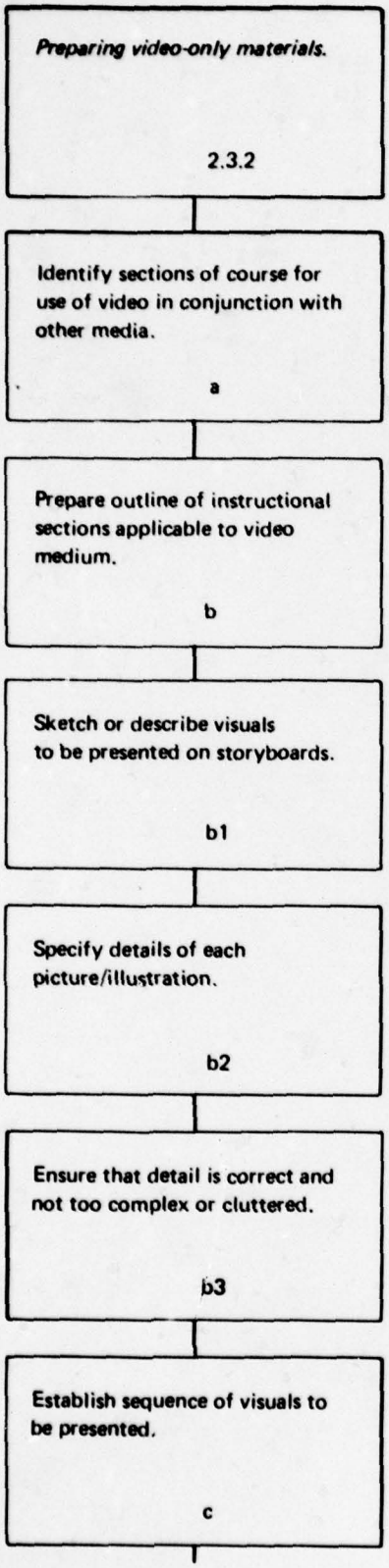


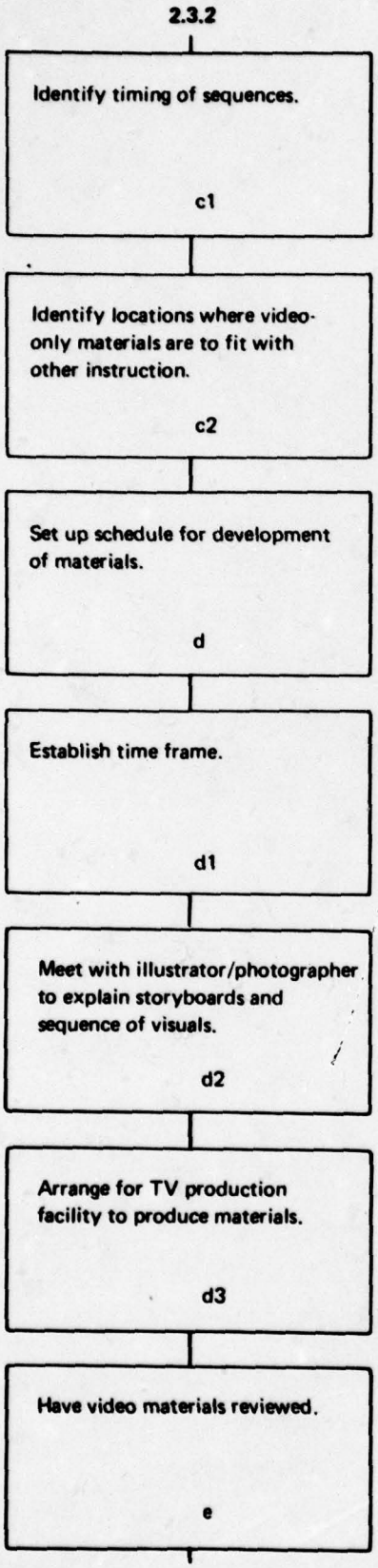
* Non-HumRRO author aid.



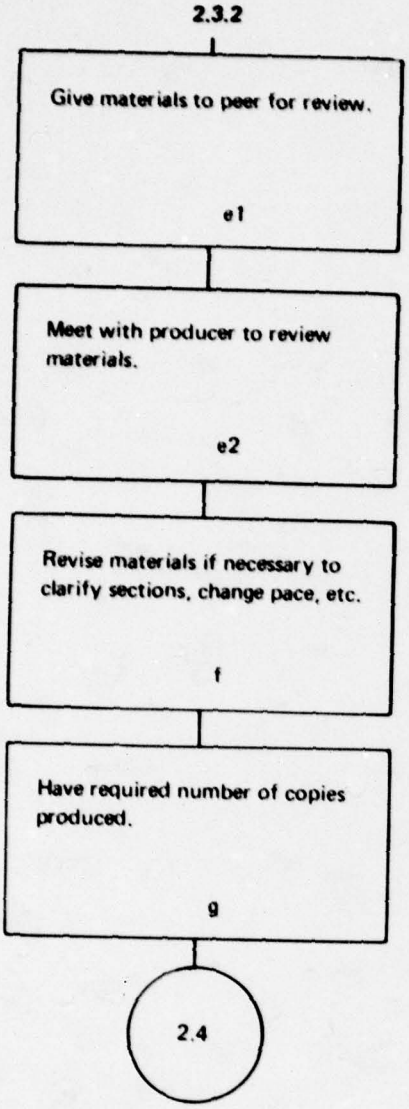
Left side should contain special instructions for cues to music, other sounds; right side contains actual script and directions to narrator.

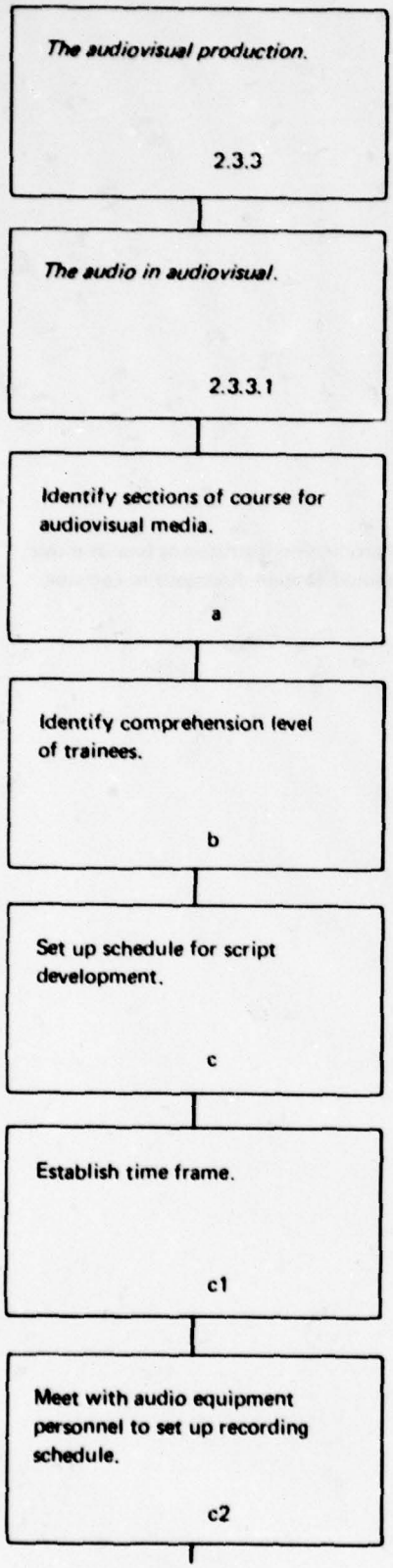

2.3.1
Meet with producer to review script.
f2
Revise script if necessary to change pace, clarify sections, etc.
g
Prepare required number of copies of script for production purposes.
h
Make recording of script.
i
2.4


Preparing video-only materials.
2.3.2
Identify sections of course for use of video in conjunction with other media.
a
Review TLO's and LO's.
Prepare outline of instructional sections applicable to video medium.
b
Sketch or describe visuals to be presented on storyboards.
b1
Specify details of each picture/illustration.
b2
Include special effects, lettering, shading, amount of detail.
Ensure that detail is correct and not too complex or cluttered.
b3
Establish sequence of visuals to be presented.
c

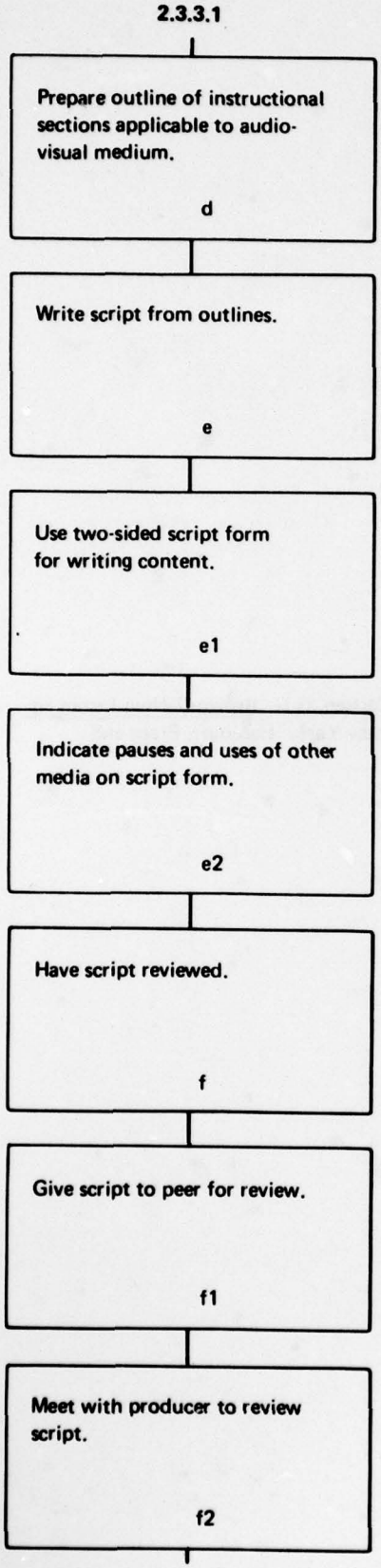


Determine what TV facilities are required and/or available, (i.e., studio equipment, personnel, materials, etc.)

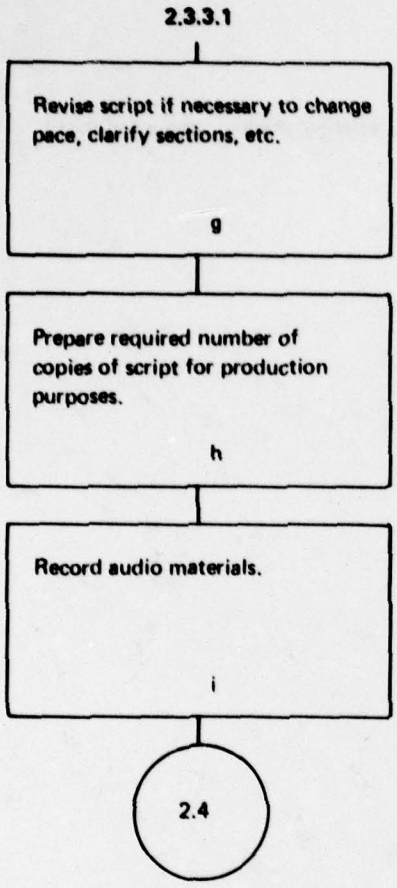

2.3.2
Give materials to peer for review.
e1
Meet with producer to review materials.
e2
Revise materials if necessary to clarify sections, change pace, etc.
f
Have required number of copies produced.
g
2.4



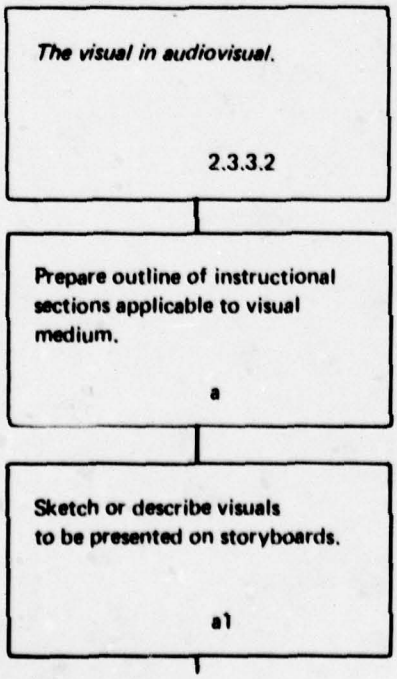
*Non-HumRRO author aid.



Left side should contain production instructions (use of music, special cues); right side should contain directions to narrator.

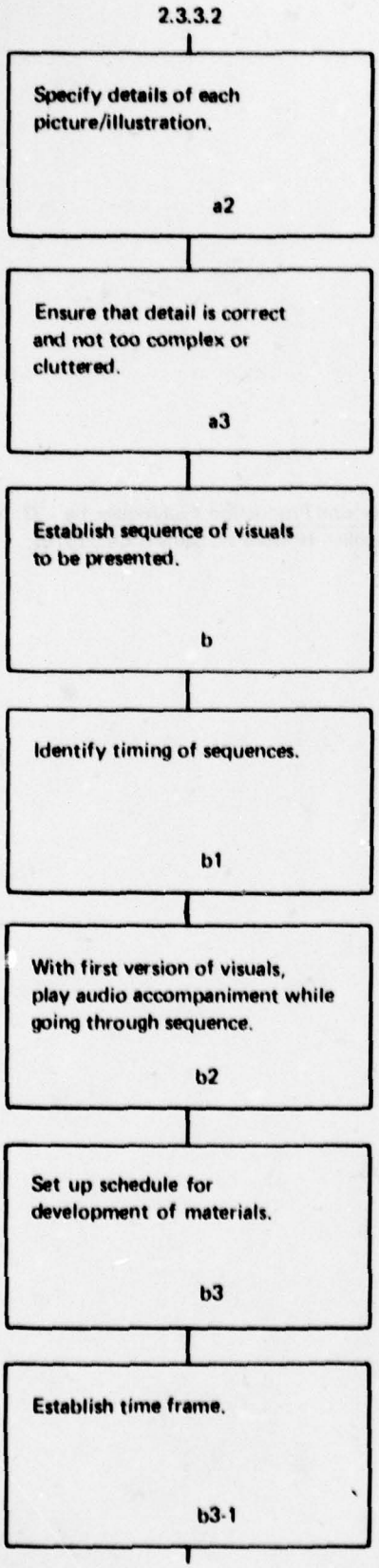


See Closed-Circuit Television Production Techniques, by L.G. Goodwin & T. Koehring. (Indianapolis: Howard W. Sams & Co., 1970).

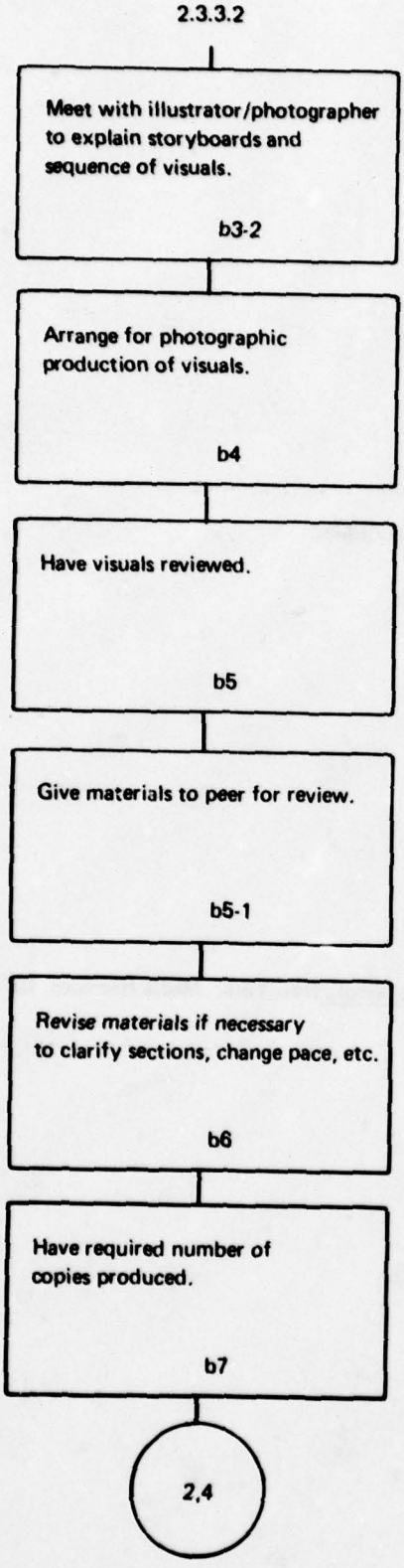


Review TLO's and LO's.

*Non-HumRRO author aid.



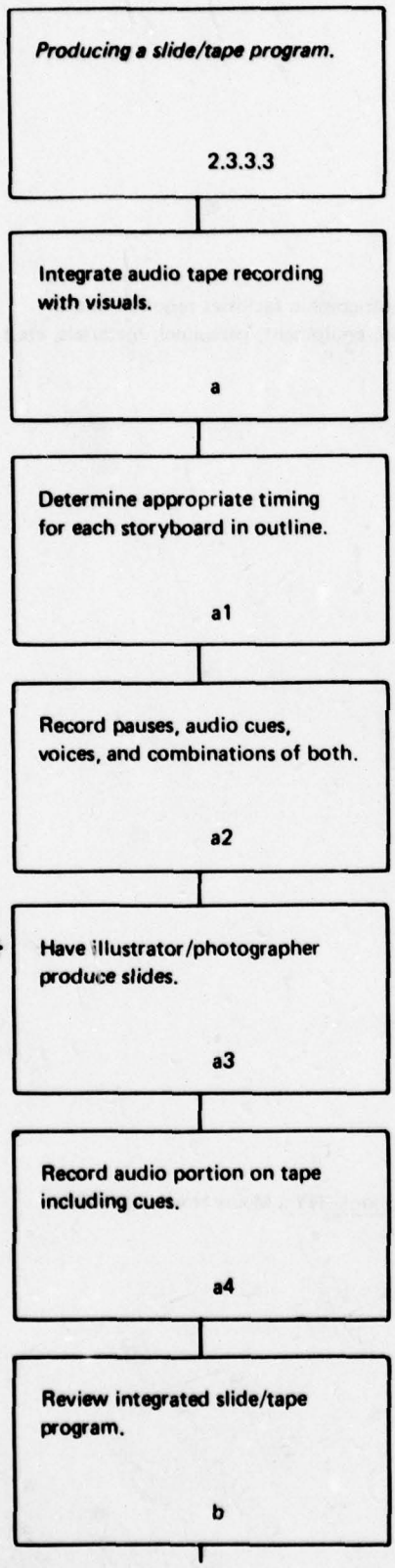
Include special effects, lettering, shading, amount of detail.



Determine what photographic facilities required and/or available (i.e., studio, equipment, personnel, materials, etc.)

See The Video Handbook, NY: Media Horizons, 1972.

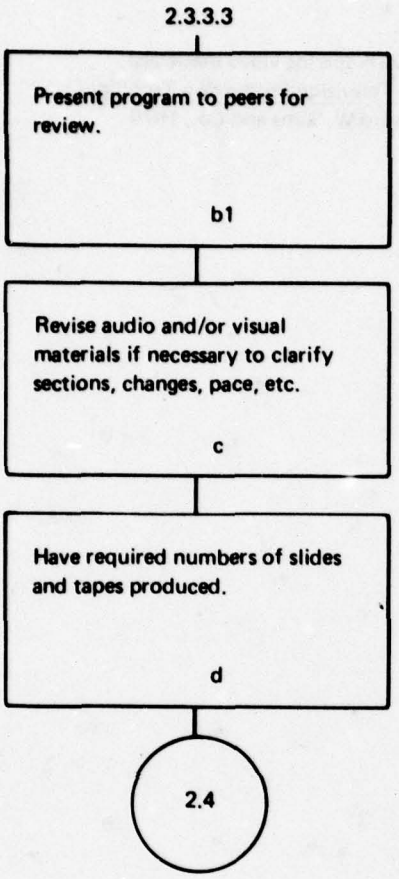
*Non-HumRRO author aid.

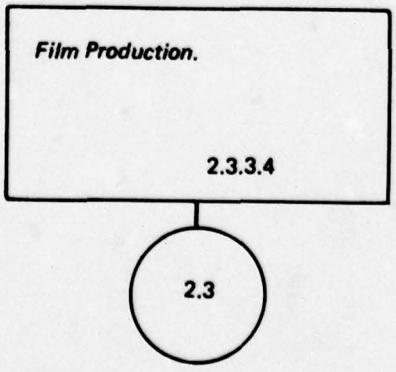


Refer to audiovisual outlines.

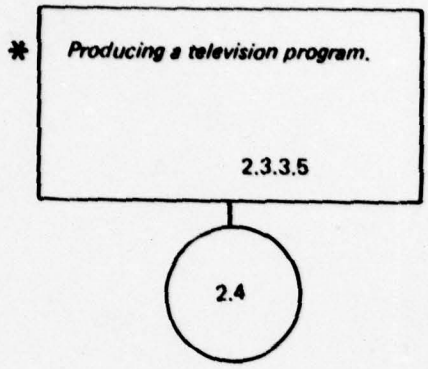
* See The Video Handbook, New York: Media Horizons, 1972.

*Non-HumRRC author aid.

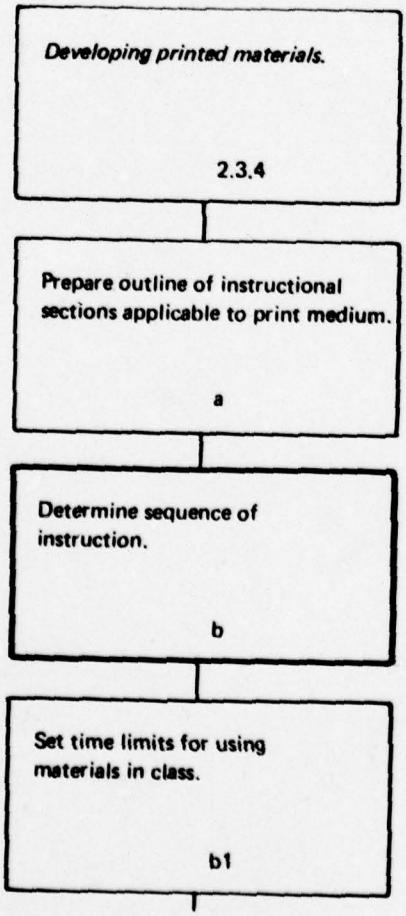




Not recommended.

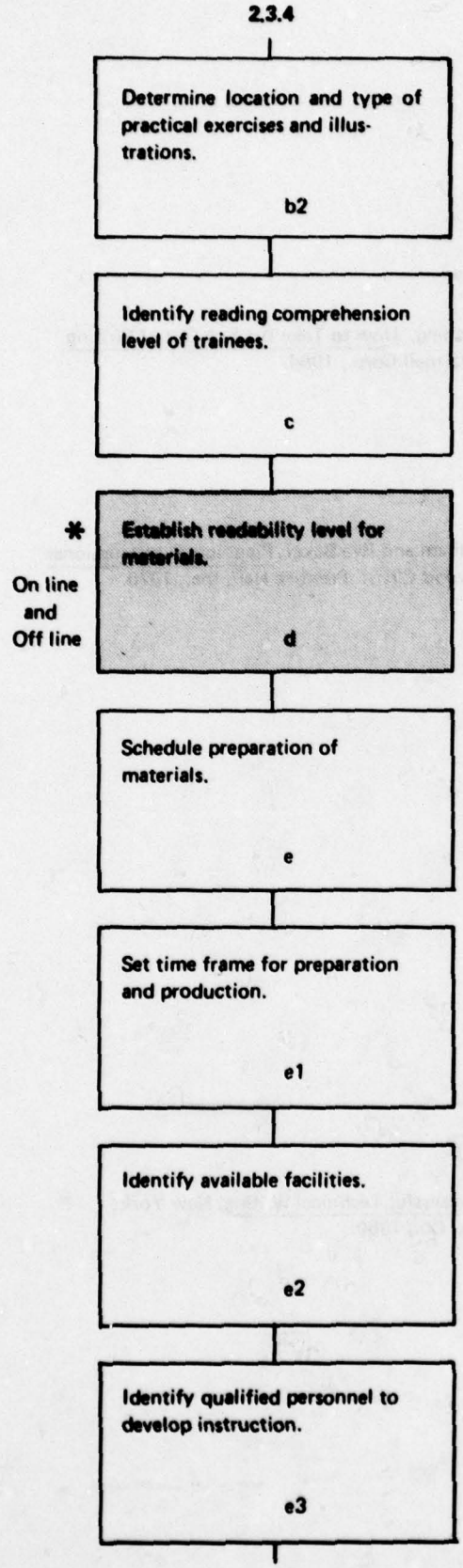


Follow steps for 2.3.2 (Preparing video materials).
See Closed-Circuit Television Production Techniques, Indianapolis: Howard W. Sams and Co., 1970.

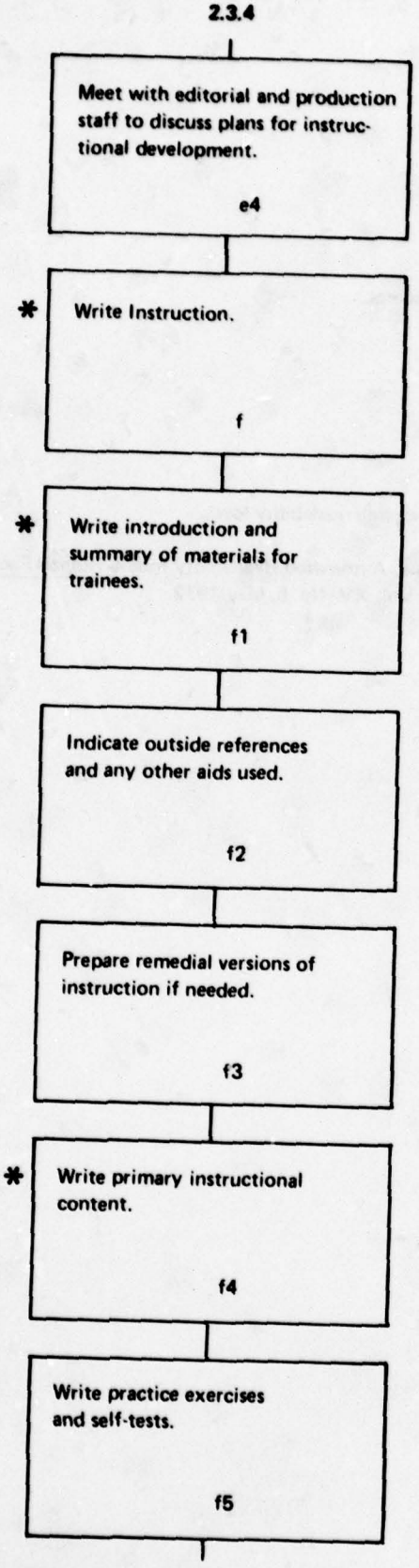


Review TLO's and LO's.

*Non-HumRRO author aid.



*Non-HumRRO author aid.

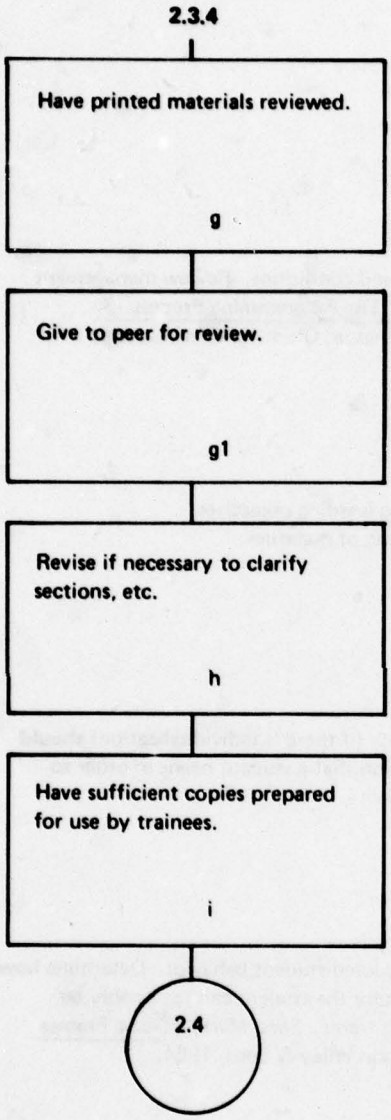


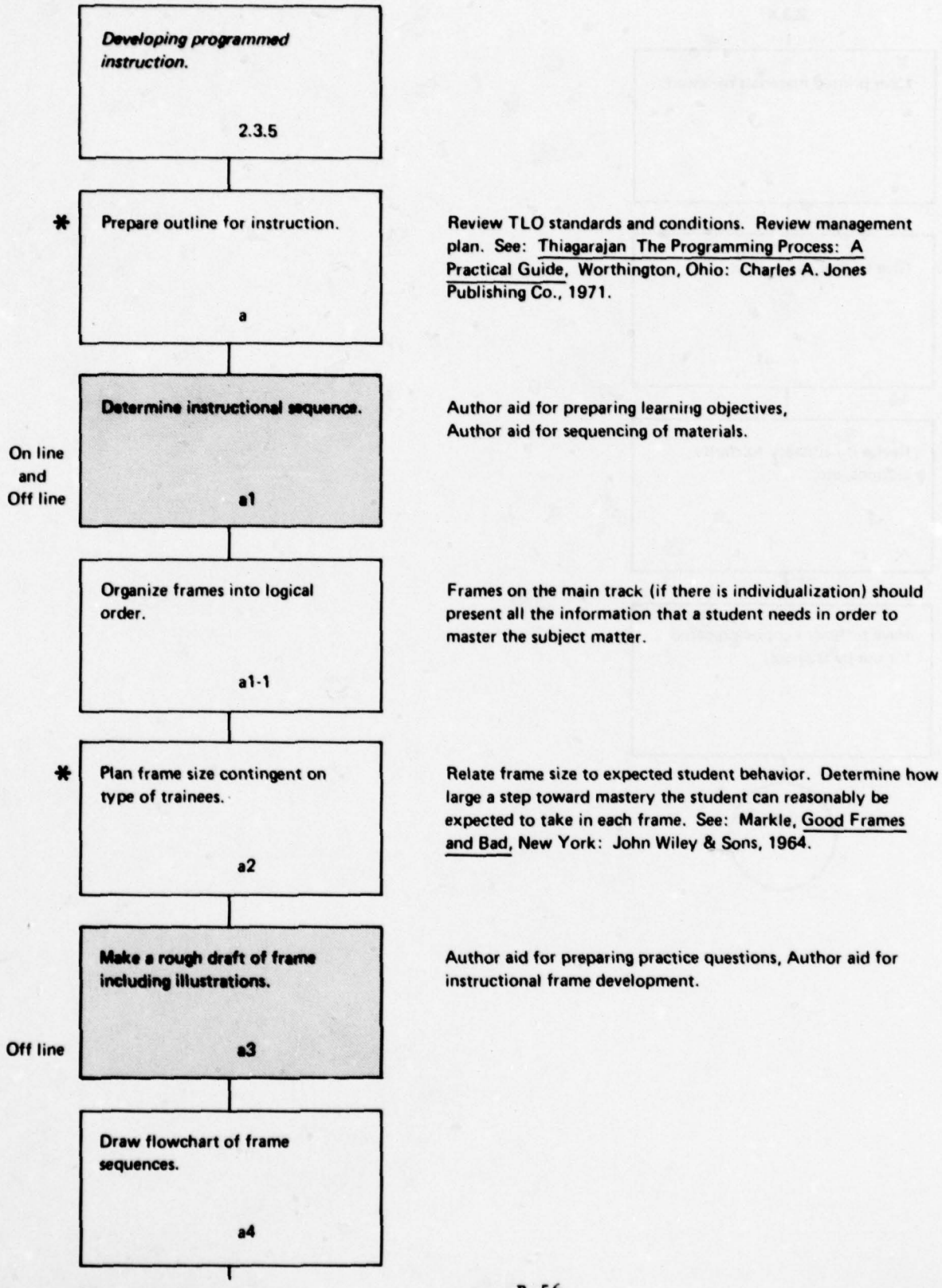
See: Robert Gunning. How to Take the Fog Out of Writing. Chicago: The Dartnell Corp., 1964.

See W. James Popham and Eva Baker, Planning an Instructional Sequence, Englewood Cliffs: Prentice Hall, Inc., 1970.

Tyler G. Hicks, Successful Technical Writing, New York: McGraw-Hill Book, Co., 1959.

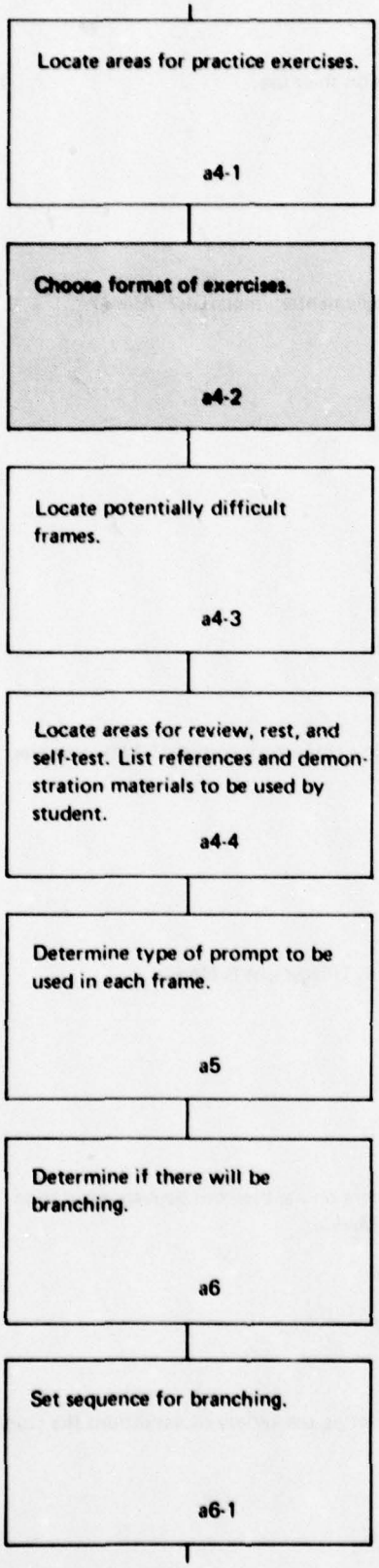
* Non-HumRRO author aid.


2.3.4
Have printed materials reviewed.
g
Give to peer for review.
g1
Revise if necessary to clarify sections, etc.
h
Have sufficient copies prepared for use by trainees.
i
2.4



* Non-HumRRO author aid.

2.3.5



Determine the amount of practice necessary beyond the minimal range of examples. See: Markle, 1964.

Multiple choice, true/false, completion? See: Markle, Good Frames and Bad, New York: John Wiley & Sons, 1964.

Author aids for preparing multiple choice, true/false and constructed response practice questions.

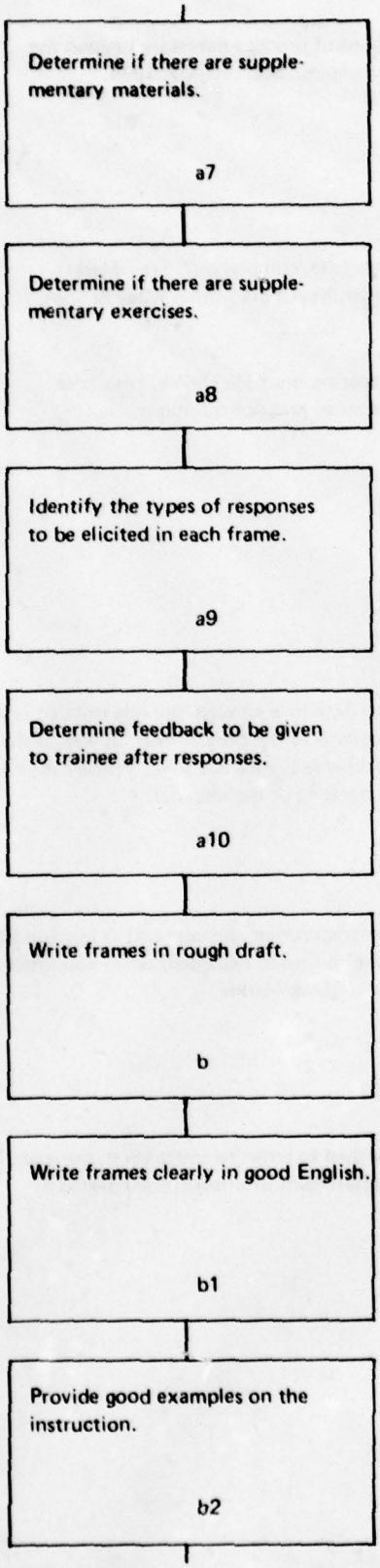
Where the program is extensive enough, provide isolated review and test items as feedback to the programmer, as well as the student on how well the teaching sequence has gone. Prepare quiz which tests students understanding of the material.

Make use of the thematic prompts (in context). Only use formal prompts (multiple-choice format excluded) when absolutely necessary. See Thiagarajan & Markle.

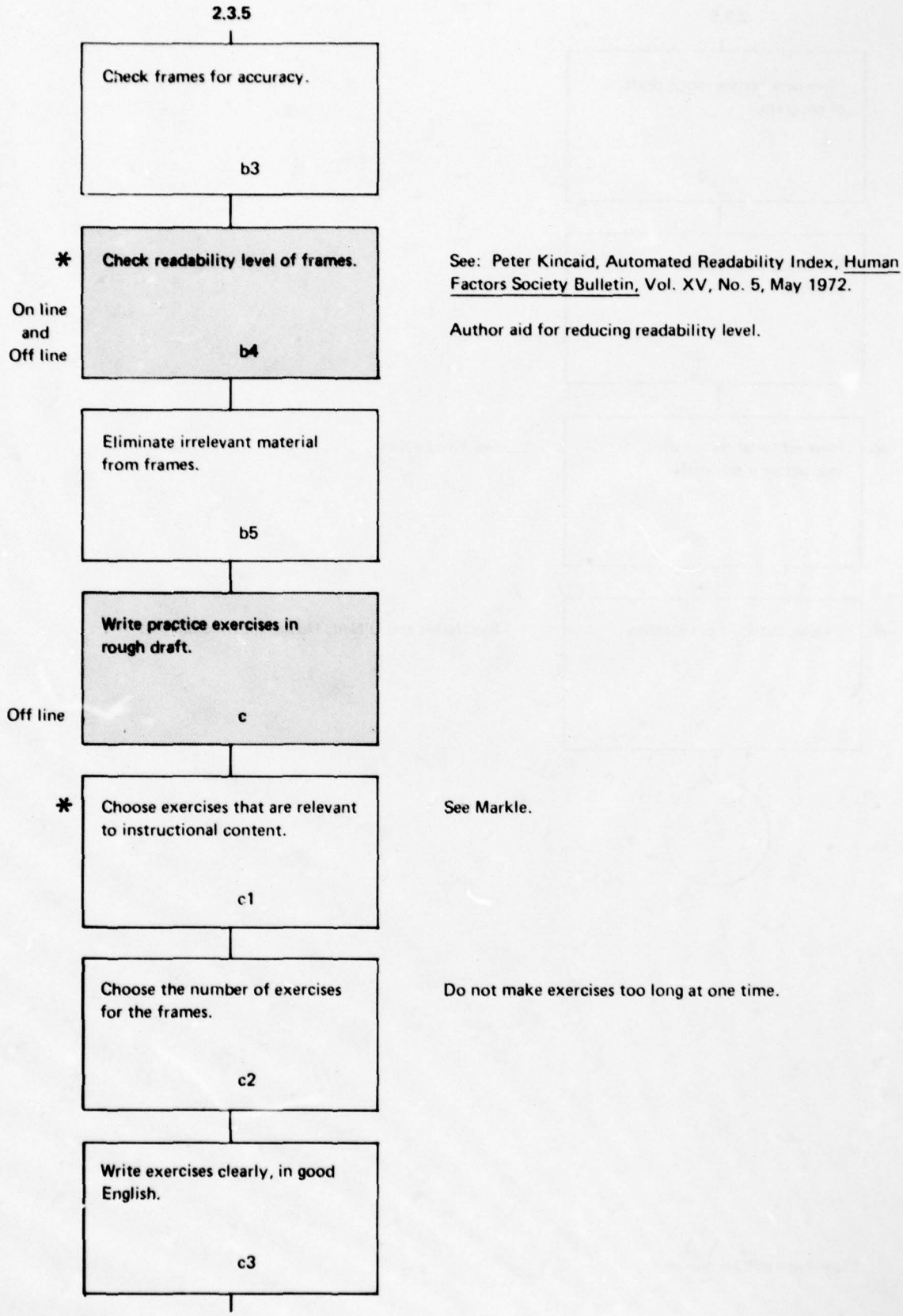
If the student is branched to remedial instruction, the material should represent a restatement of information covered in the main track.

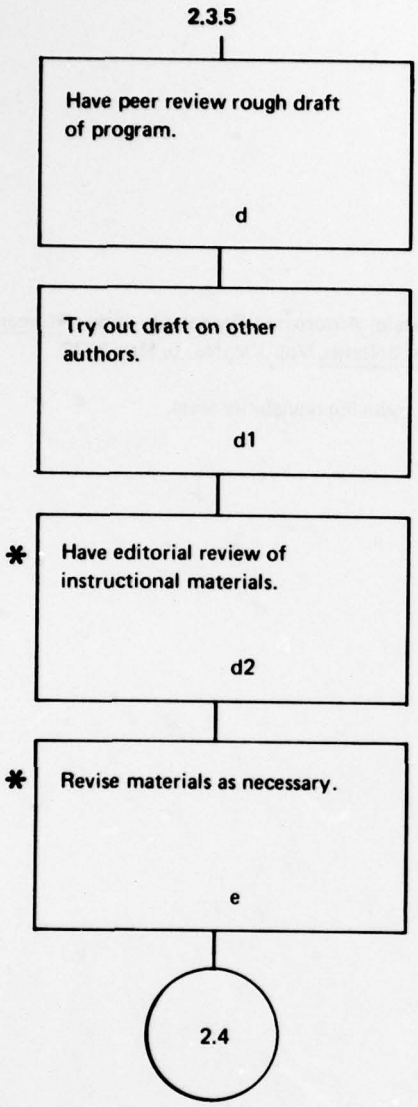
* Non-HumRRO author aid.

2.3.5



* Non-HumRRO author aid.

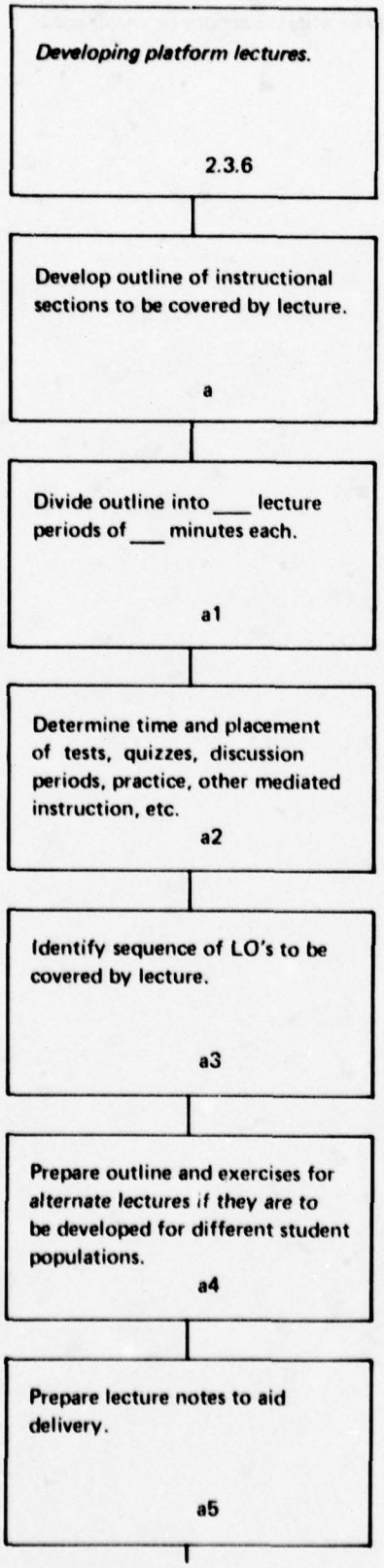

2.3.5
Check frames for accuracy.
b3
*
Check readability level of frames.
On line and Off line
b4
See: Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.
Author aid for reducing readability level.
Eliminate irrelevant material from frames.
b5
Write practice exercises in rough draft.
Off line
c
*
Choose exercises that are relevant to instructional content.
c1
See Markle.
Choose the number of exercises for the frames.
c2
Do not make exercises too long at one time.
Write exercises clearly, in good English.
c3
* Non-HumRRO author aid.

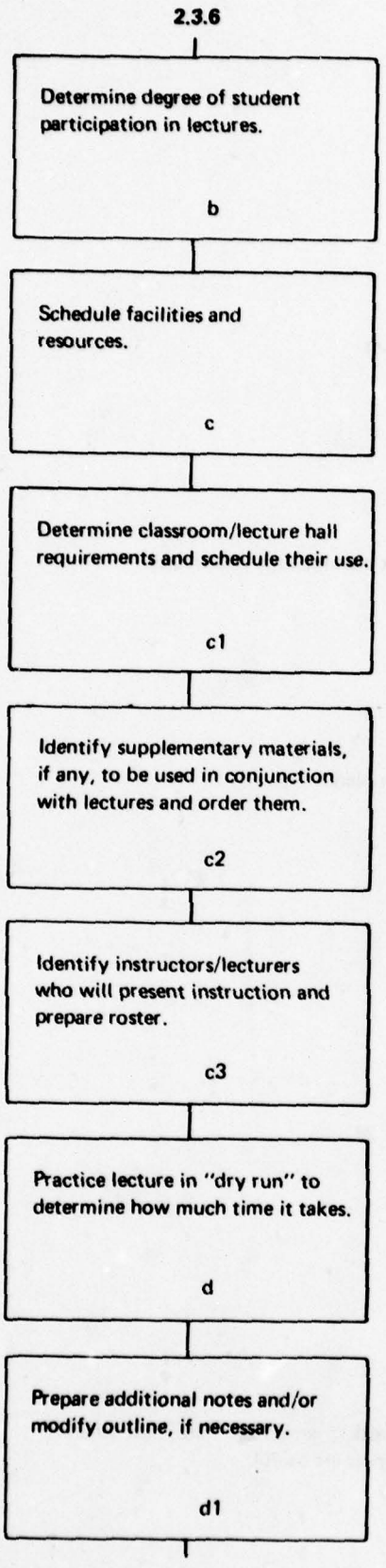


* See Thiagarajan.

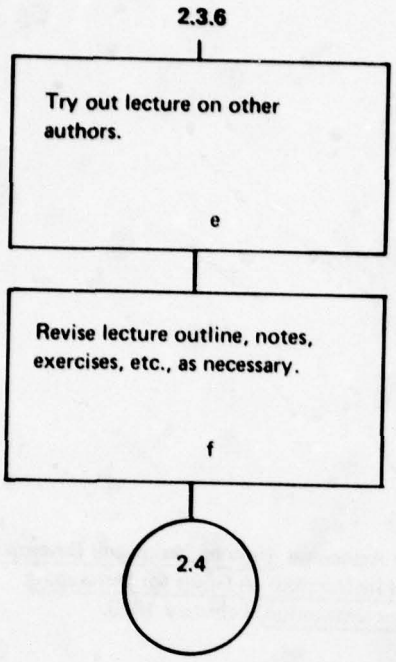
* See Nesbit and O'Neil, Thiagarajan and Markle.

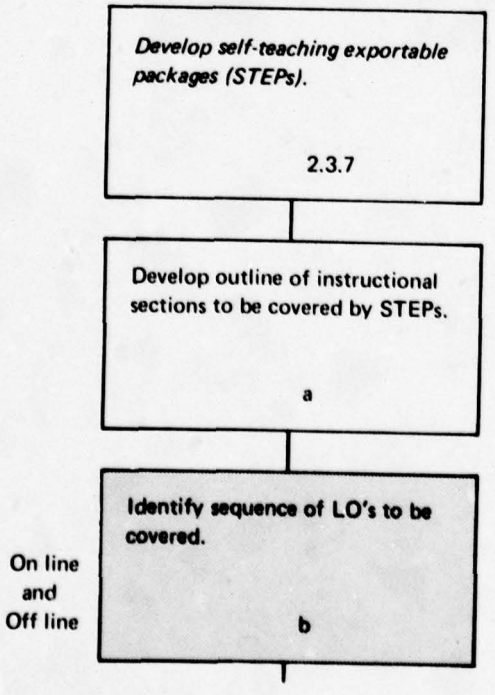
* Non-HumRRO author aid.


Developing platform lectures.
2.3.6
Develop outline of instructional sections to be covered by lecture.
a
Review TLO's and LO's.
Divide outline into ___ lecture periods of ___ minutes each.
a1
Refer to management plan for time constraints.
Determine time and placement of tests, quizzes, discussion periods, practice, other mediated instruction, etc.
a2
Refer to management plan.
Identify sequence of LO's to be covered by lecture.
a3
Prepare outline and exercises for alternate lectures if they are to be developed for different student populations.
a4
Prepare lecture notes to aid delivery.
a5
Note different concepts to get across. Also, note where supplementary materials are useful.



Will students listen only or will interactions be encouraged?

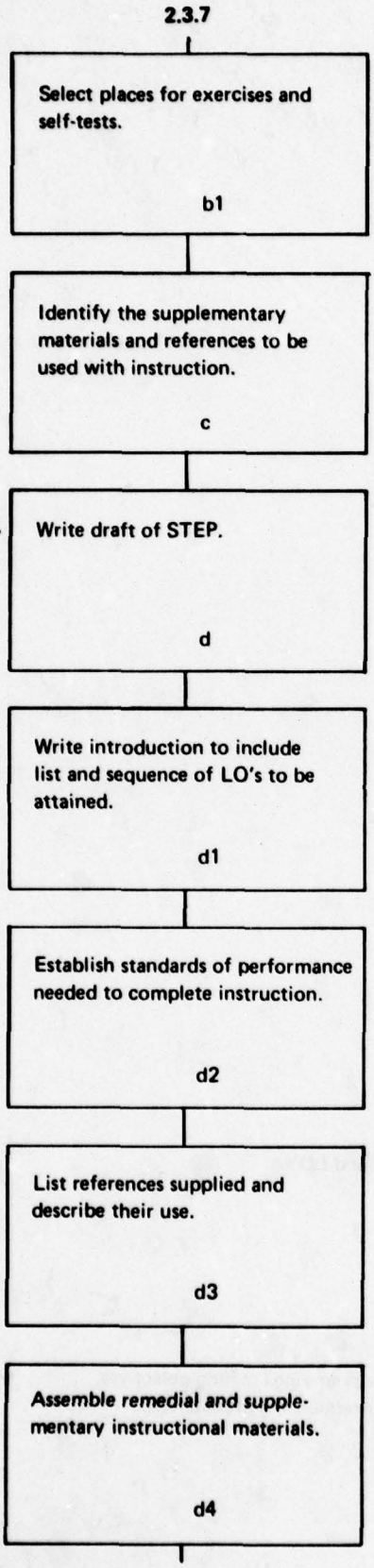




Review TLO's and LO's.

On line and Off line

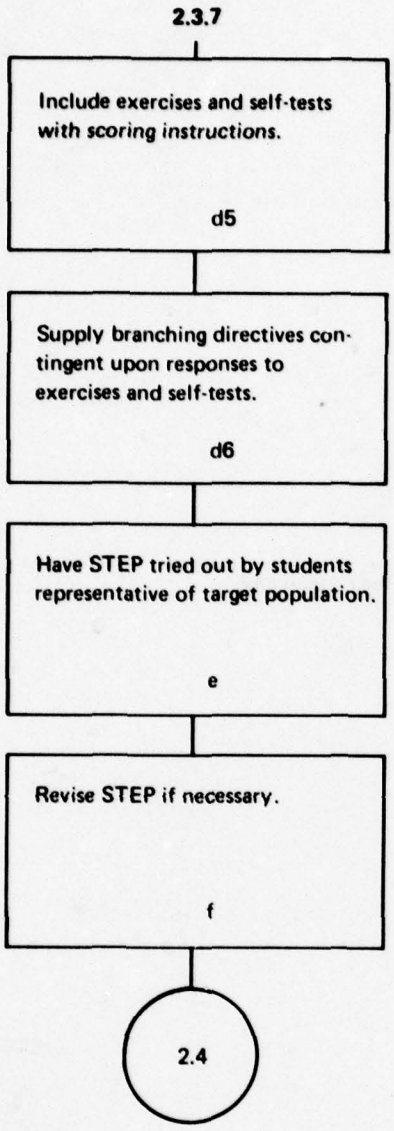
Author aid for preparing learning objectives,
Author aid for sequencing of materials.



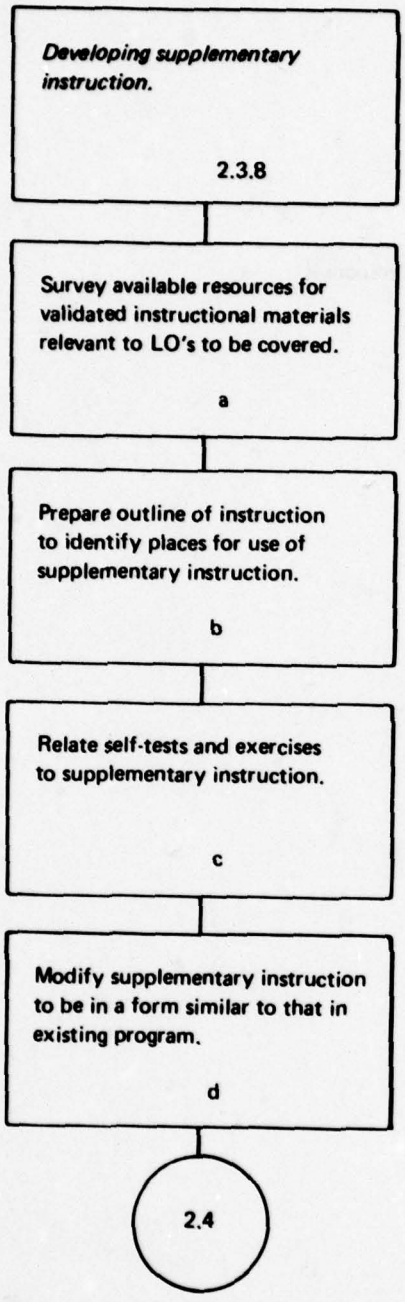
See: Deterline Associates, How to Design and Develop Self and Supervised Instruction: A Guide for Developing Correspondence Instruction, February 1975.

See: Preparing Extension Training, TRADOC Pamphlet 350-31, (Draft), February 1976.

* Non-HumRRO author aid.

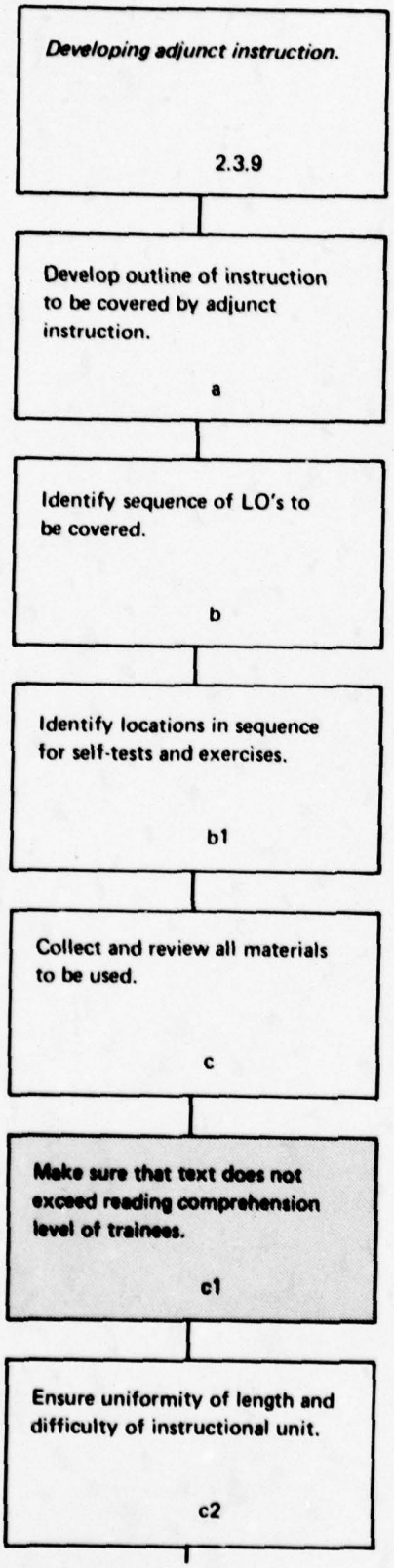


Provide discussions regarding all responses.



Review LO's for requirements.

Identify special instructions for their use, if any.



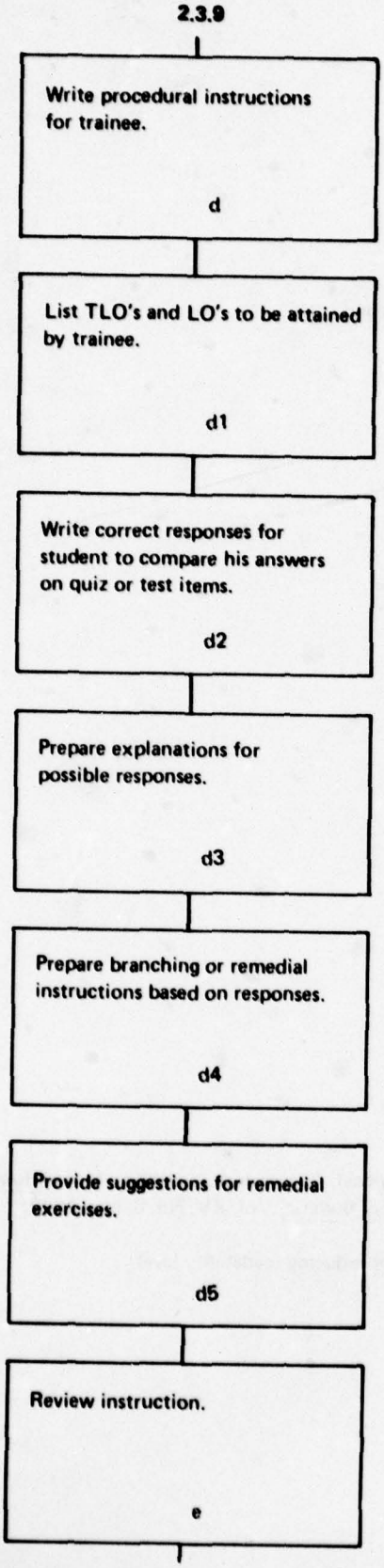
Review TLO's and LO's.

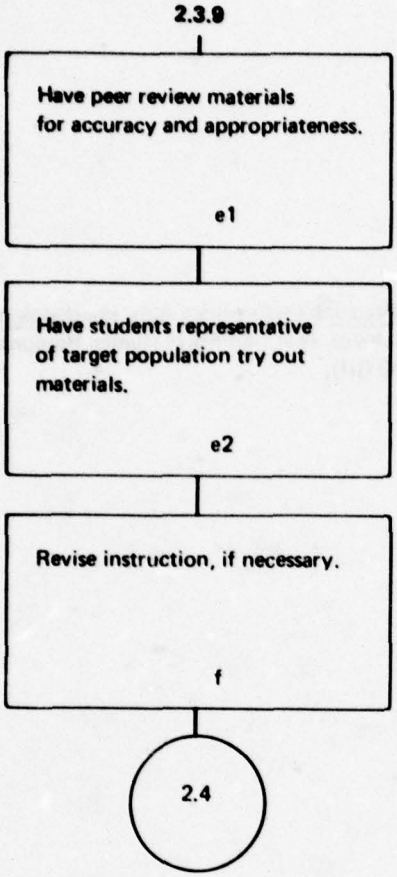
On line and Off line

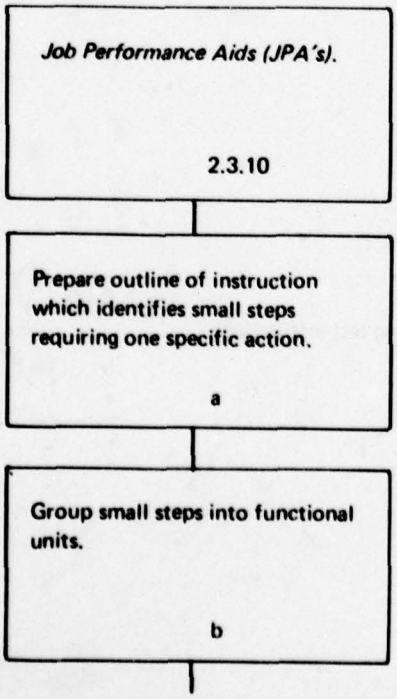
See: Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.

Author aid for reducing readability level.

* Non-HumRRO author aid.

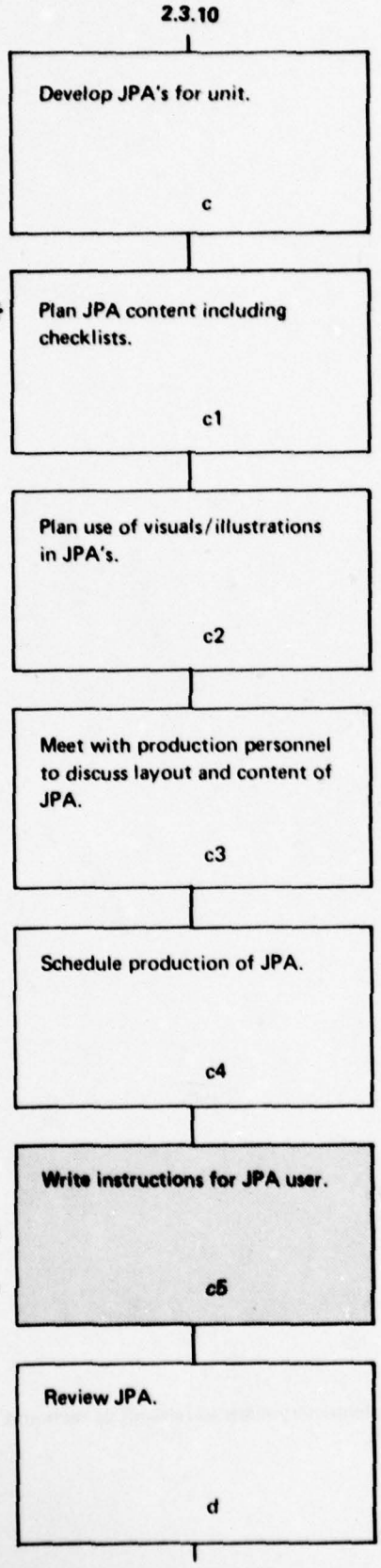

2.3.9
Write procedural instructions for trainee.
d
List TLO's and LO's to be attained by trainee.
d1
Write correct responses for student to compare his answers on quiz or test items.
d2
Prepare explanations for possible responses.
d3
Prepare branching or remedial instructions based on responses.
d4
Provide suggestions for remedial exercises.
d5
Review instruction.
e





Review TLO's and LO's

Note reference and supplementary material relevant to each unit.

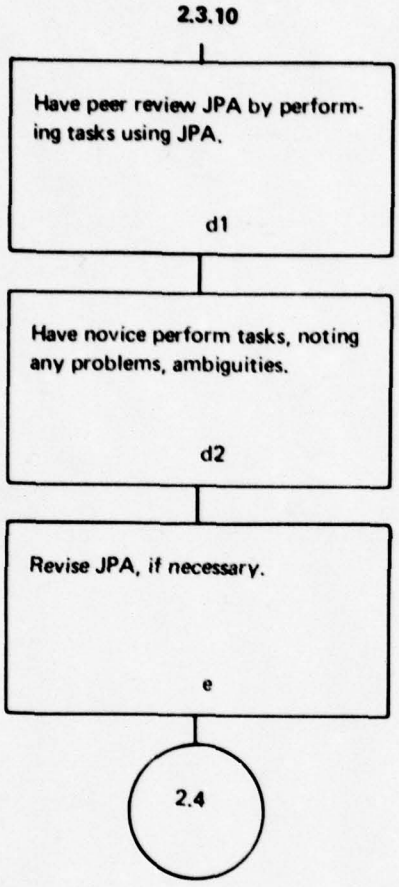


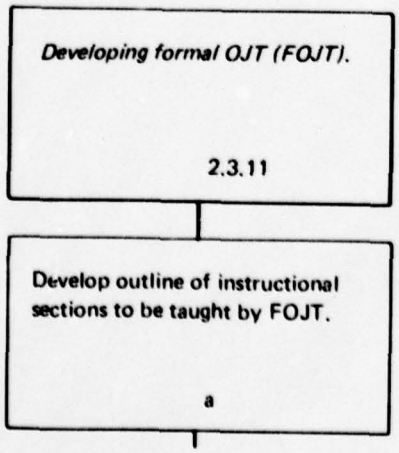
See: Fully Proceduralized Job Performance Aids, Handbook for JPA Developers by Reid P. Joyce, et.al., Air Force Human Resources Lab, AFHRL-TR-73-43 (III).

Include references.

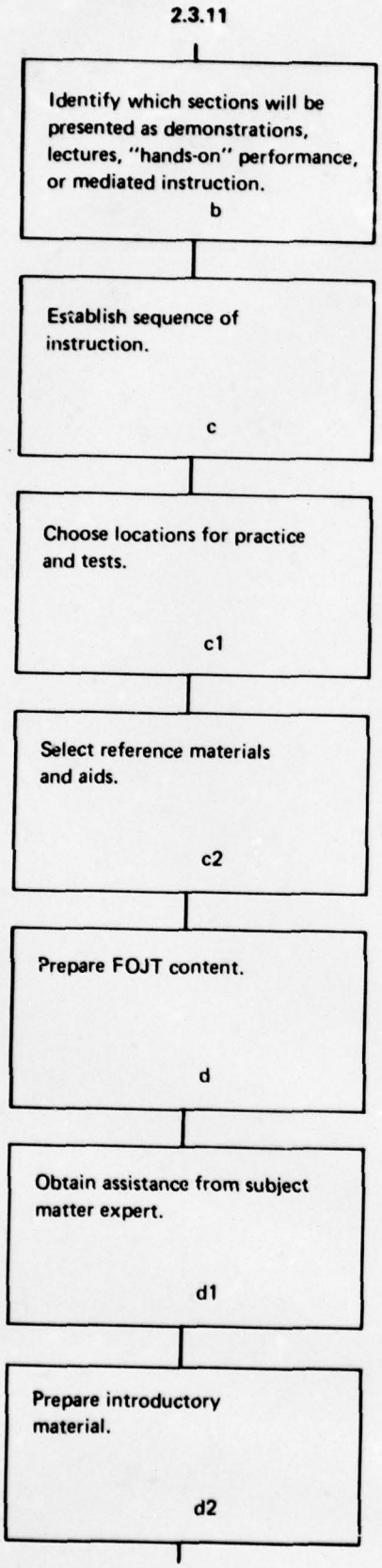
Author aid for preparing test instructions.

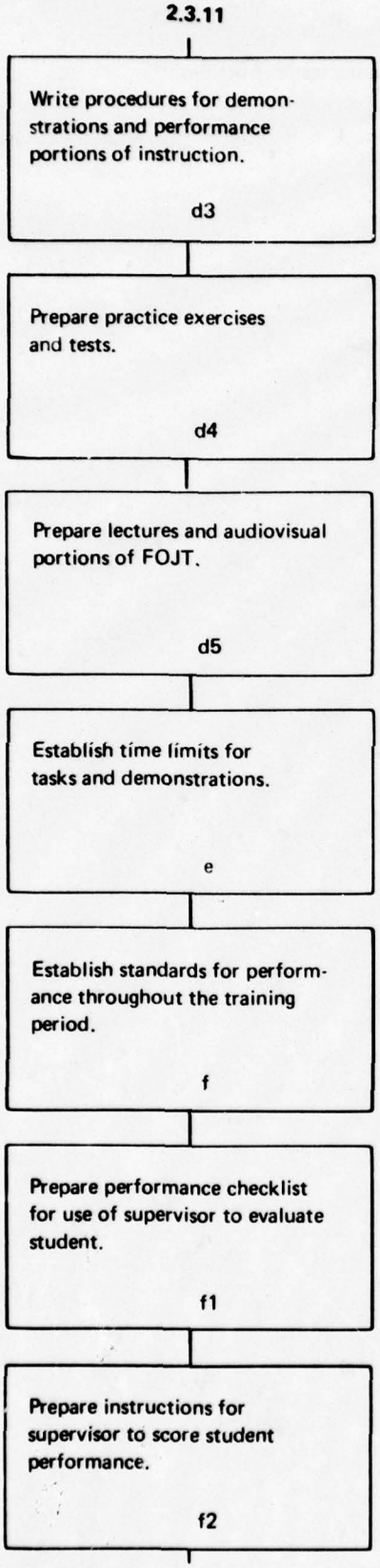
*Non-HumRRO author aid.



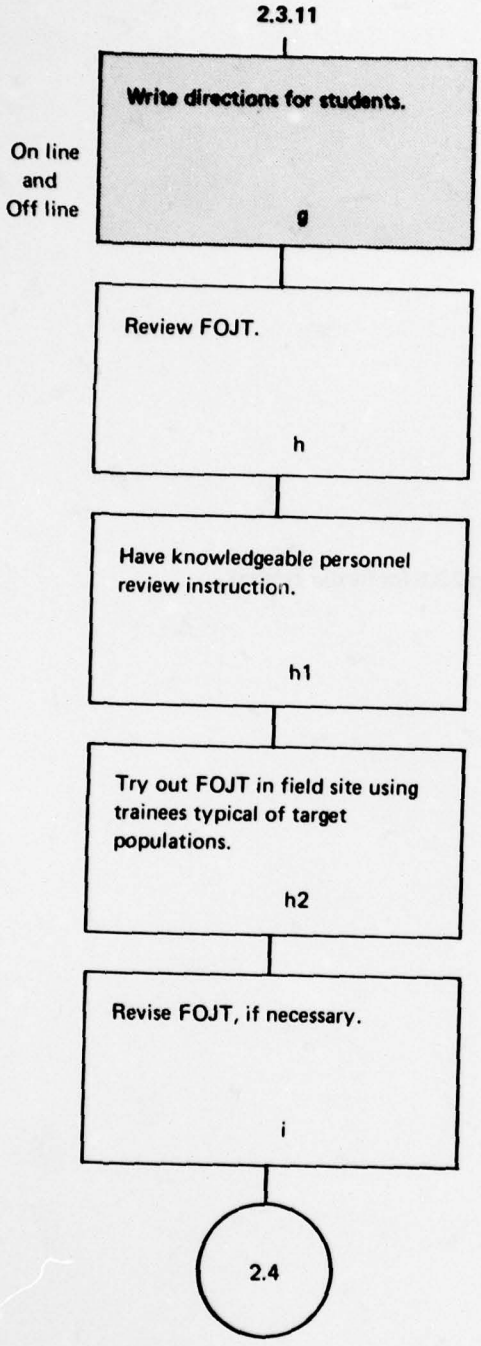


Review TLO's and LO's.

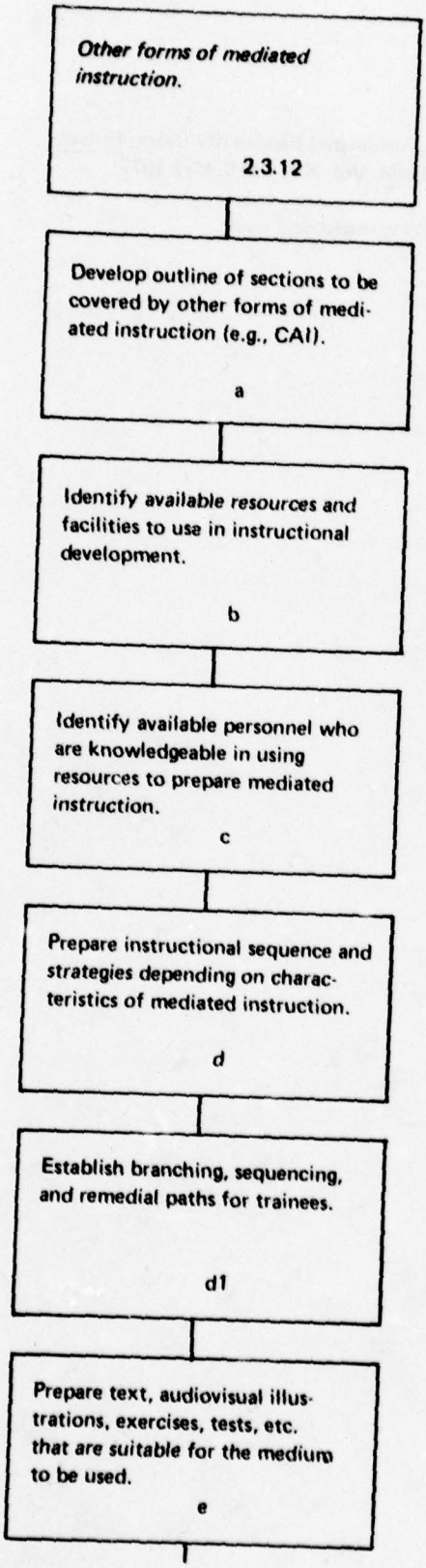

2.3.11
Identify which sections will be presented as demonstrations, lectures, "hands-on" performance, or mediated instruction.
b
Establish sequence of instruction.
c
Choose locations for practice and tests.
c1
Select reference materials and aids.
c2
Prepare FOJT content.
d
Obtain assistance from subject matter expert.
d1
Prepare introductory material.
d2



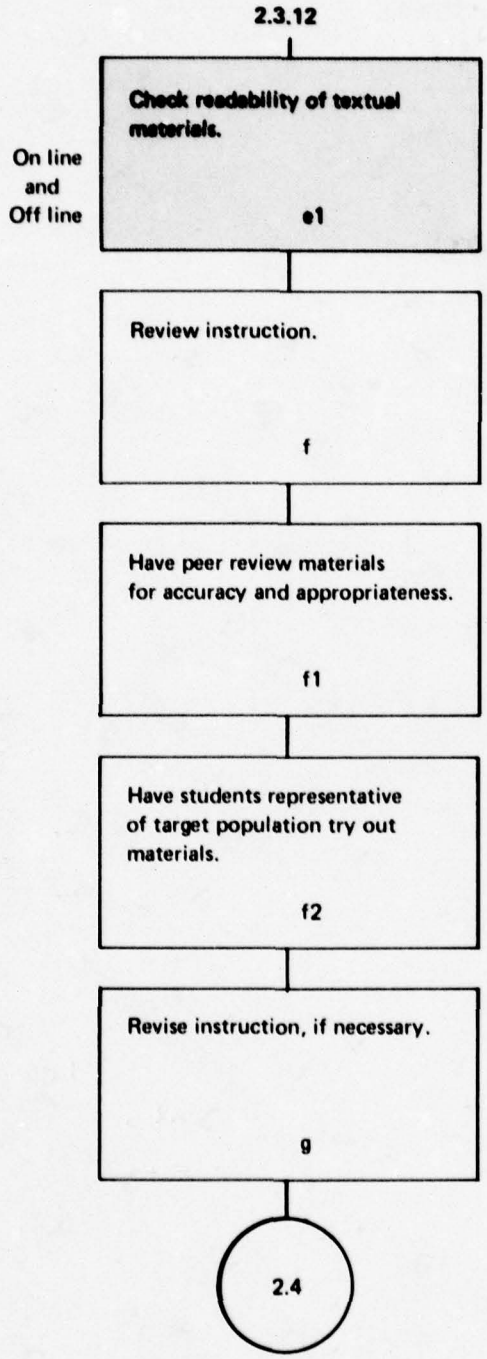
See blocks 2.3.3 and 2.3.6 for further reference.



Author aid for preparing test instructions.



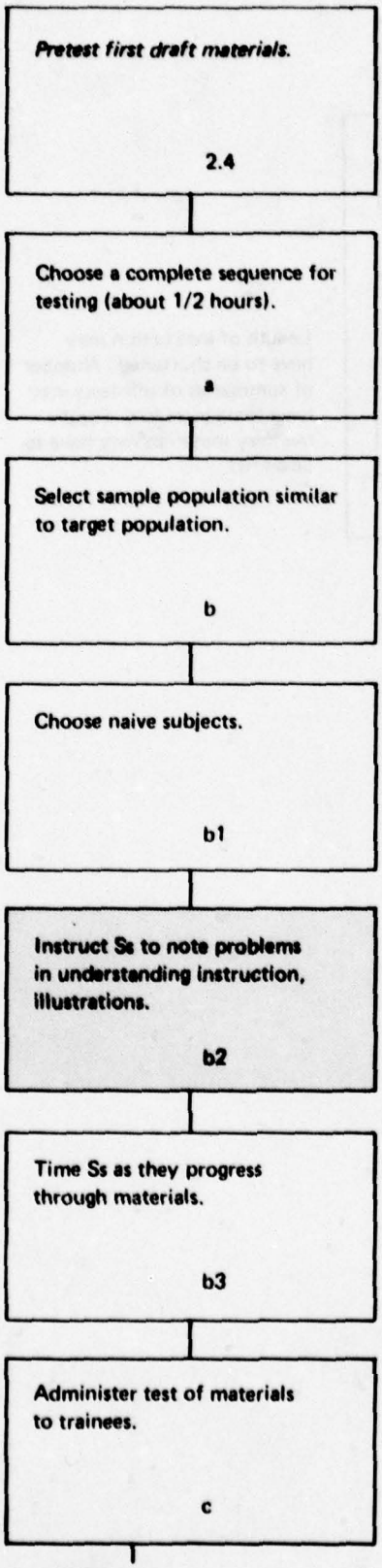
Review TLO's and LO's.



See: Peter Kincaid, Automated Readability Index, Human Factors Society Bulletin, Vol. XV, No. 5, May 1972.

Author aid for reducing readability level.

*Non-HumRRO author aid.

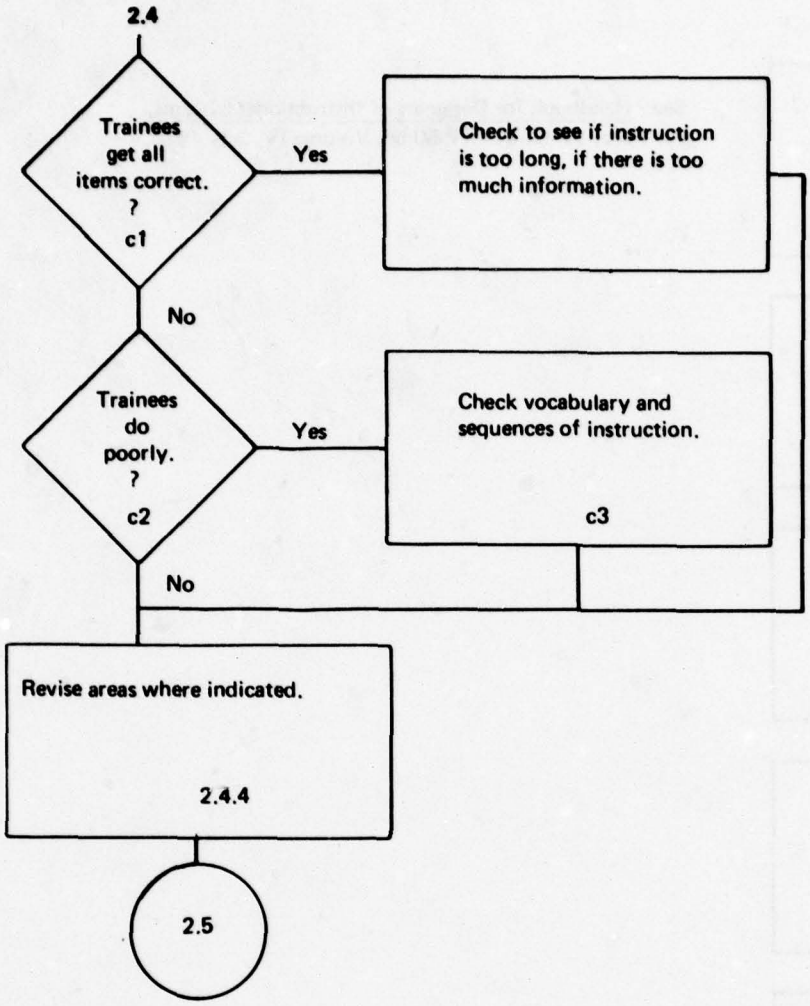


See: Handbook for Designers of Instructional Systems, Air Force pamphlet AFP-50-58, Volume IV, July 1973.

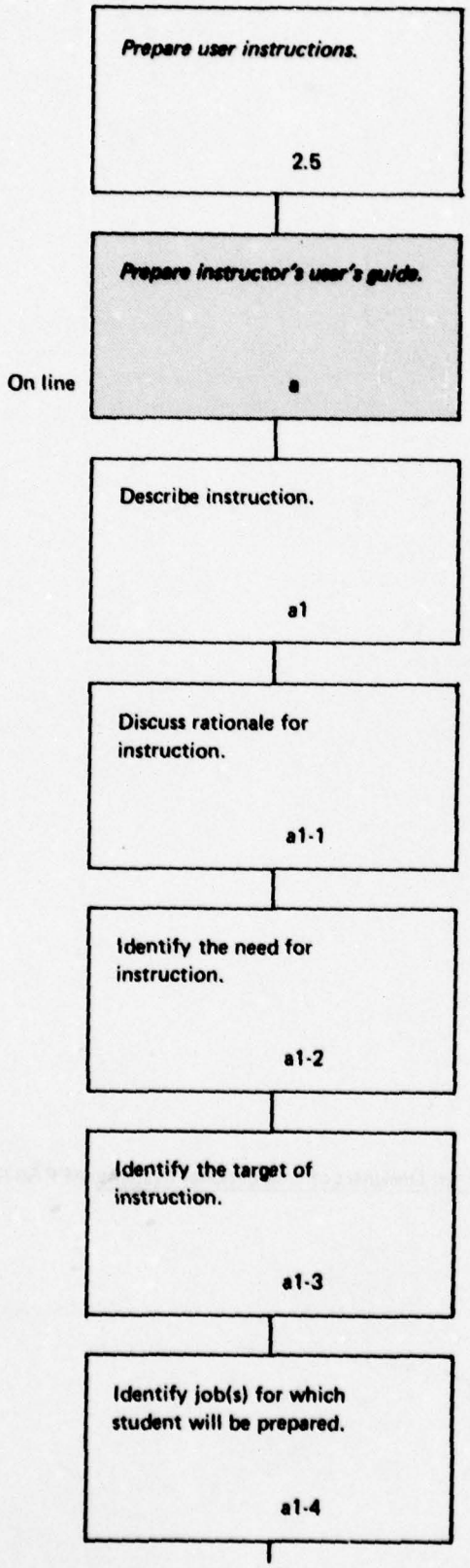
Author aid on attitudinal questionnaires for CAI.

See: Handbook of Procedures for the Design of Instruction, Leslie J. Briggs, Pittsburgh: AIR, 1970.

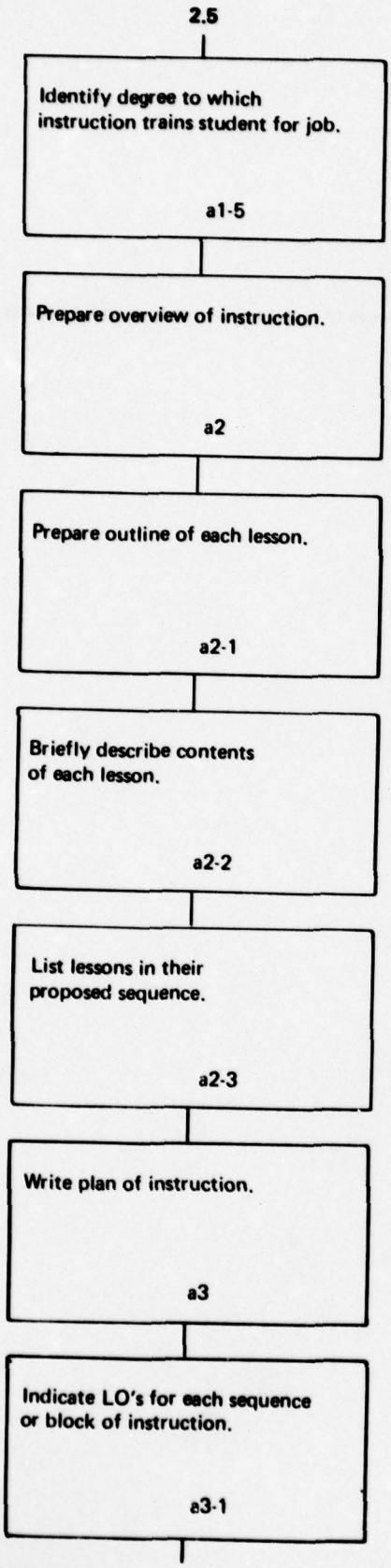
* Non-HumRRO author aid.



Length of instruction may have to be shortened. Number of summaries of self-tests may have to be increased. Supplementary materials may have to be added.

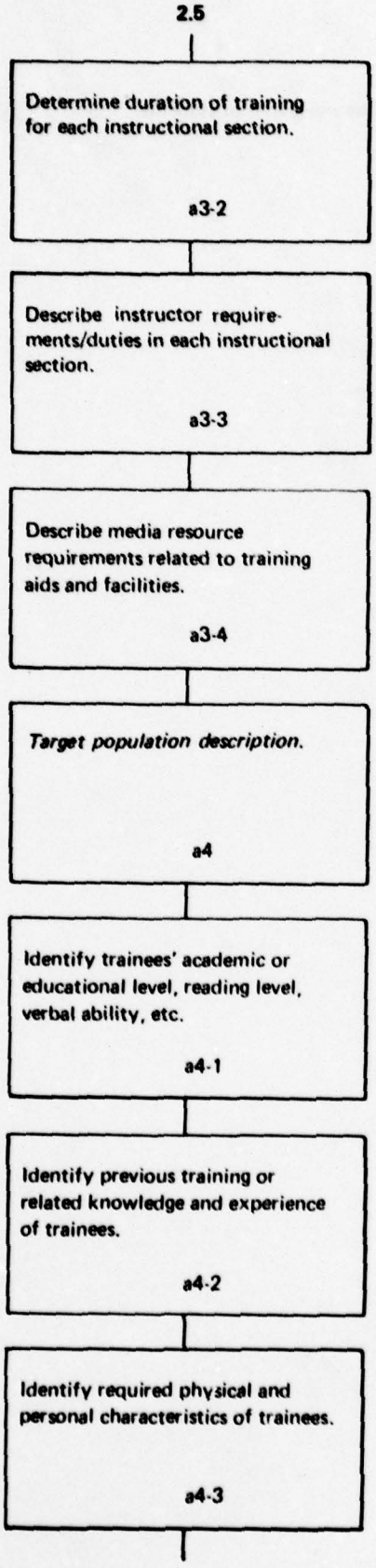


Guide for the use of author aids in preparing CAI materials.



See: Handbook for Designers of Instructional Systems, AFP 50-58, July 1973.

* Non-HumRRO author aid.



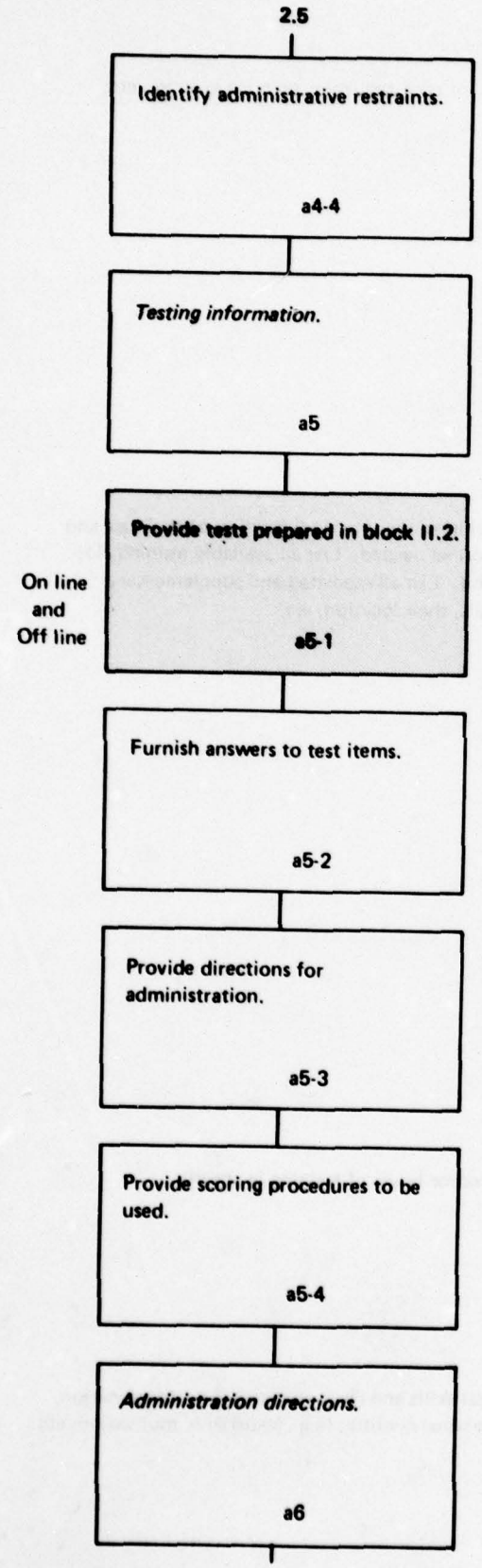
List time constraints for each sequence, practice exercise, etc.

List the available facilities, the time and duration of their use and the supervisory personnel needed. List all available training aids for each block or unit. List all mediated and supplementary instructional materials, their location, etc.

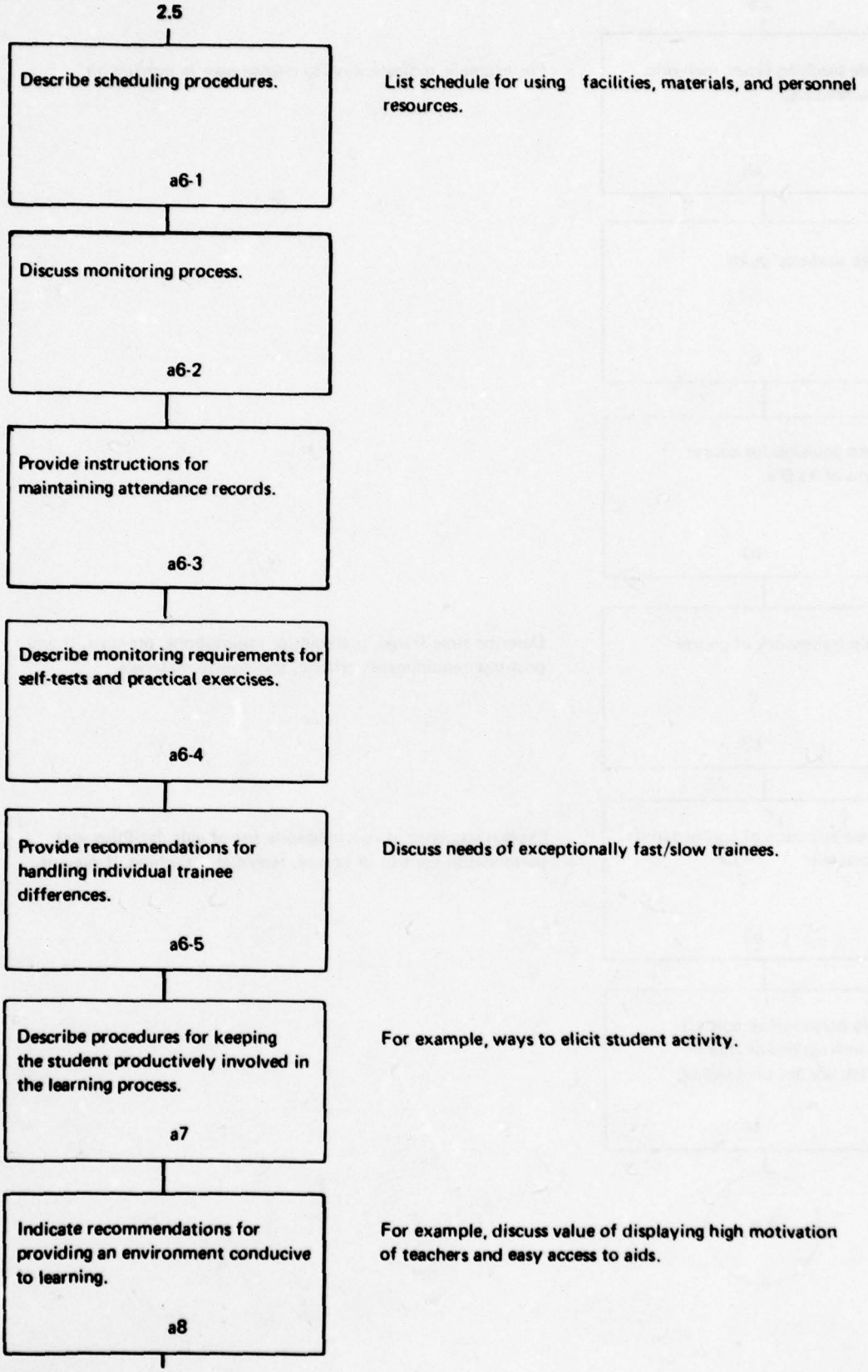
Refer to entry tests.

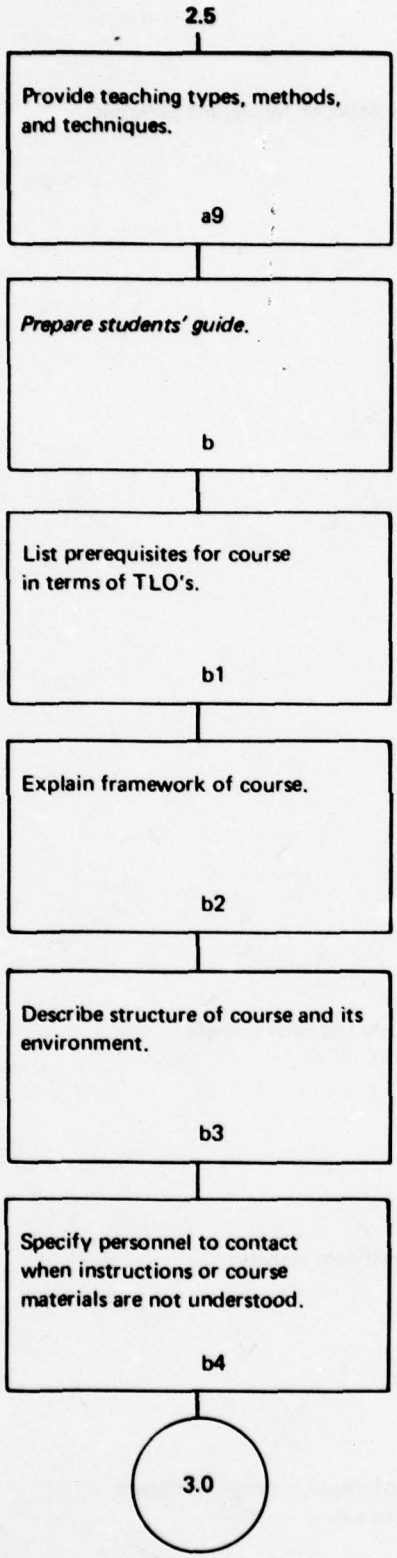
List courses taken and/or hours of training in specific prerequisite areas.

List required physical skills and characteristics (e.g., coordination, motor skills) and personal qualities (e.g., leadership, motivation, etc.).



List all sequence ranks and grades of students.


2.5
Describe scheduling procedures.
a6-1
List schedule for using facilities, materials, and personnel resources.
Discuss monitoring process.
a6-2
Provide instructions for maintaining attendance records.
a6-3
Describe monitoring requirements for self-tests and practical exercises.
a6-4
Provide recommendations for handling individual trainee differences.
a6-5
Discuss needs of exceptionally fast/slow trainees.
Describe procedures for keeping the student productively involved in the learning process.
a7
For example, ways to elicit student activity.
Indicate recommendations for providing an environment conducive to learning.
a8
For example, discuss value of displaying high motivation of teachers and easy access to aids.

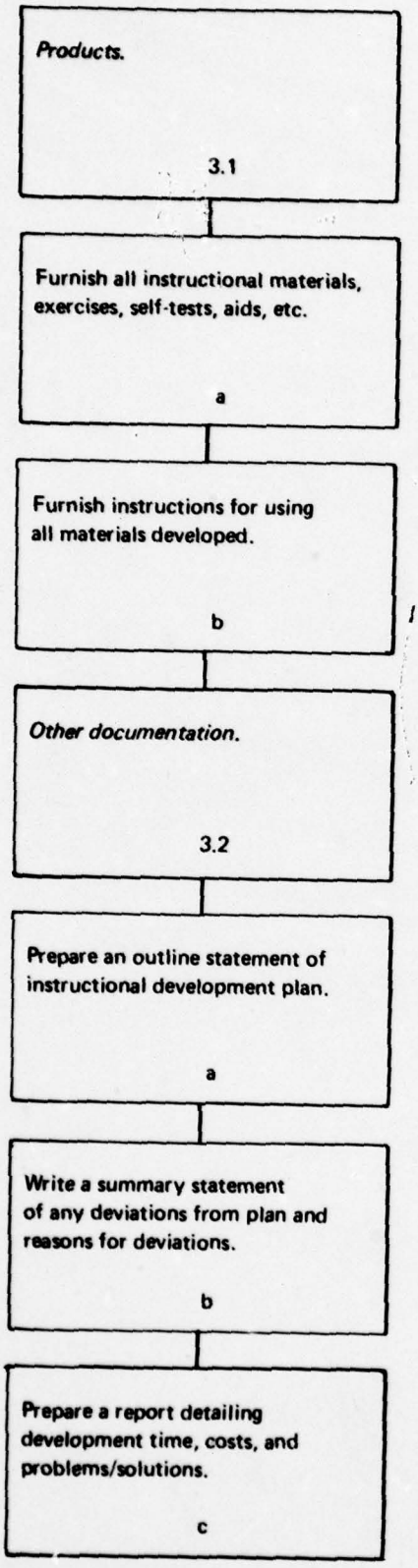


For example, indicate ways to change pace in instruction.

Describe time frame, prerequisite assumptions, pre-tests, if any, post-test requirements/criteria, and course materials.

Explain sequence of course lessons, use of aids, facilities, and personnel in control of course, remedial branching, if present.

3.0 *Outputs*



Describe management of course and students.

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BRIGGS, Leslie, J. Handbook of Procedures for the Design of Instruction. Pittsburgh: American Institutes for Research (AIR), 1970.

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GOODWIN, L.G., and Koehring, T. Closed-Circuit Television Production Techniques. Indianapolis: Howard W. Sames & Co., 1970.

GUNNING, Robert. How to Take the Fog Out of Writing. Chicago: The Dartnell Corp., 1964.

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Appendic C

DETAILED FLOWCHARTS OF AUTHOR AIDS FOR IPISD BLOCK II.2 (DEVELOP TESTS) AND BLOCK III.4 (DEVELOP INSTRUCTION)

The two sections of flowcharts in this appendix serve three purposes. First, they further clarify IPISD Blocks II.2 and III.4. The number at the beginning of each flowchart refers to the appropriate place they are to be inserted in the IPISD blocks flowcharted in Appendix B. Additional block identification was not made because of the complexity of the flowcharts.

The second purpose of the flowcharts is to provide directions for the use of the on-line authoring aids for test and lesson development. These flowcharts are detailed enough to lead an author from the beginning of development (the learning objective) to the finished product (on-line for student use).

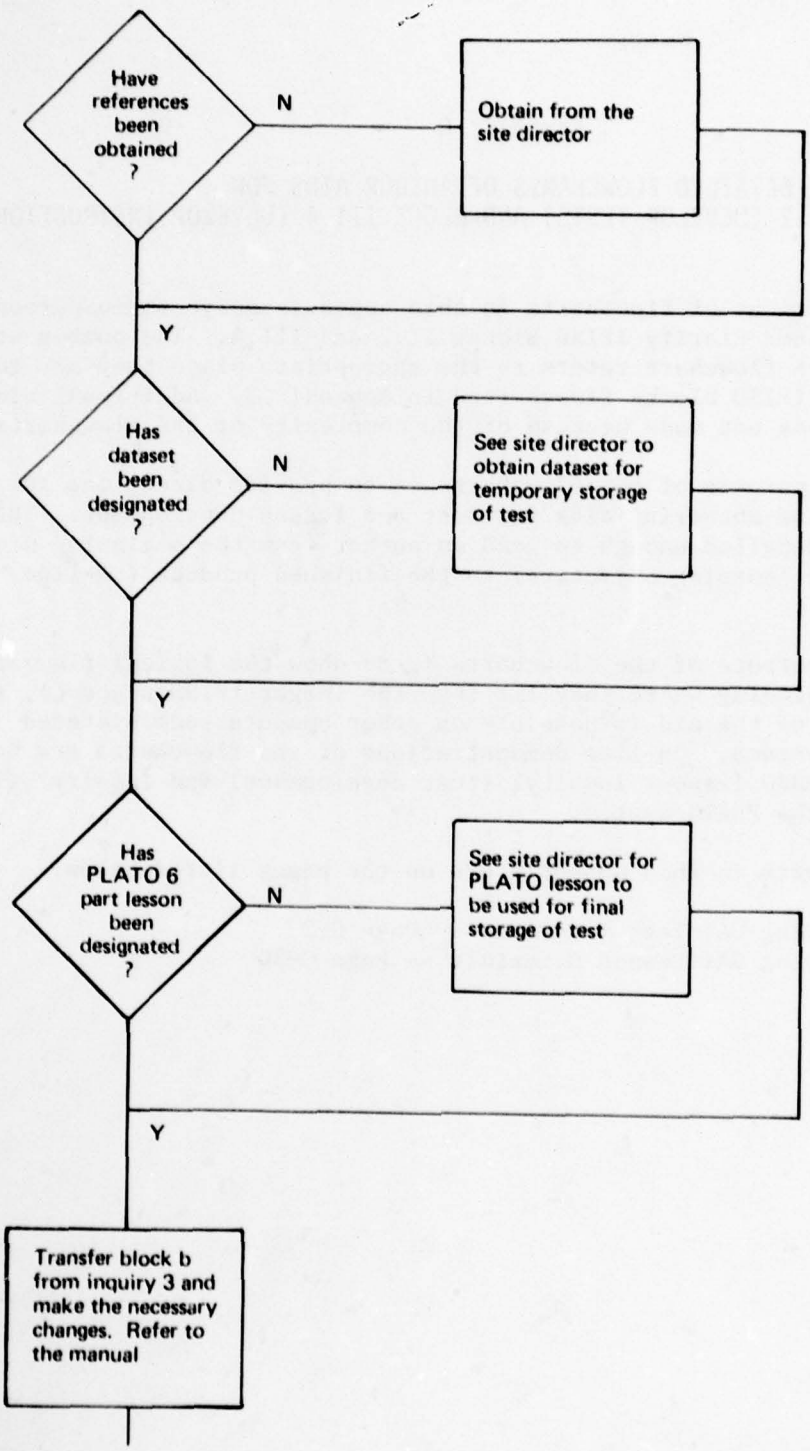
The third purpose of the flowcharts is to show the logical flow of the author aids (including where they fit into the larger IPISD process), so that conversion of the aid is possible on other computer-administered instructional systems. On-line demonstrations of the flowcharts are possible by accessing HumRRO lessons inquiry1 (test development) and inquiry2 (lesson development on the PLATO system.

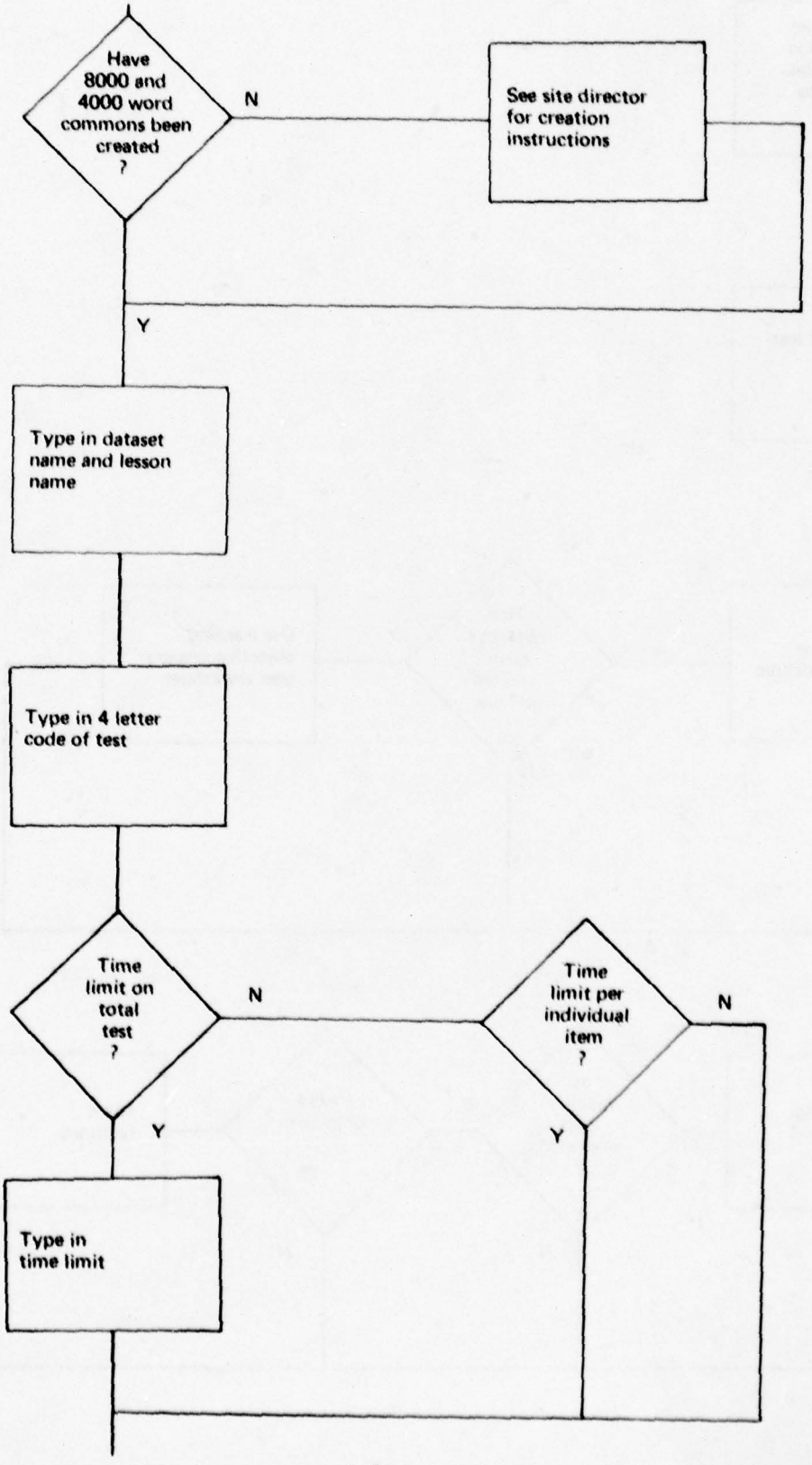
The flowcharts in this appendix are on the pages listed below.

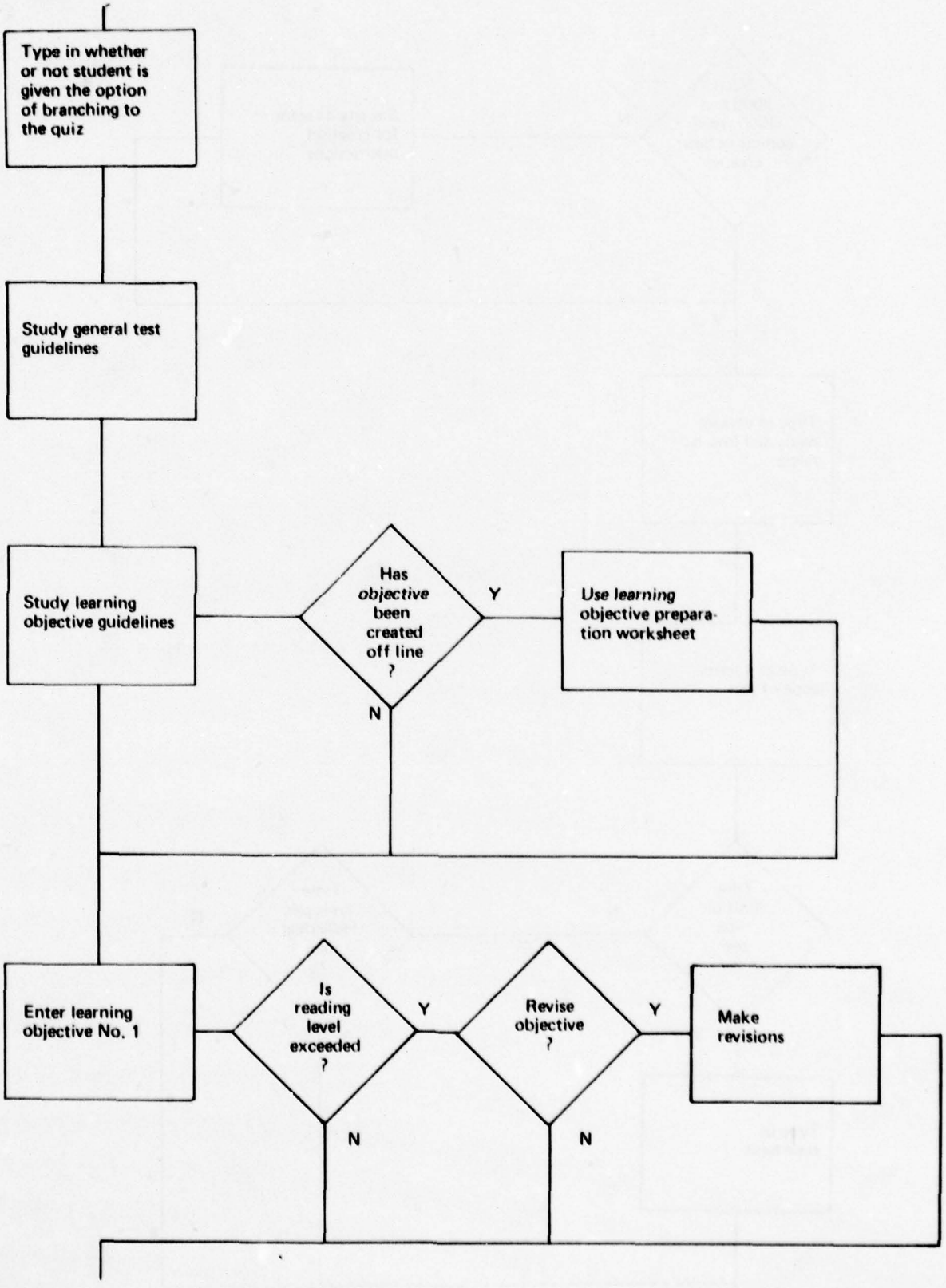
Preparing CAI Test Materials -- Page C-2
Preparing CAI Lesson Materials -- Page C-30

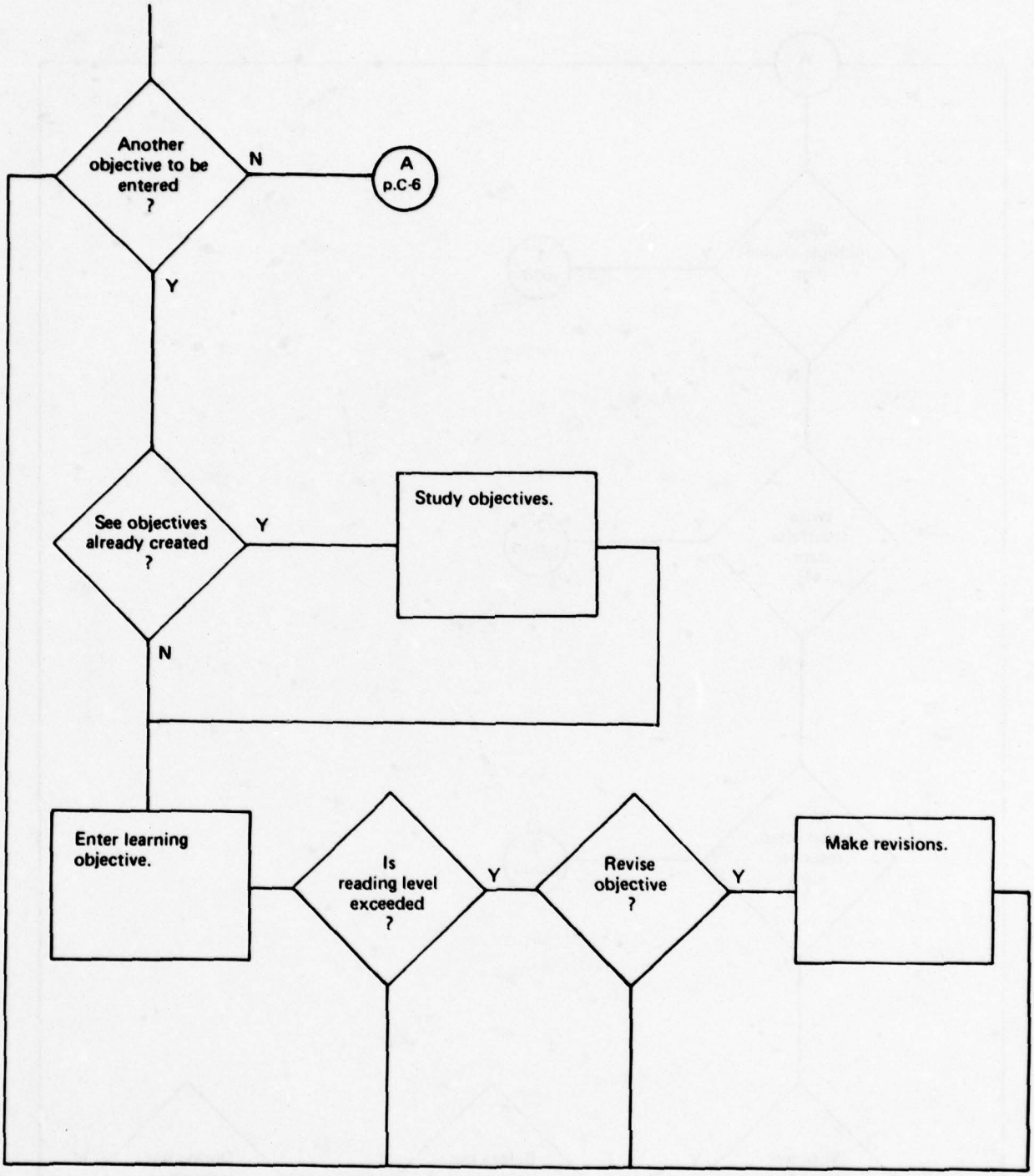
II.2.2.1.1.b

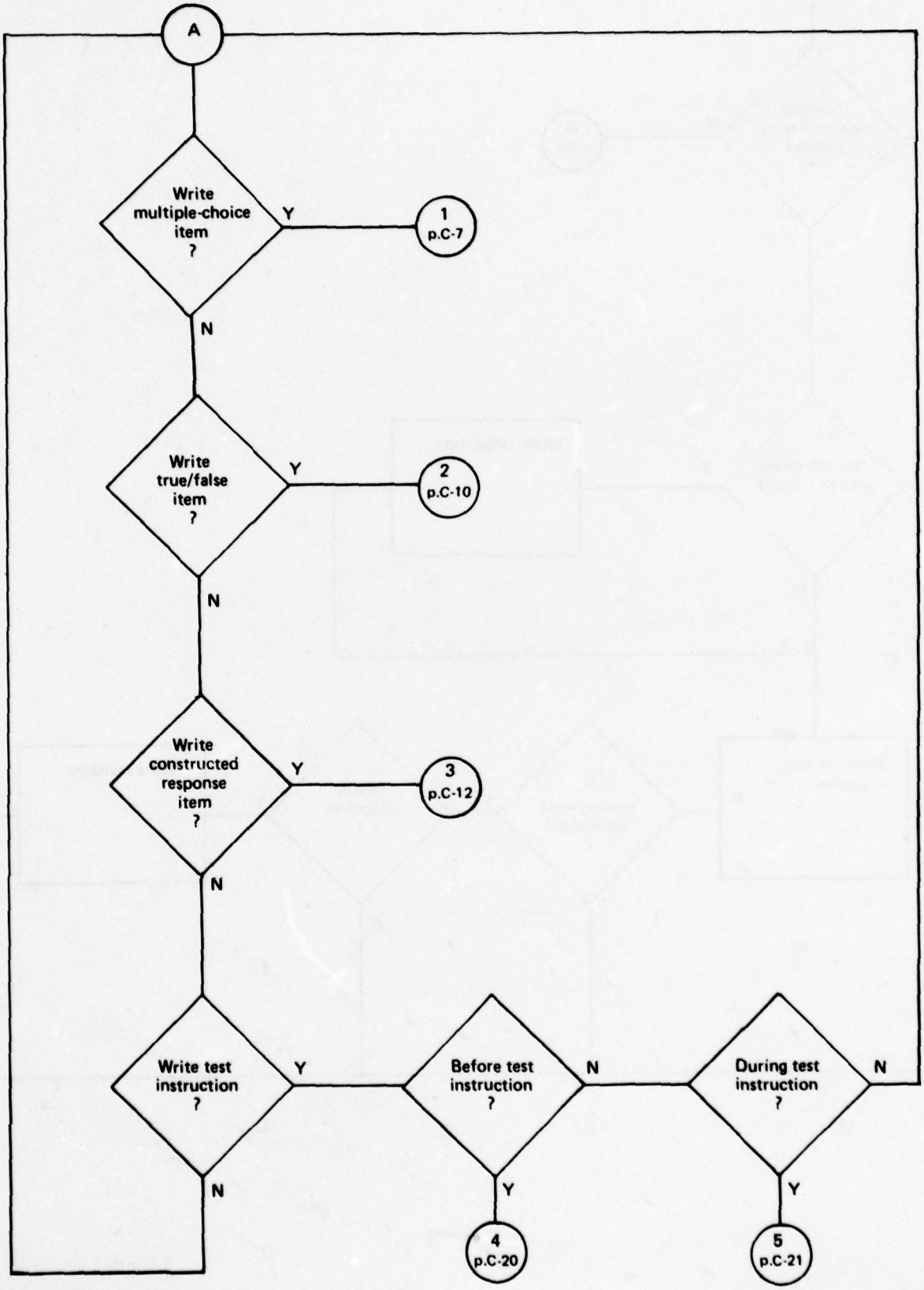
PREPARING CAI TEST MATERIALS

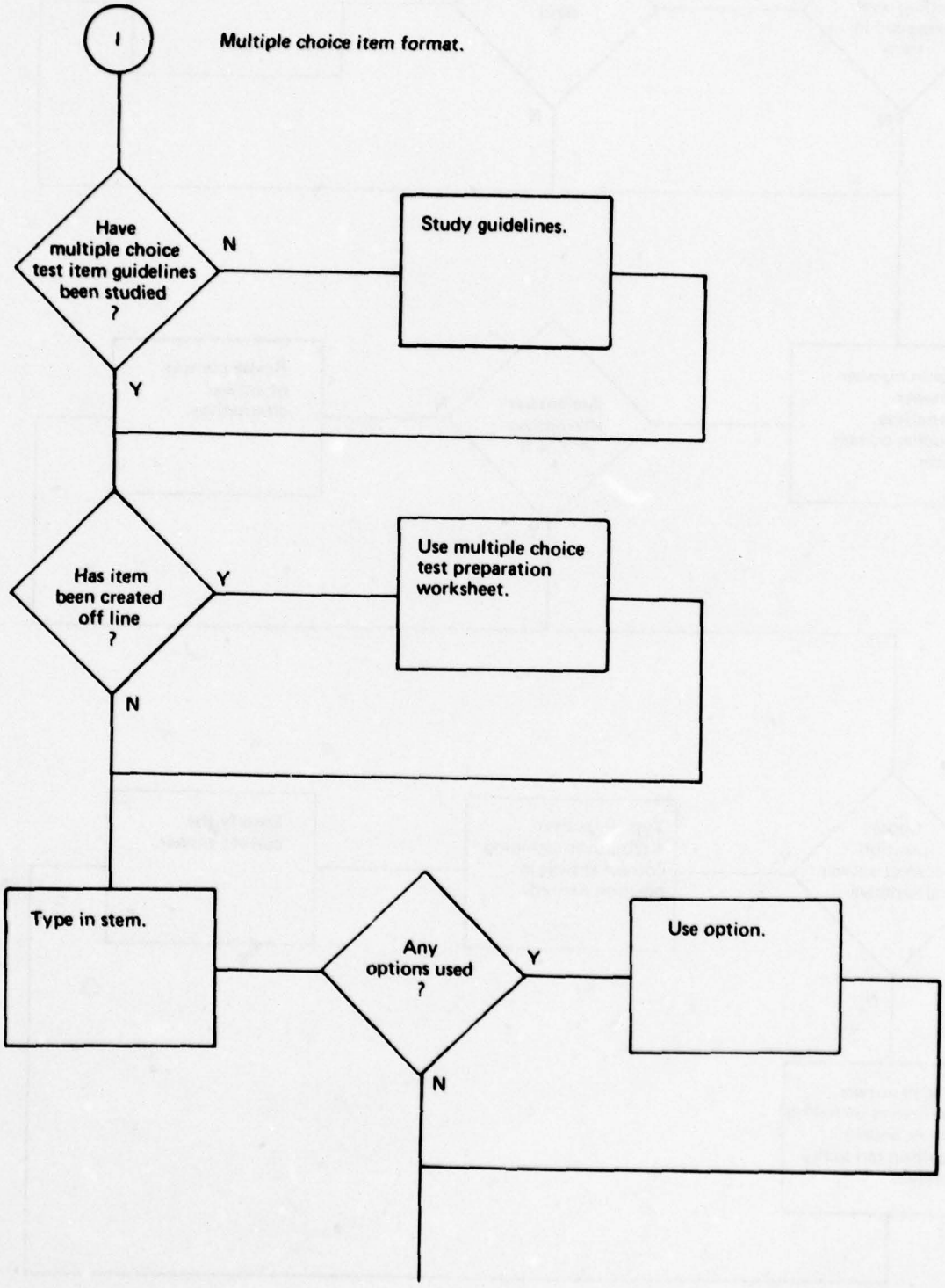


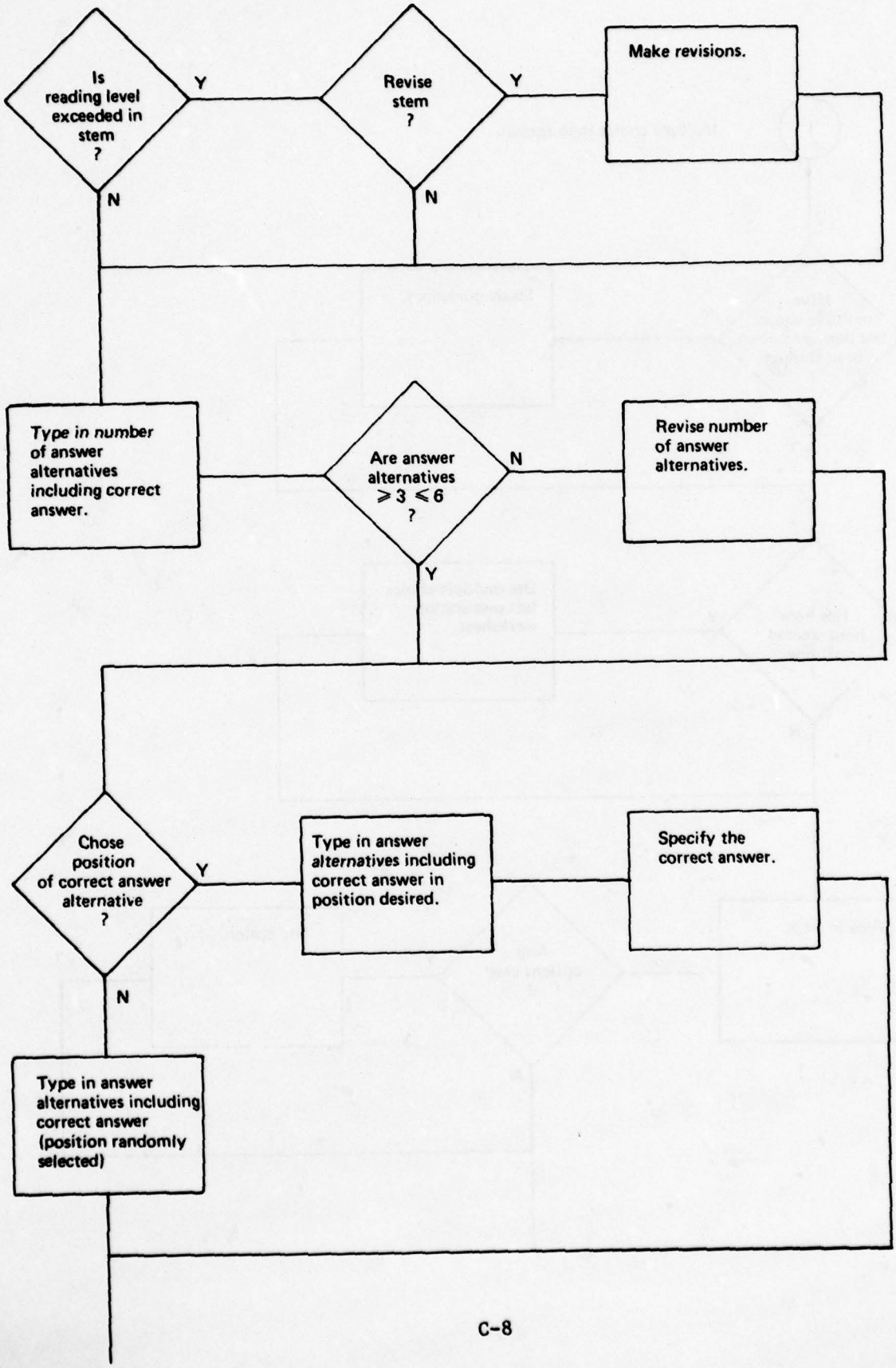

Have 8000 and 4000 word commons been created ?
N
See site director for creation instructions
Y
Type in dataset name and lesson name
Type in 4 letter code of test
Time limit on total test ?
N
Time limit per individual item ?
N
Y
Y
Type in time limit

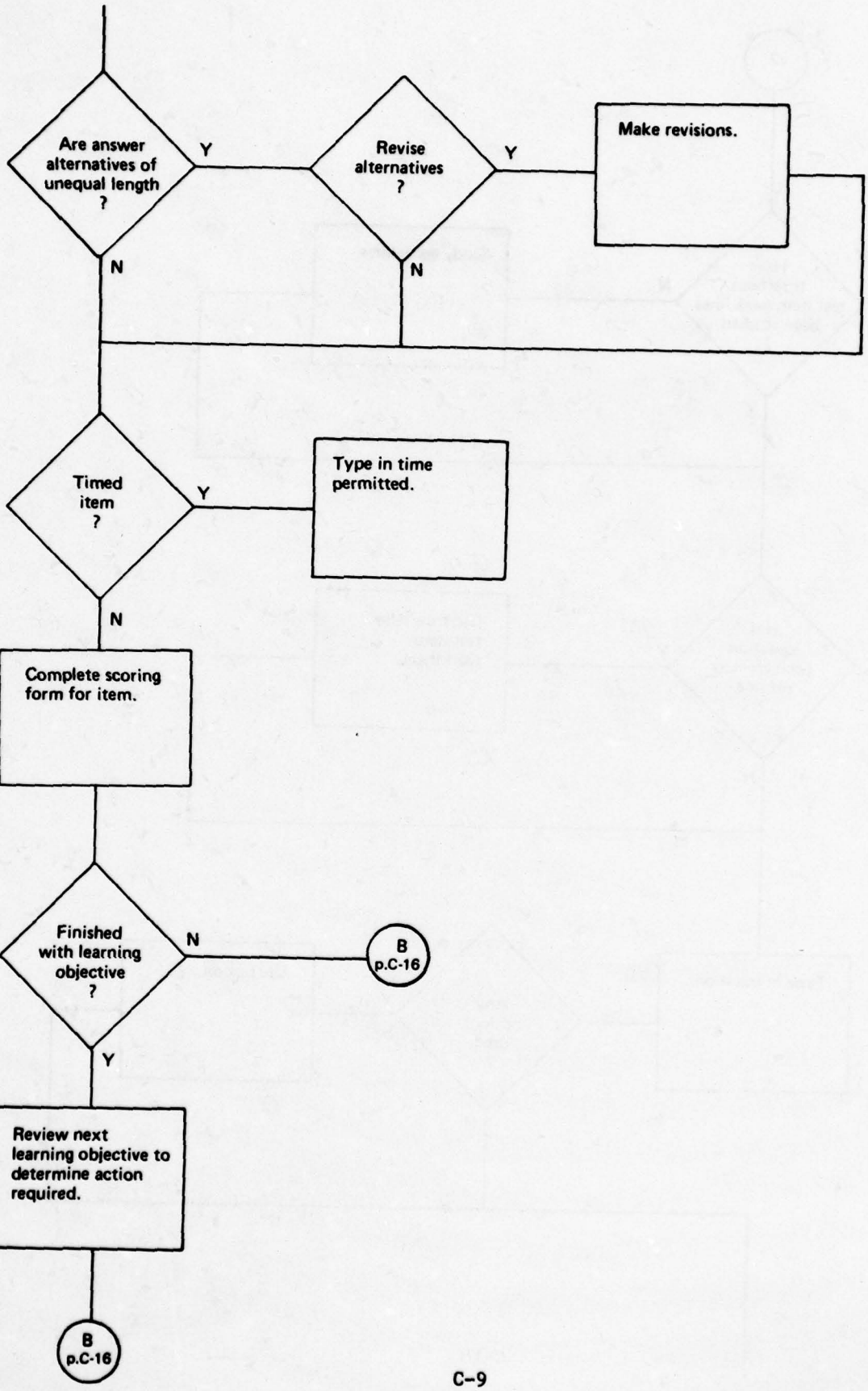

Type in whether or not student is given the option of branching to the quiz
Study general test guidelines
Study learning objective guidelines
Has *objective* been created off line ?
Y
N
Use *learning* objective preparation worksheet
Enter learning objective No. 1
Is reading level exceeded ?
Y
N
Revise objective ?
Y
N
Make revisions

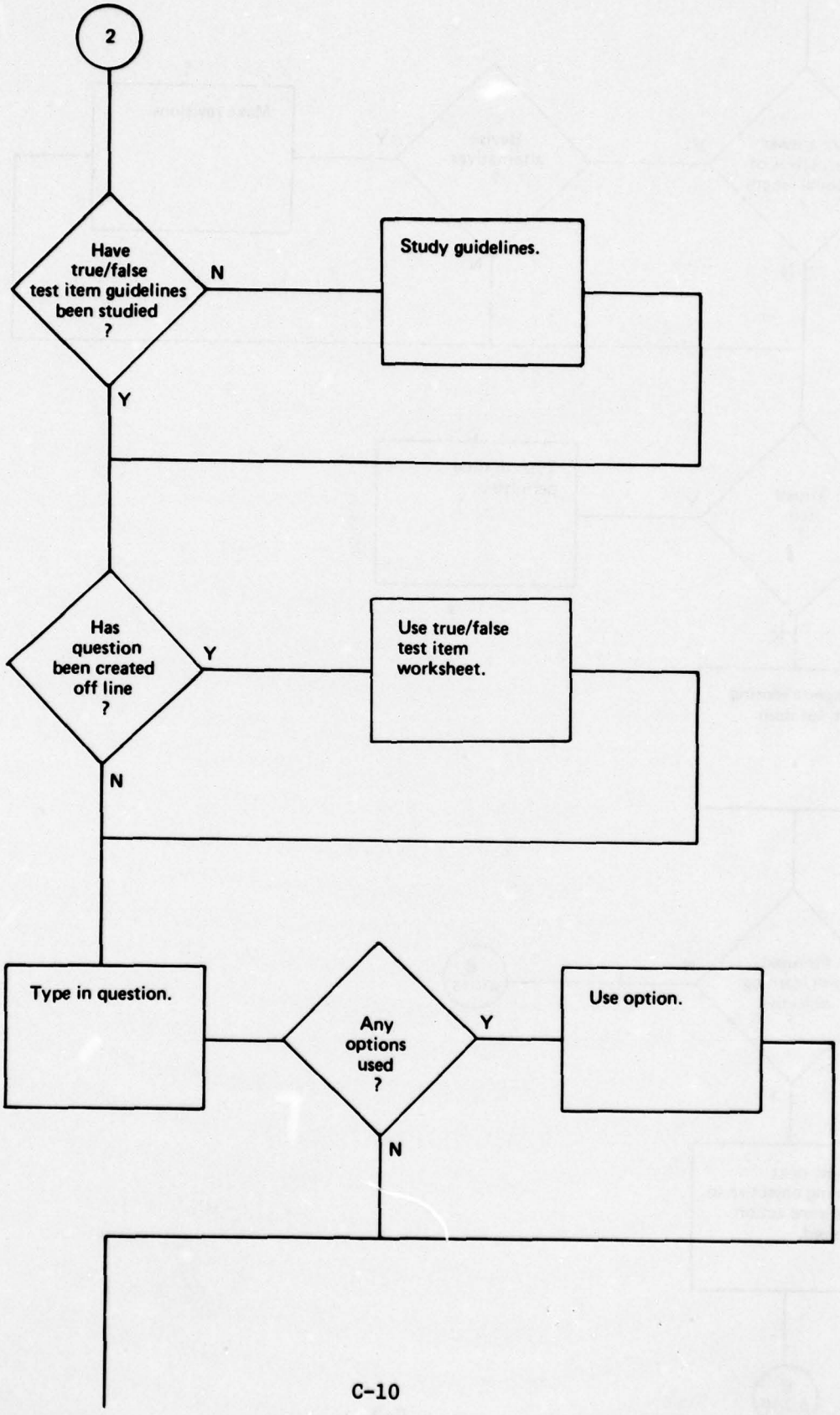

Another objective to be entered ?
N
A p.C-6
Y
See objectives already created ?
Y
Study objectives.
N
Enter learning objective.
Is reading level exceeded ?
Y
Revise objective ?
Y
Make revisions.

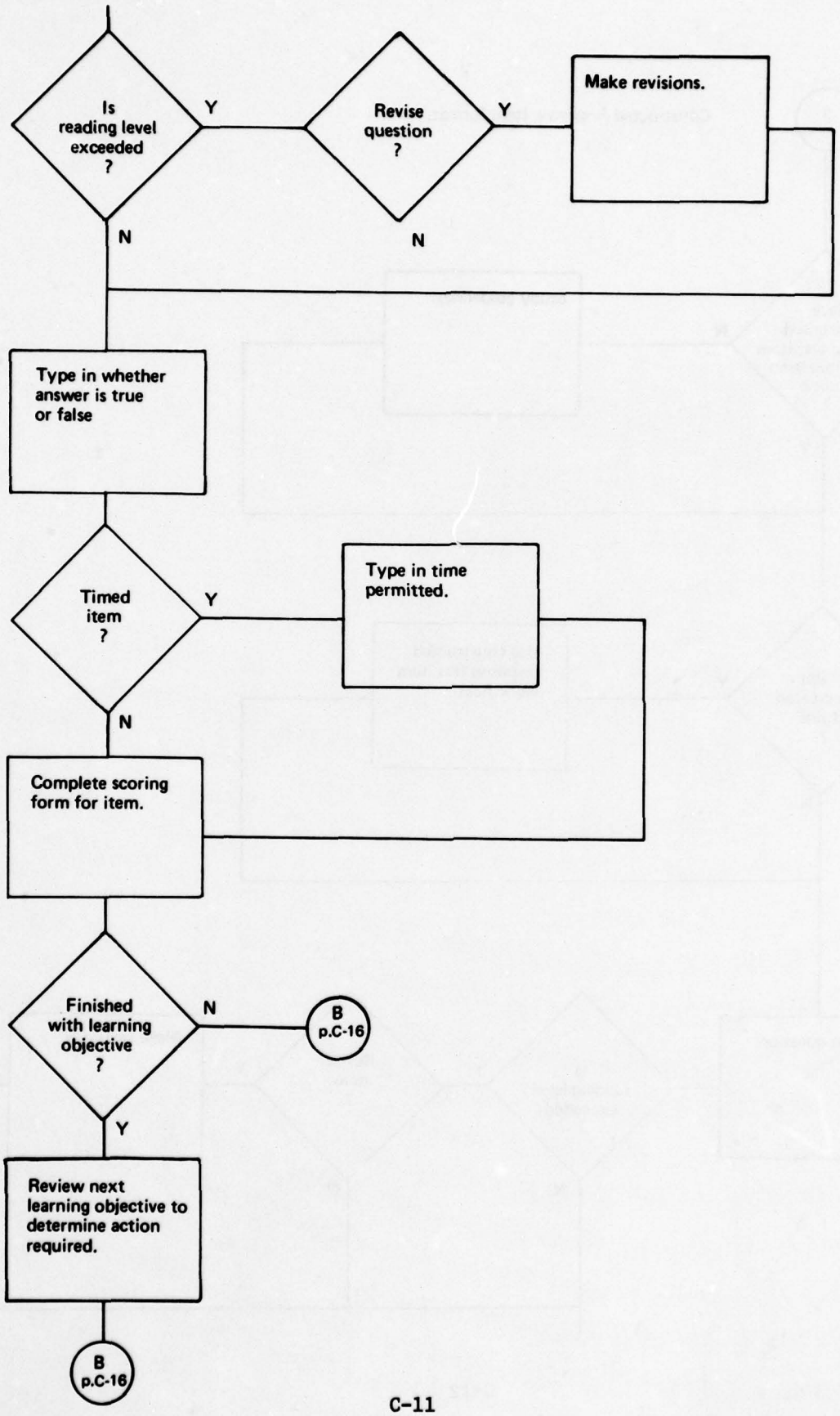

A
Write multiple-choice item ?
Y
1 p.C-7
N
Write true/false item ?
Y
2 p.C-10
N
Write constructed response item ?
Y
3 p.C-12
N
Write test instruction ?
Y
Before test instruction ?
N
During test instruction ?
N
N
Y
4 p.C-20
Y
5 p.C-21

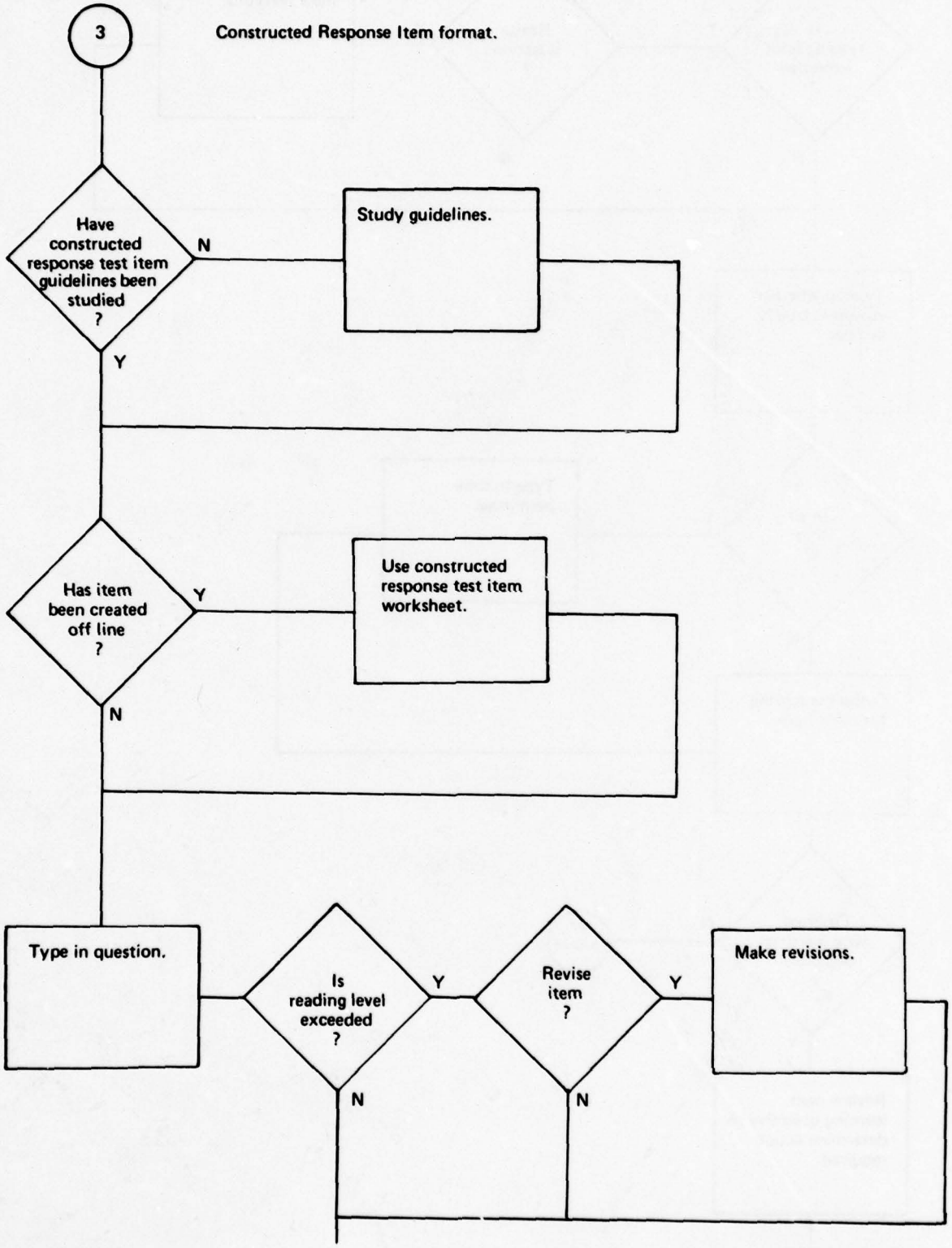

1
Multiple choice item format.
Have multiple choice test item guidelines been studied ?
N
Study guidelines.
Y
Has item been created off line ?
Y
Use multiple choice test preparation worksheet.
N
Type in stem.
Any options used ?
Y
Use option.
N

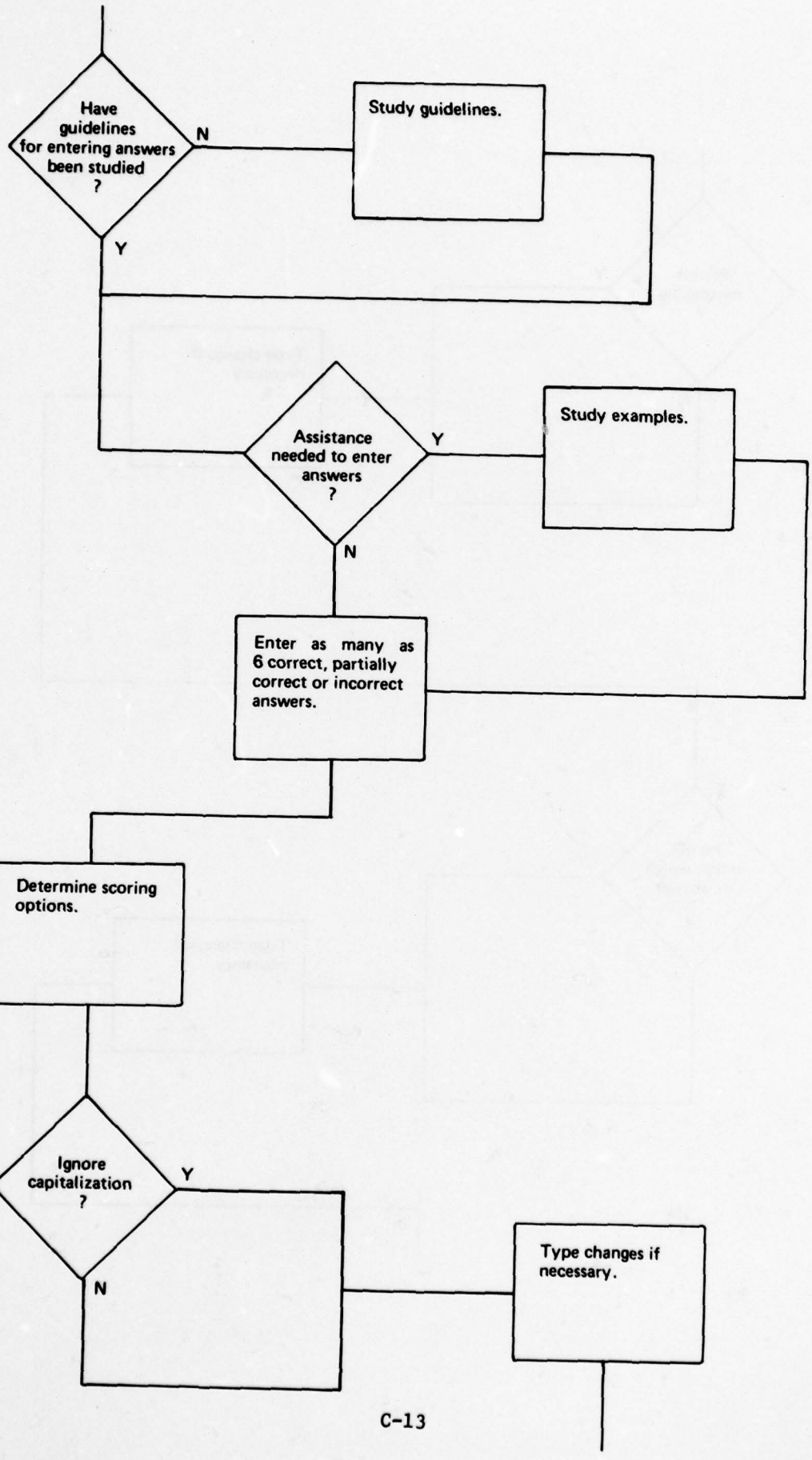

Is reading level exceeded in stem ?
Y
N
Revise stem ?
Y
N
Make revisions.
Type in number of answer alternatives including correct answer.
Are answer alternatives ⩾3 ⩽6 ?
N
Y
Revise number of answer alternatives.
Chose position of correct answer alternative ?
Y
N
Type in answer alternatives including correct answer in position desired.
Specify the correct answer.
Type in answer alternatives including correct answer (position randomly selected)

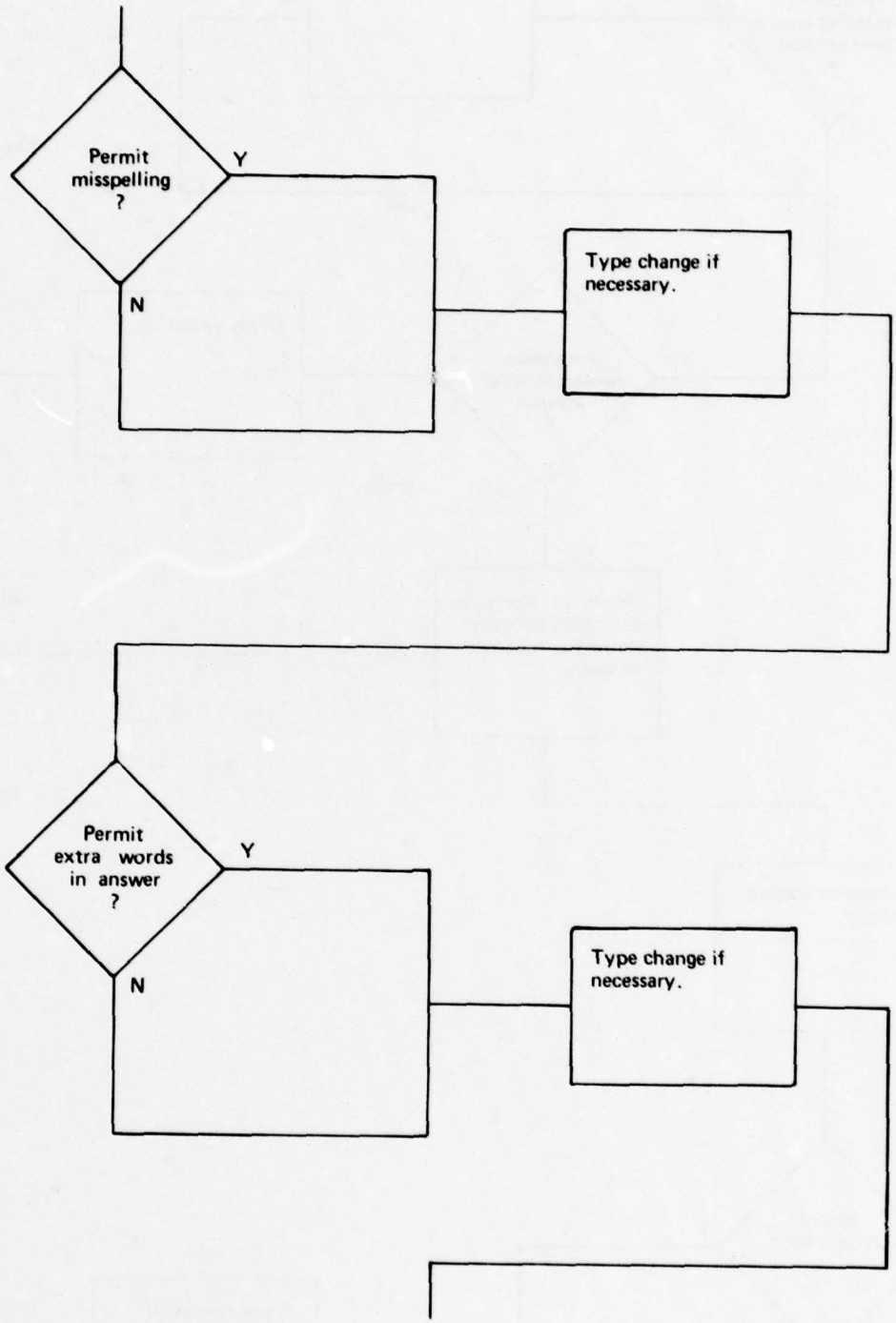

Are answer alternatives of unequal length ?
Y
Revise alternatives ?
Y
Make revisions.
N
N
Timed item ?
Y
Type in time permitted.
N
Complete scoring form for item.
Finished with learning objective ?
N
B p.C-16
Y
Review next learning objective to determine action required.
B p.C-16

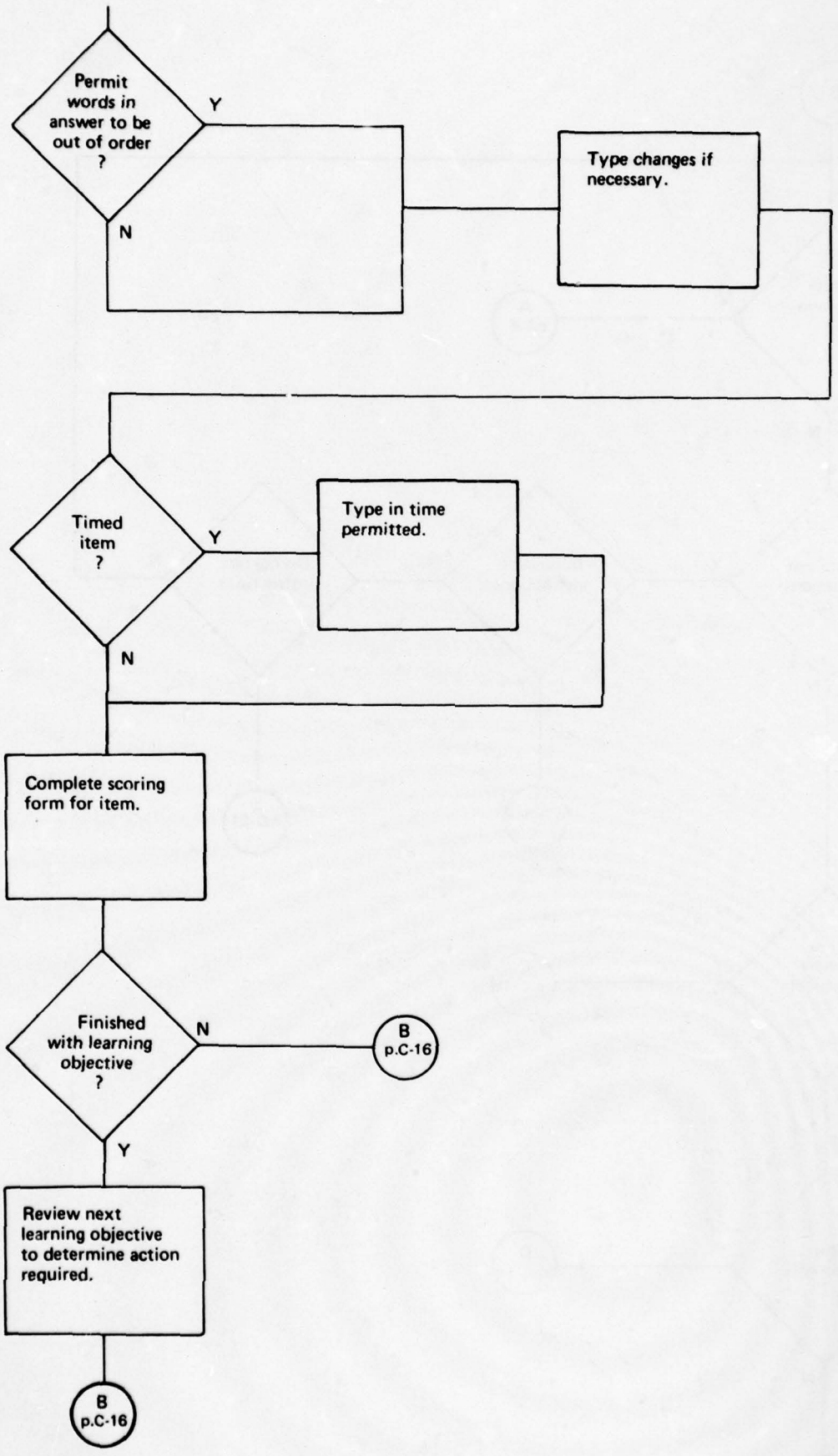

2
Have true/false test item guidelines been studied ?
N
Study guidelines.
Y
Has question been created off line ?
Y
Use true/false test item worksheet.
N
Type in question.
Any options used ?
Y
Use option.
N

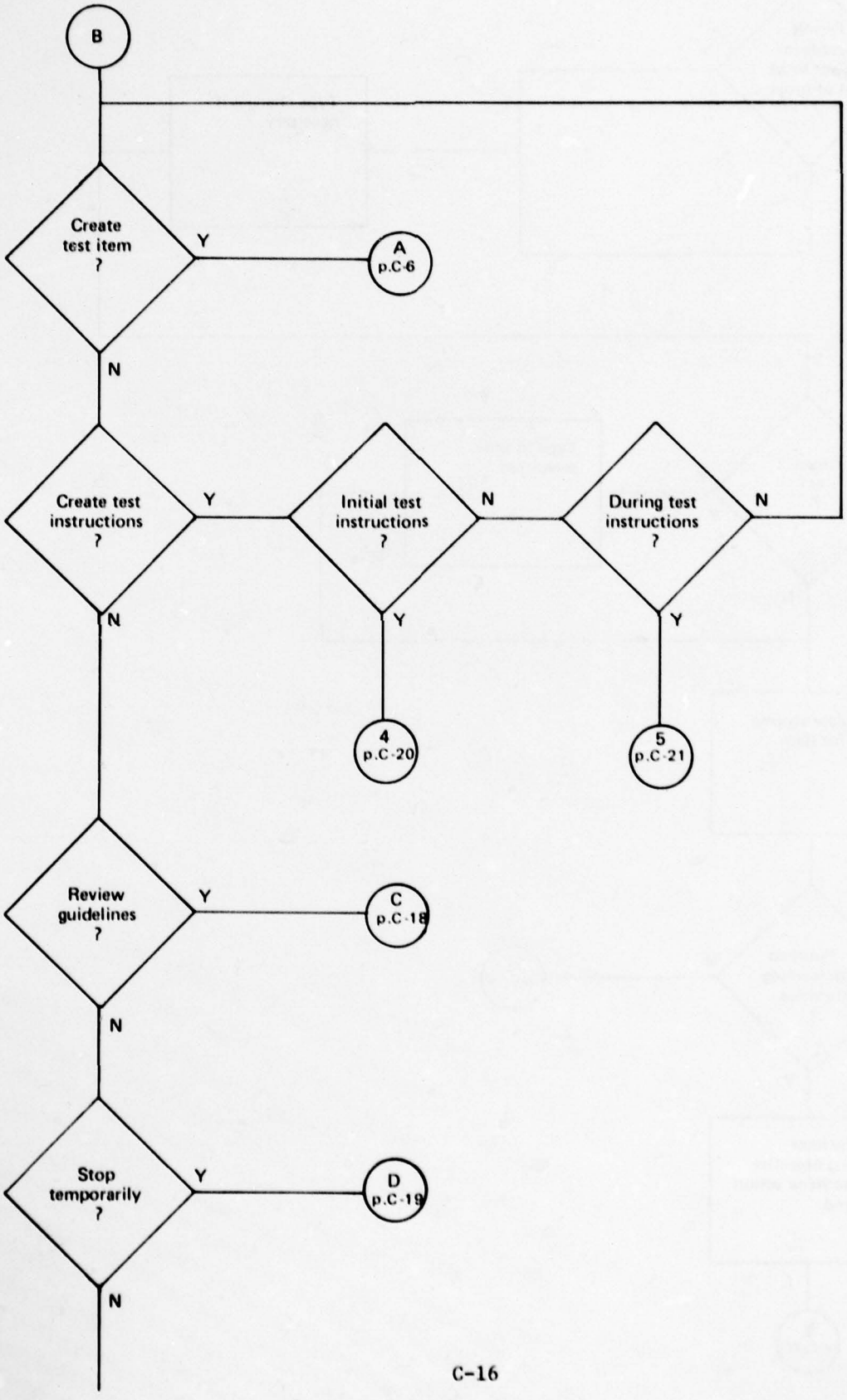

Is reading level exceeded ?
Y
Revise question ?
Y
Make revisions.
N
N
Type in whether answer is true or false
Timed item ?
Y
Type in time permitted.
N
Complete scoring form for item.
Finished with learning objective ?
N
B p.C-16
Y
Review next learning objective to determine action required.
B p.C-16

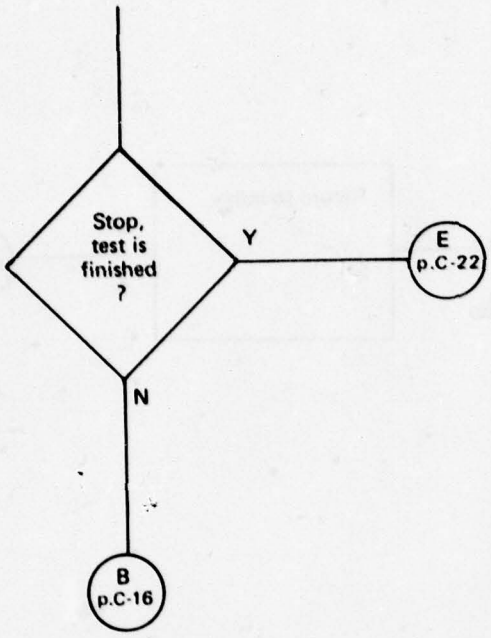

3
Constructed Response Item format.
Have constructed response test item guidelines been studied ?
N
Study guidelines.
Y
Has item been created off line ?
Y
Use constructed response test item worksheet.
N
Type in question.
Is reading level exceeded ?
Y
Revise item ?
Y
Make revisions.
N
N

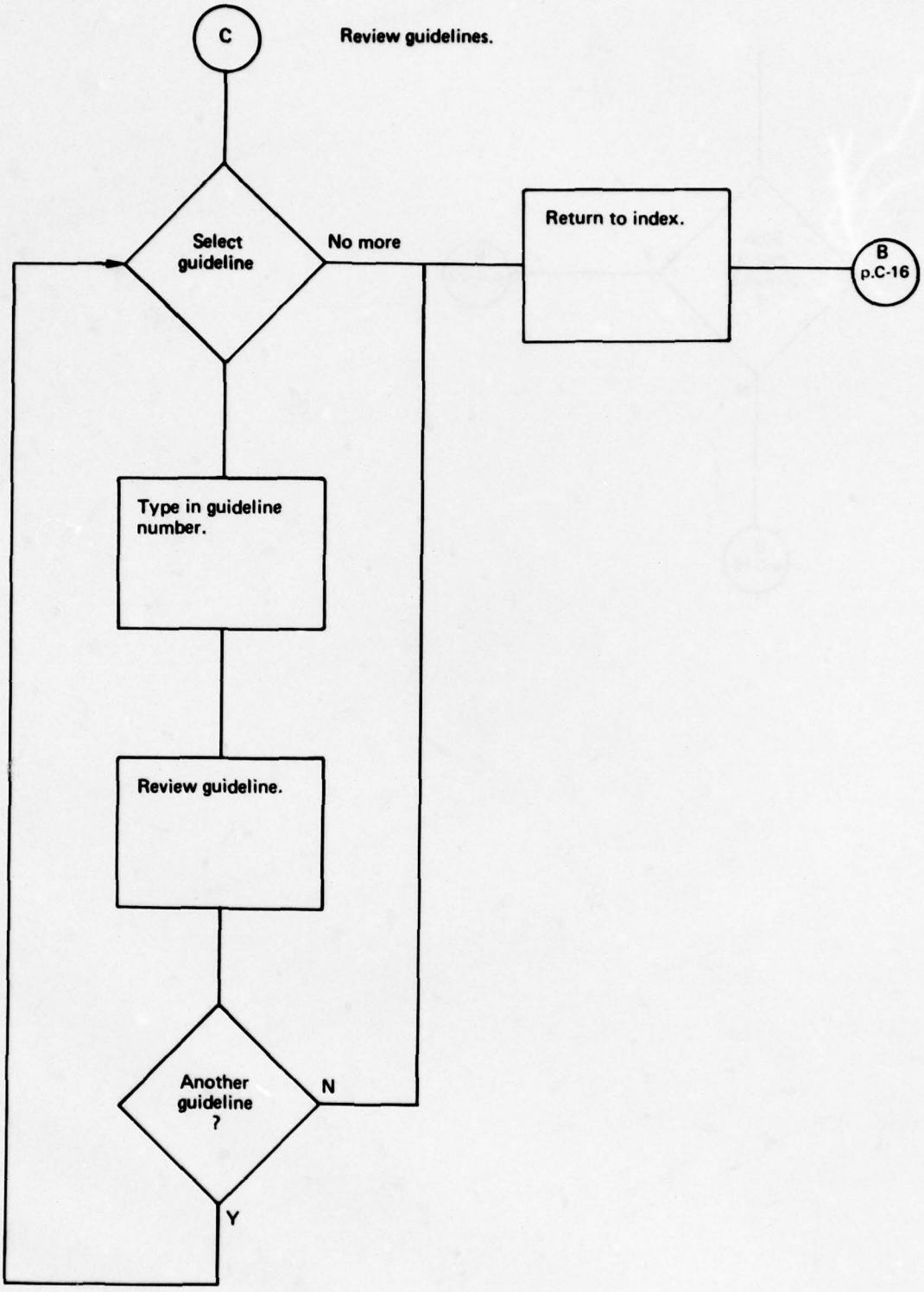

Have guidelines for entering answers been studied ?
N
Study guidelines.
Y
Assistance needed to enter answers ?
Y
Study examples.
N
Enter as many as 6 correct, partially correct or incorrect answers.
Determine scoring options.
Ignore capitalization ?
Y
N
Type changes if necessary.

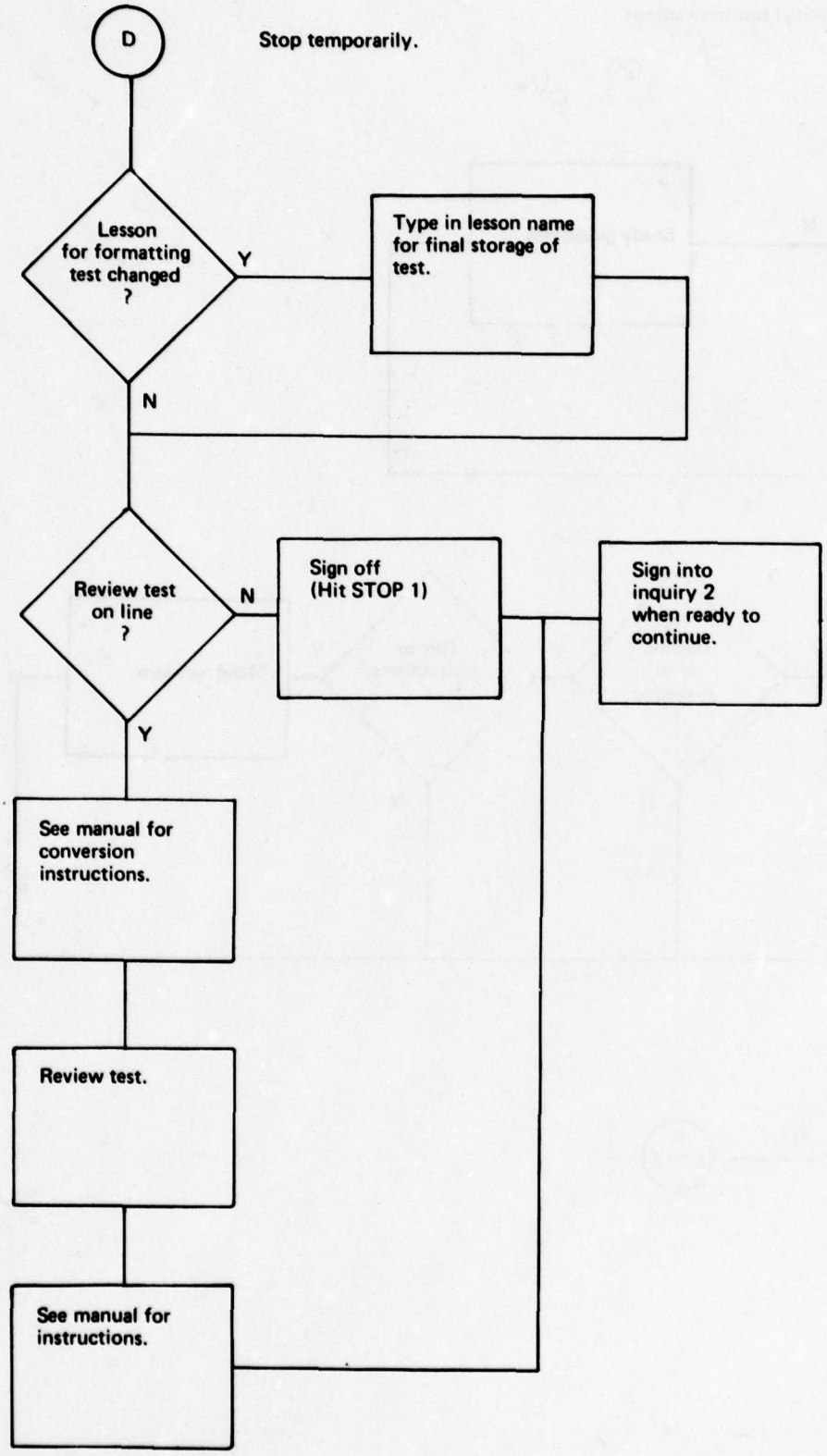

Permit misspelling ?
Y
N
Type change if necessary.
Permit extra words in answer ?
Y
N
Type change if necessary.

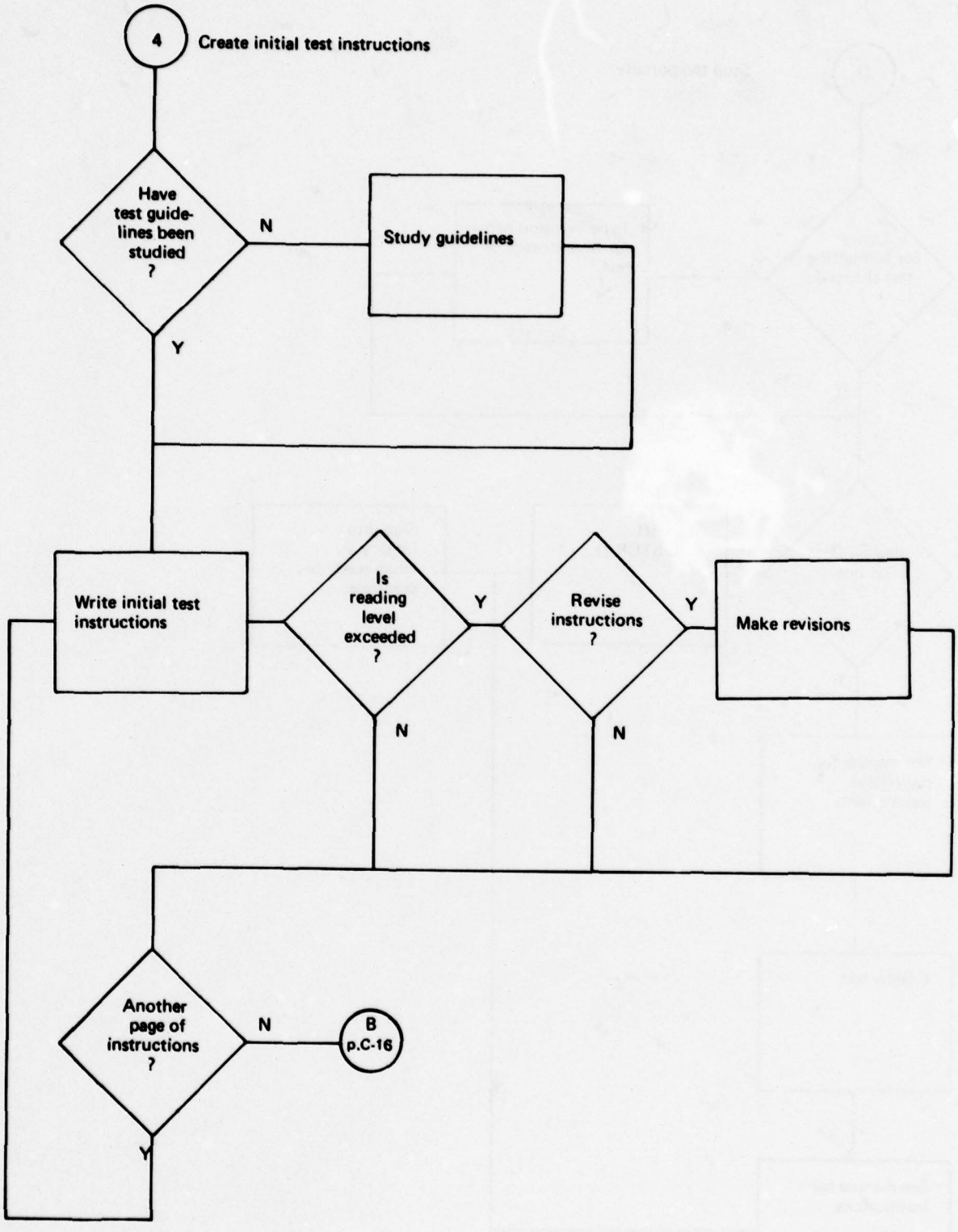

Permit words in answer to be out of order ?
Y
N
Type changes if necessary.
Timed item ?
Y
N
Type in time permitted.
Complete scoring form for item.
Finished with learning objective ?
N
B p.C-16
Y
Review next learning objective to determine action required.
B p.C-16

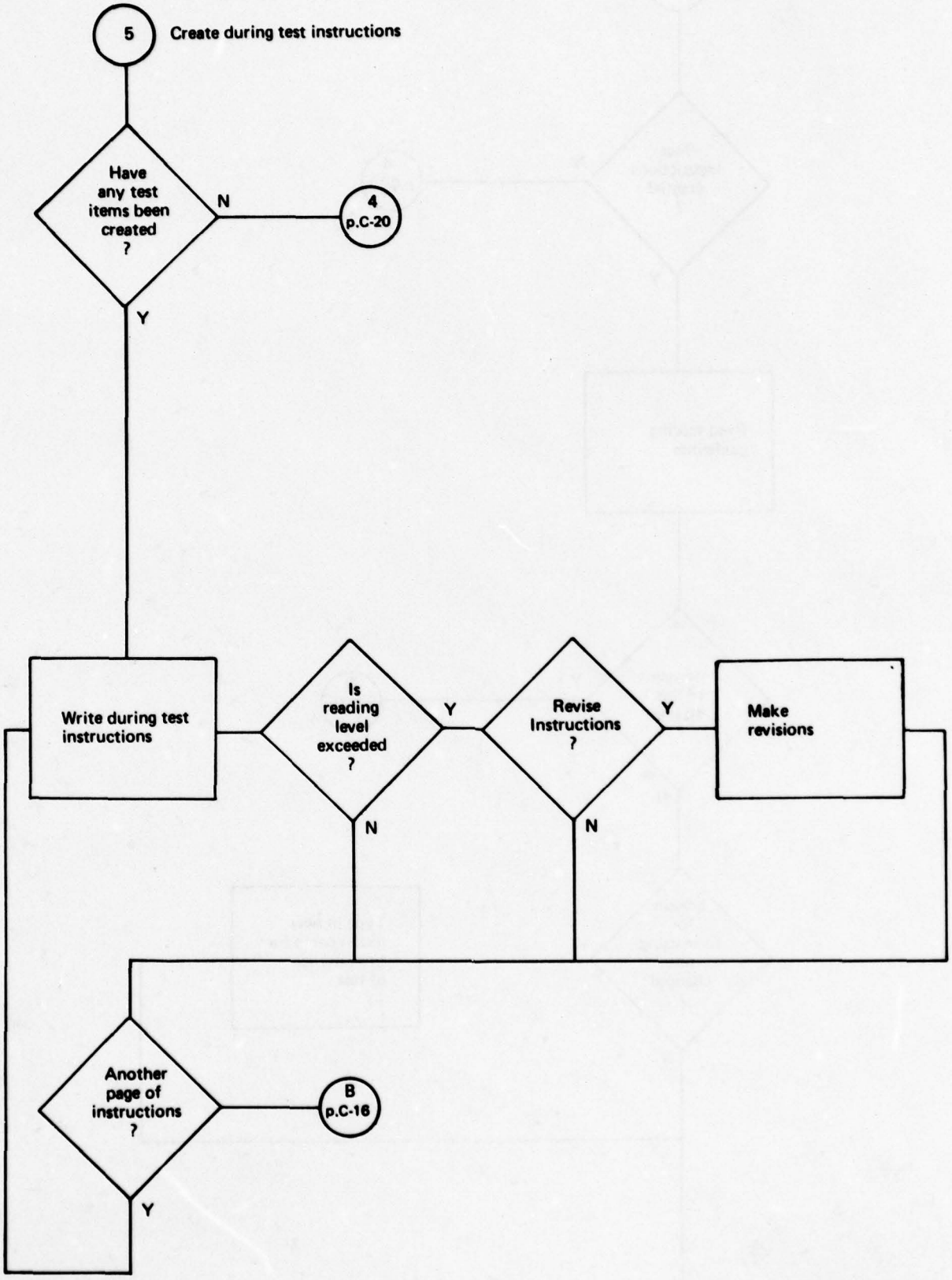

B
Create test item ?
Y
A p.C-6
N
Create test instructions ?
Y
Initial test instructions ?
N
During test instructions ?
N
N
Y
Y
4 p.C-20
5 p.C-21
Review guidelines ?
Y
C p.C-18
N
Stop temporarily ?
Y
D p.C-19
N

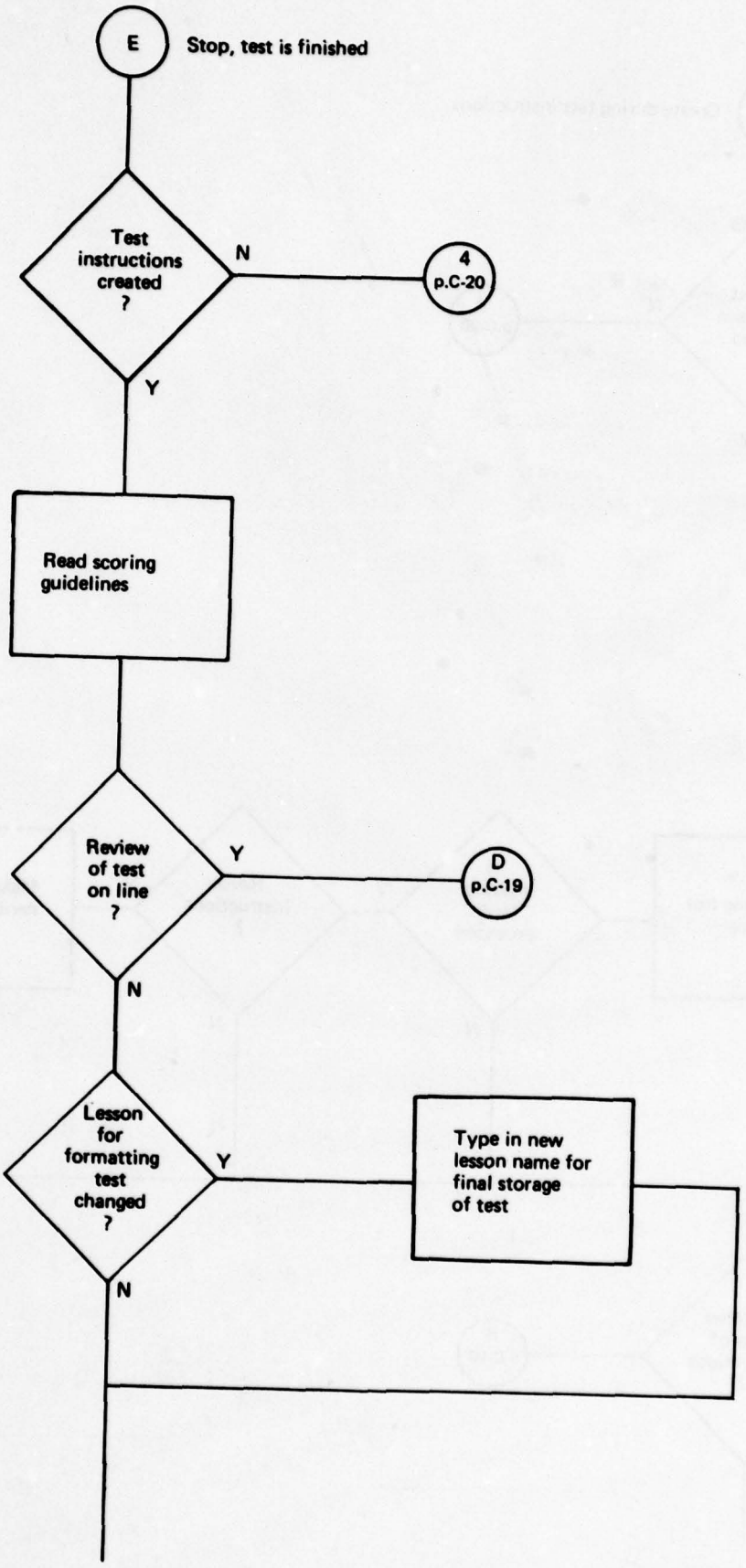

Stop, test is finished ?
Y
E
p.C-22
N
B
p.C-16

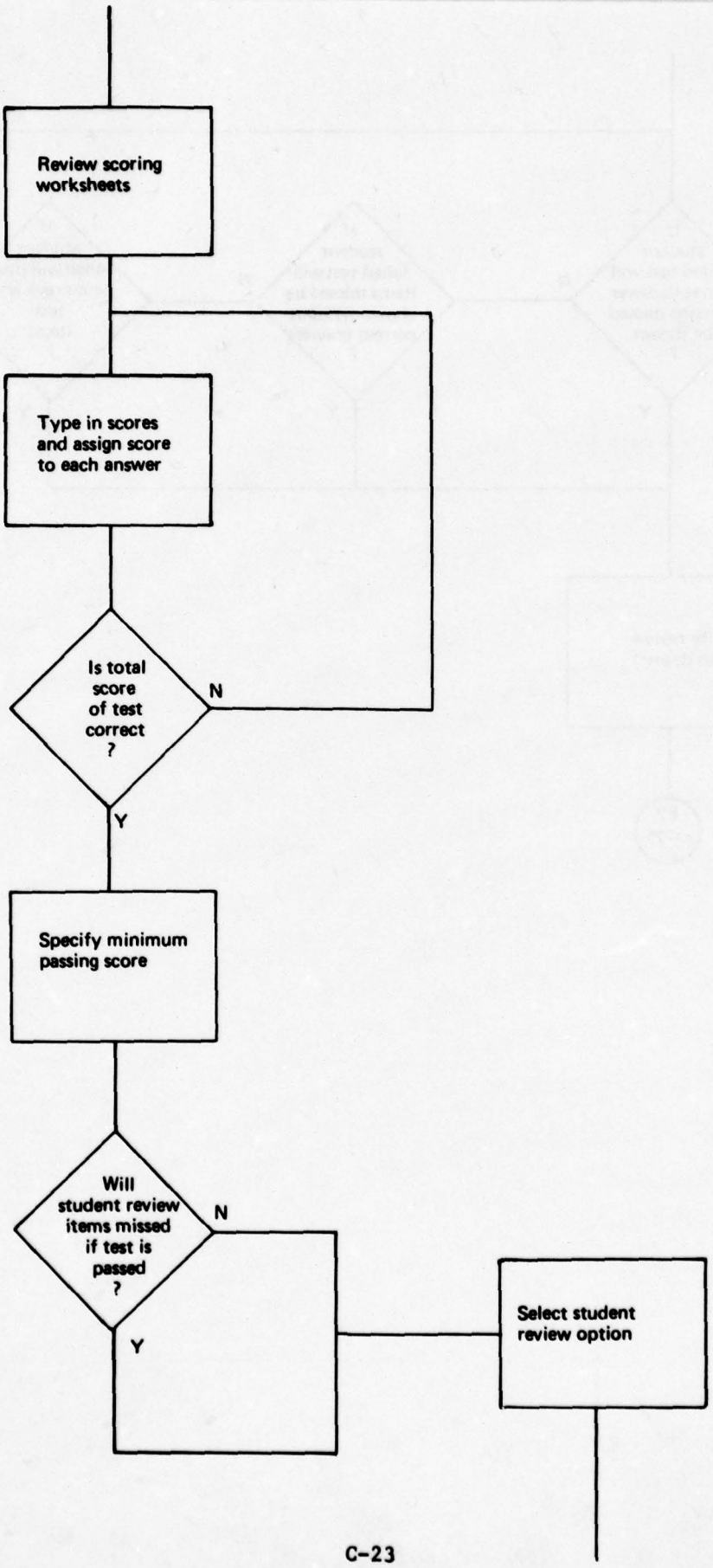

C
Review guidelines.
Select guideline
No more
Return to index.
B
p.C-16
Type in guideline number.
Review guideline.
Another guideline ?
N
Y

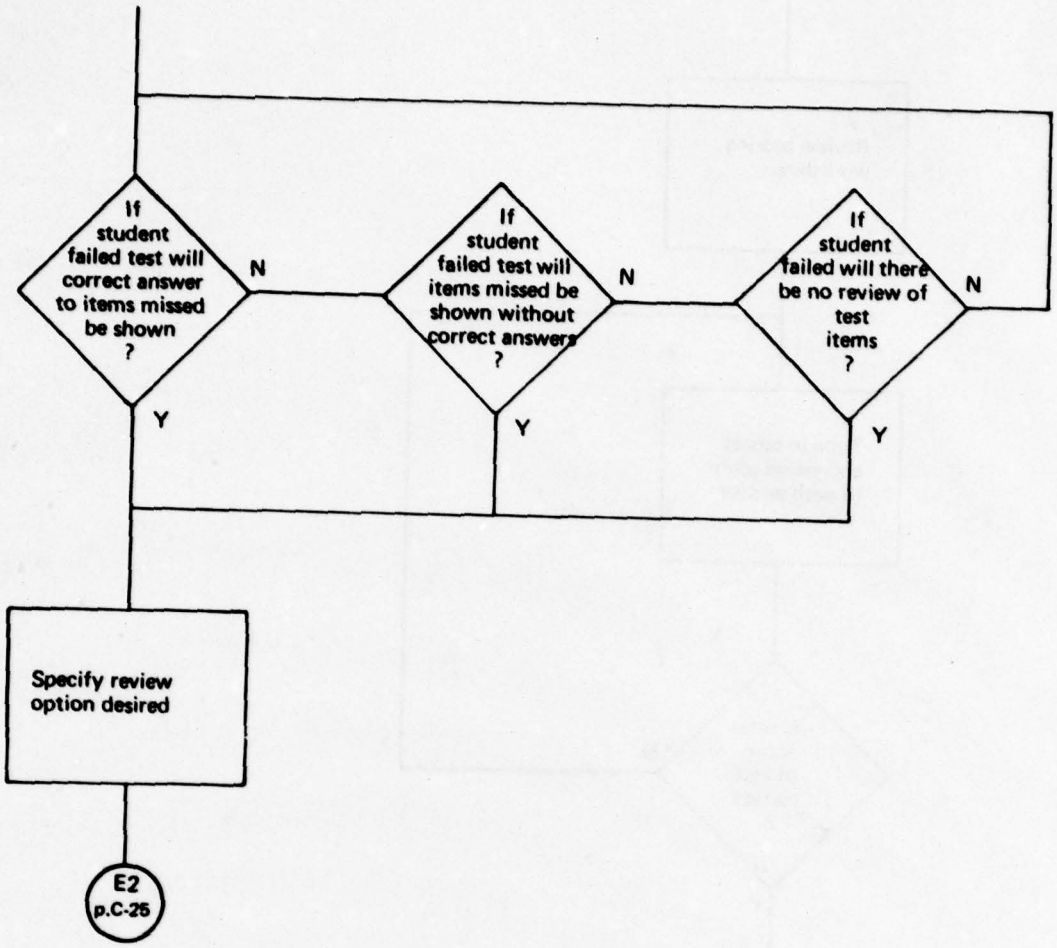

D
Stop temporarily.
Lesson for formatting test changed ?
Y
Type in lesson name for final storage of test.
N
Review test on line ?
N
Sign off (Hit STOP 1)
Sign into inquiry 2 when ready to continue.
Y
See manual for conversion instructions.
Review test.
See manual for instructions.

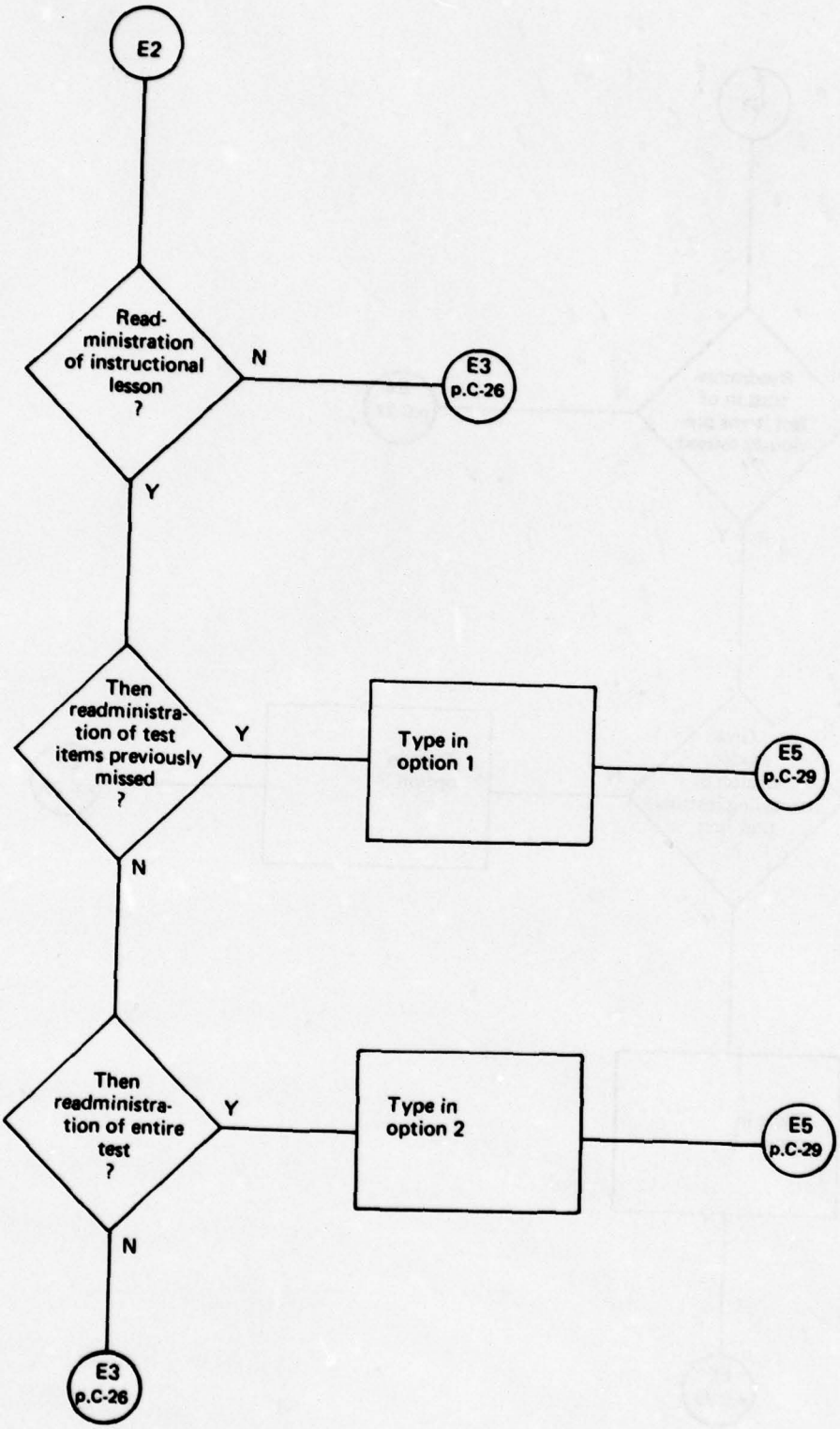

4
Create initial test instructions
Have test guide-lines been studied ?
N
Study guidelines
Y
Write initial test instructions
Is reading level exceeded ?
Y
Revise instructions ?
Y
Make revisions
N
N
Another page of instructions ?
N
B
p.C-16
Y

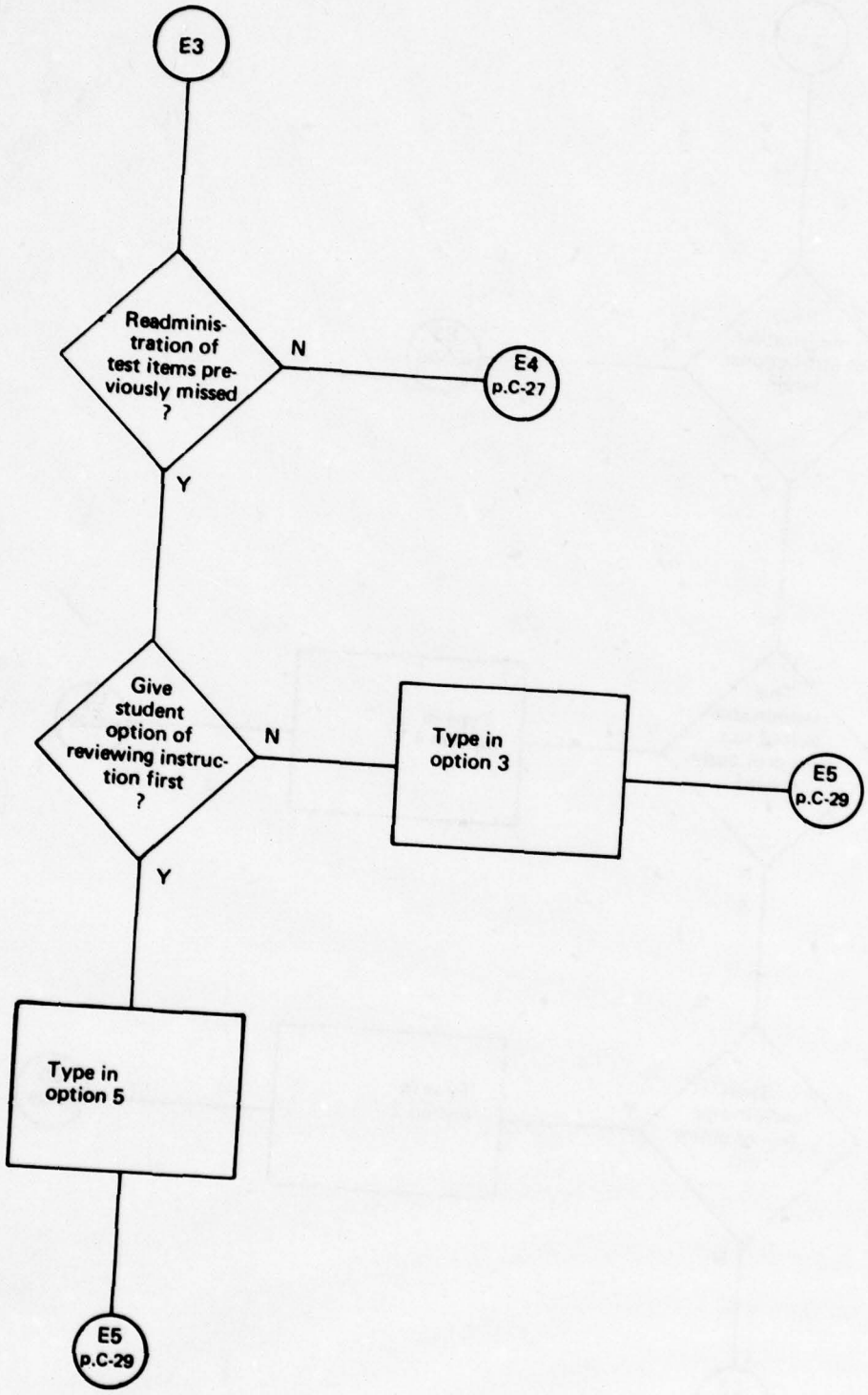

5
Create during test instructions
Have any test items been created ?
N
4
p.C-20
Y
Write during test instructions
Is reading level exceeded ?
Y
N
Revise Instructions ?
Y
N
Make revisions
Another page of instructions ?
B
p.C-16
Y

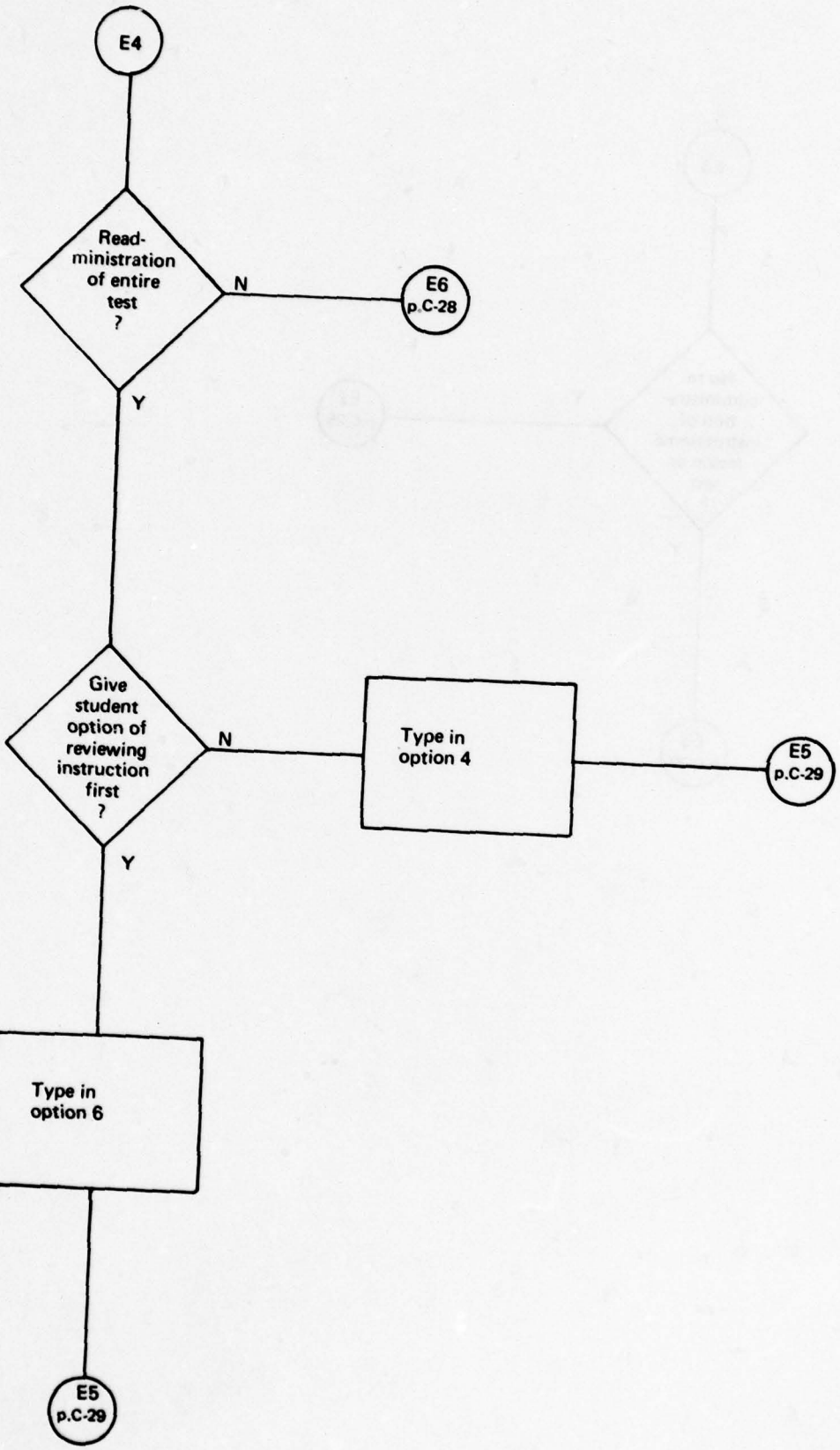

E
Stop, test is finished
Test instructions created ?
N
4 p.C-20
Y
Read scoring guidelines
Review of test on line ?
Y
D p.C-19
N
Lesson for formatting test changed ?
Y
Type in new lesson name for final storage of test
N

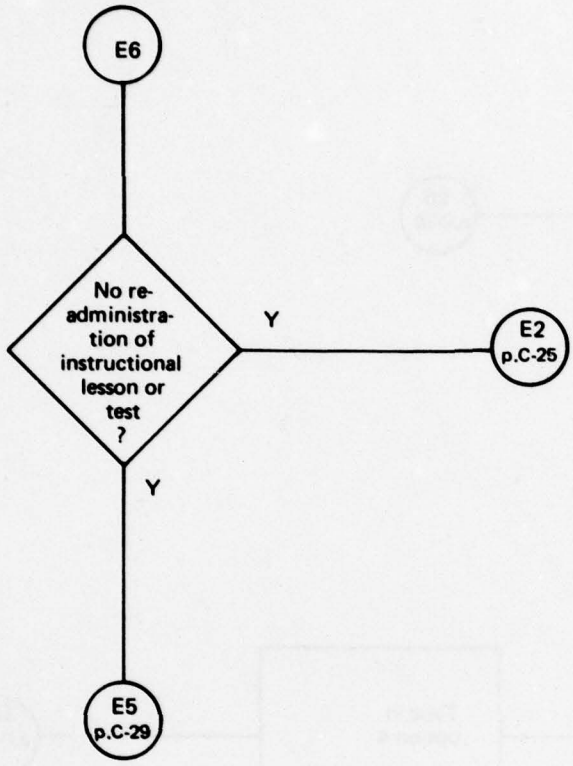

Review scoring worksheets
Type in scores and assign score to each answer
Is total score of test correct ?
N
Y
Specify minimum passing score
Will student review items missed if test is passed ?
N
Y
Select student review option

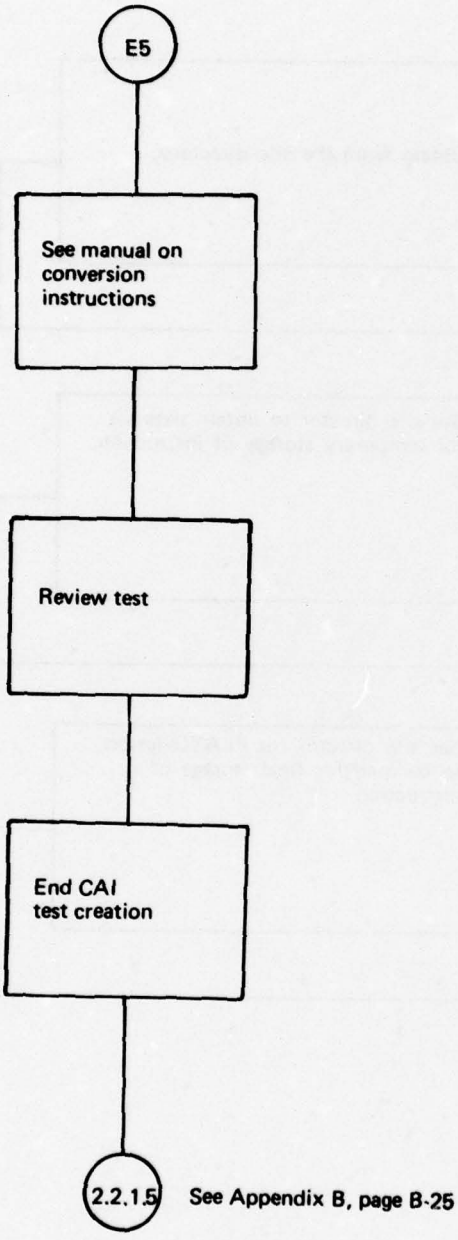

If student failed test will correct answer to items missed be shown ?
N
Y
If student failed test will items missed be shown without correct answers ?
N
Y
If student failed will there be no review of test items ?
N
Y
Specify review option desired
E2
p.C-25


E2
Read-ministration of instructional lesson ?
N
E3 p.C-26
Y
Then readministra-tion of test items previously missed ?
Y
Type in option 1
E5 p.C-29
N
Then readministra-tion of entire test ?
Y
Type in option 2
E5 p.C-29
N
E3 p.C-26


E3
Readministration of test items previously missed ?
N
E4
p.C-27
Y
Give student option of reviewing instruction first ?
N
Type in option 3
E5
p.C-29
Y
Type in option 5
E5
p.C-29


E4
Read-ministration of entire test ?
N
E6 p.C-28
Y
Give student option of reviewing instruction first ?
N
Type in option 4
E5 p.C-29
Y
Type in option 6
E5 p.C-29

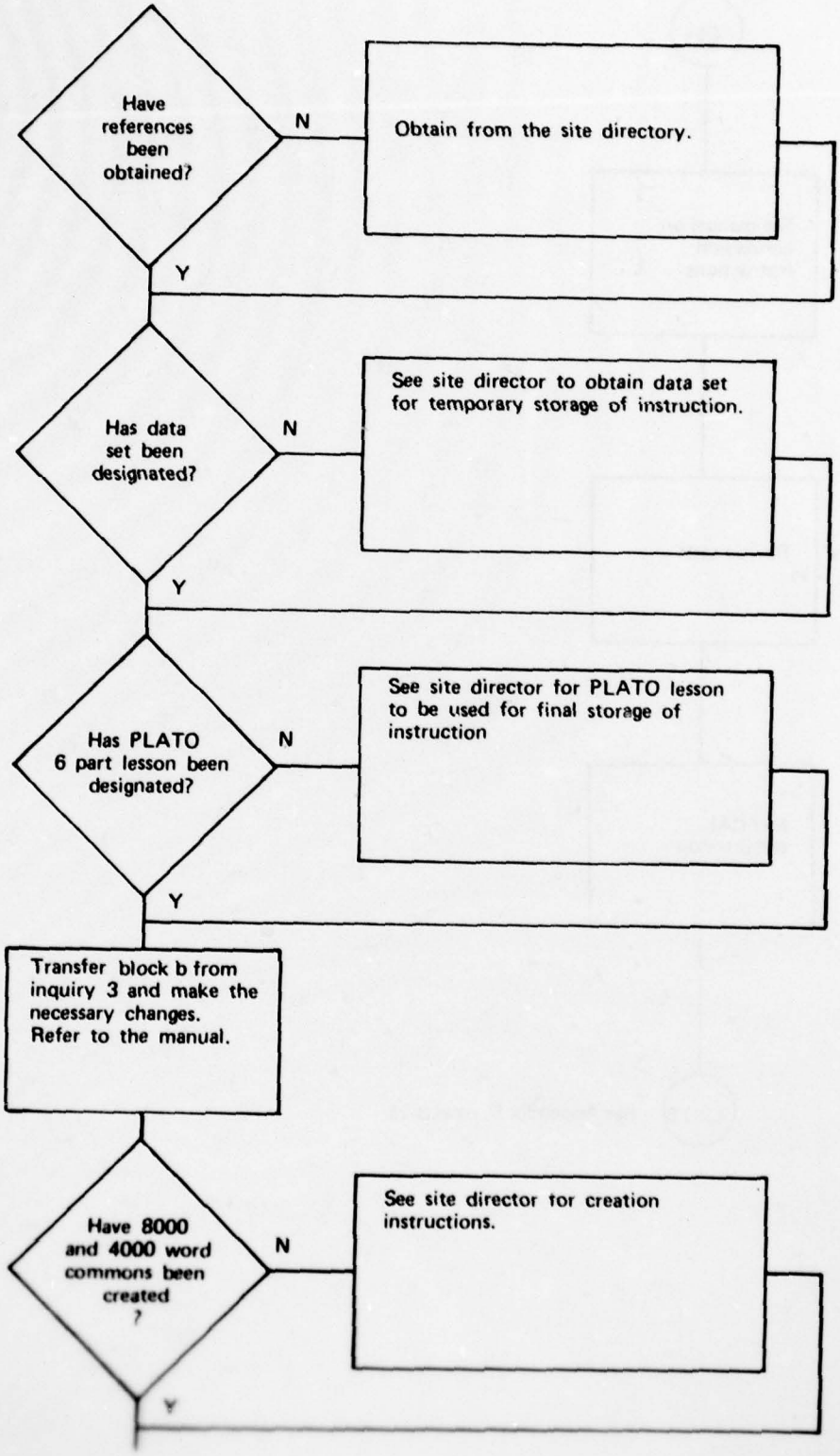

E6
No re-administration of instructional lesson or test ?
Y
E2
p.C-25
Y
E5
p.C-29

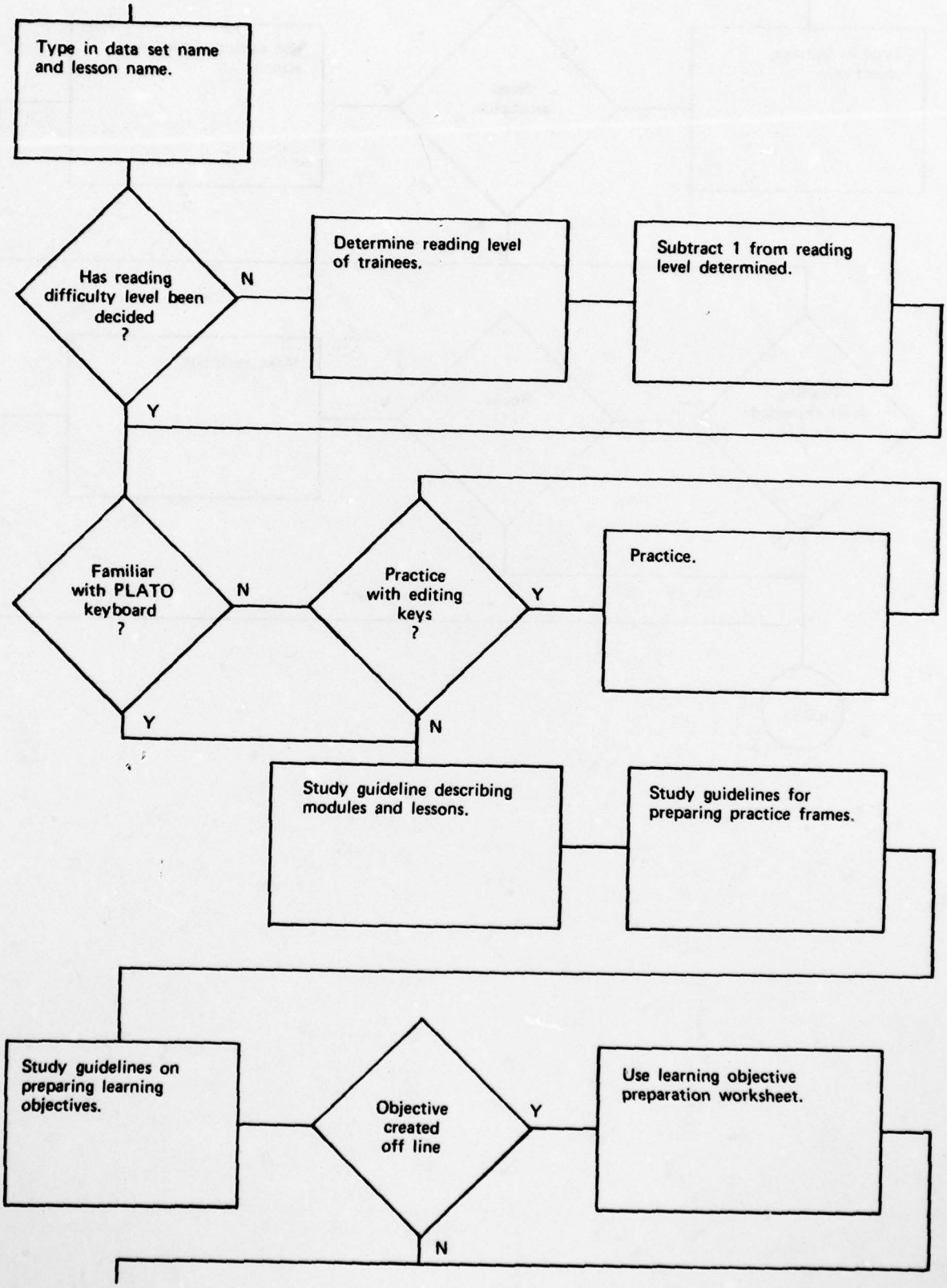


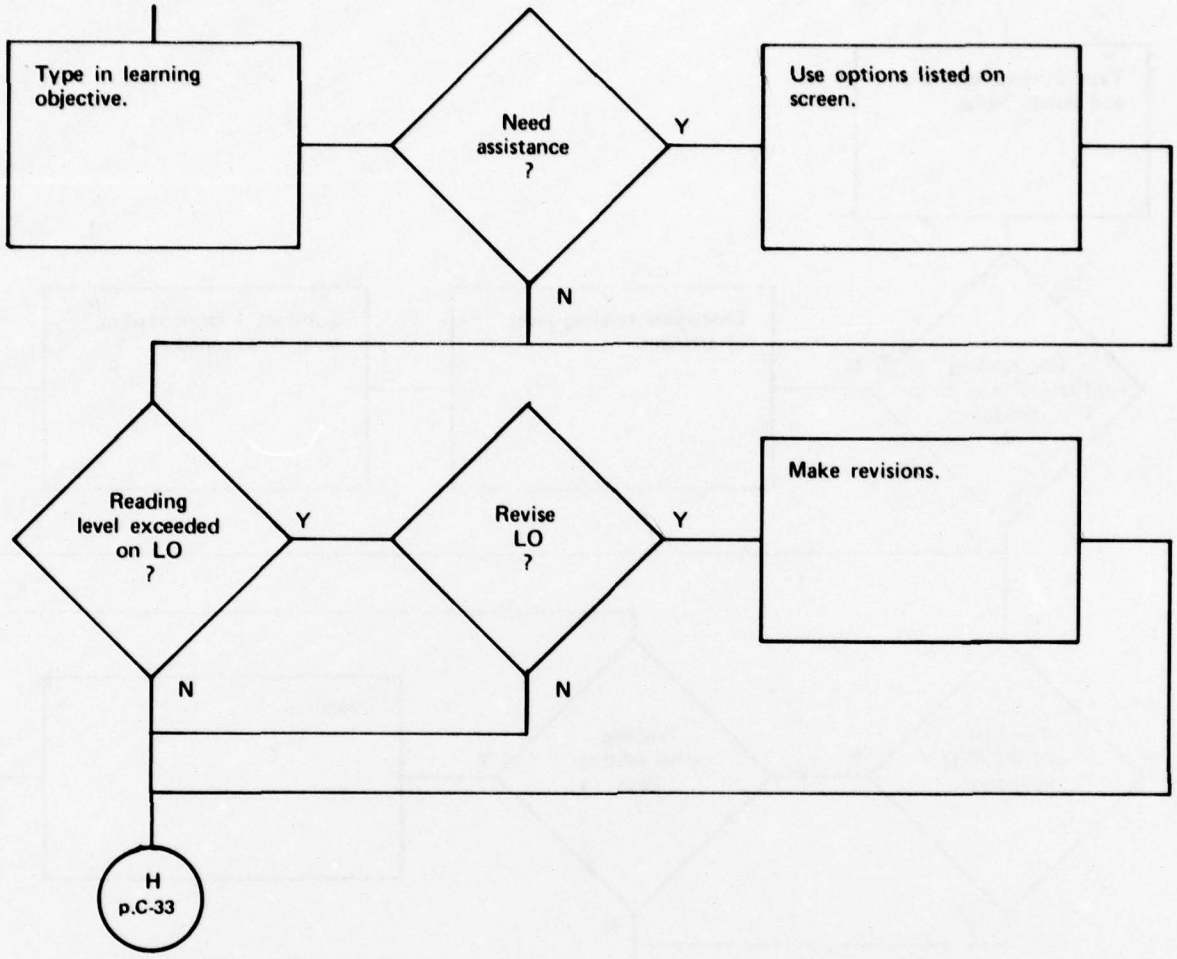
See Appendix B, page B-25

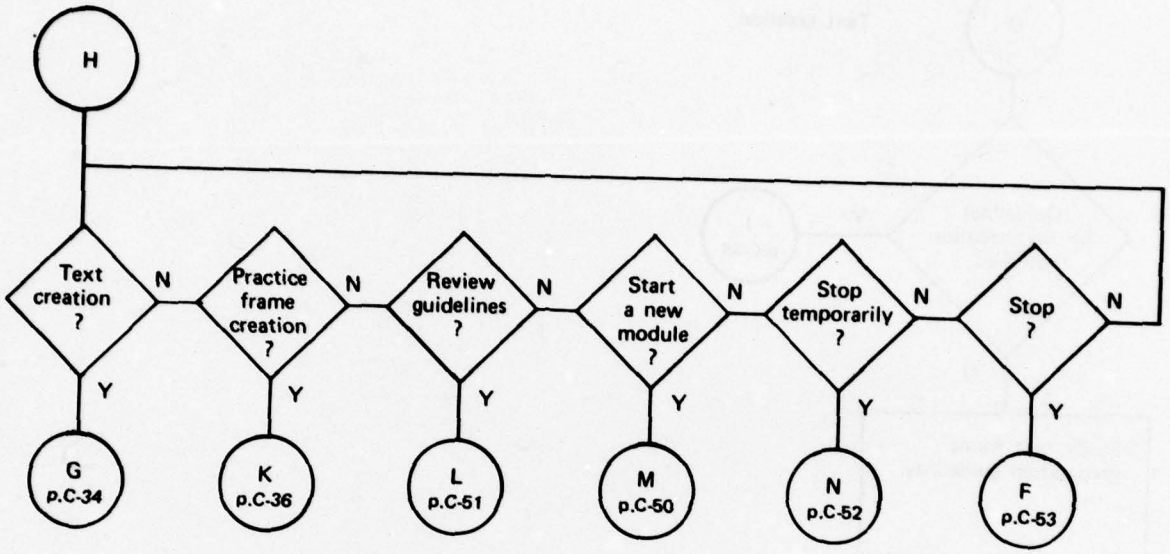
PREPARING CAI LESSON MATERIALS

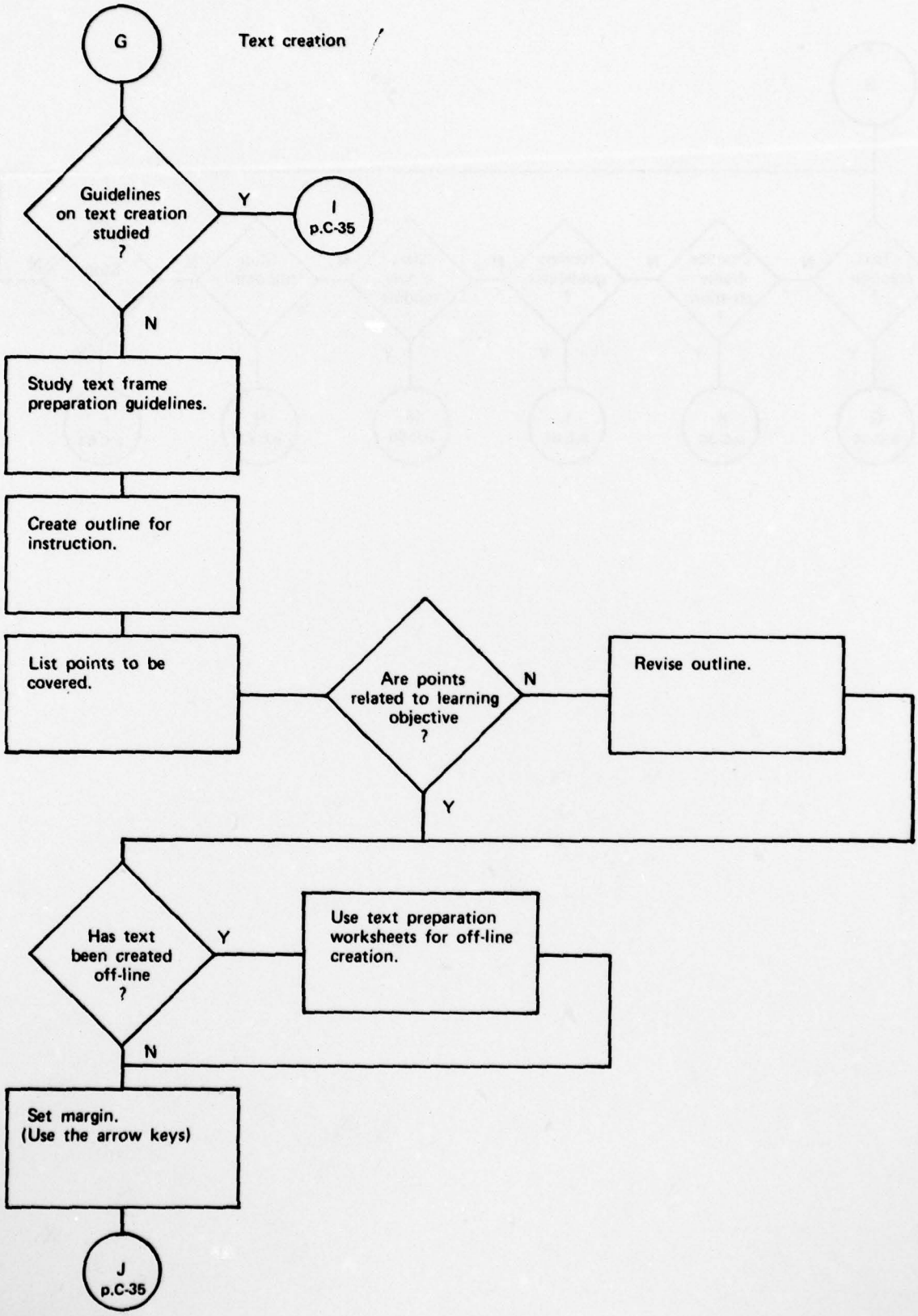
III. 4.2.3.13

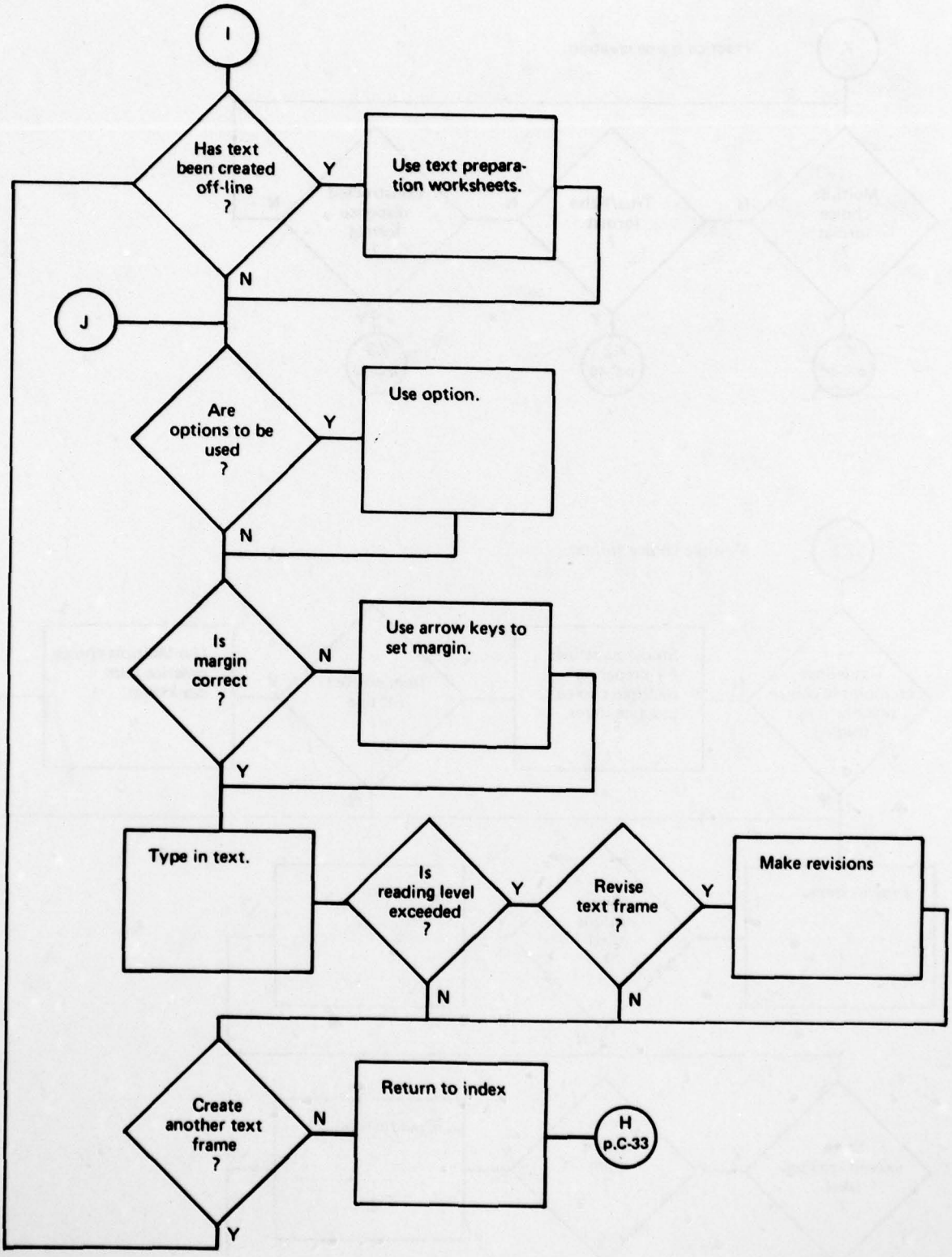


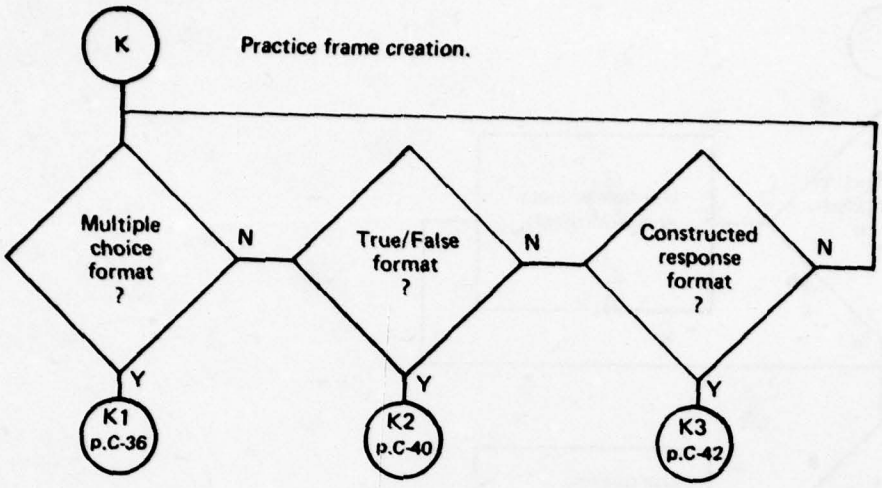

Type in data set name and lesson name.
Has reading difficulty level been decided ?
N
Determine reading level of trainees.
Subtract 1 from reading level determined.
Y
Familiar with PLATO keyboard ?
N
Practice with editing keys ?
Y
Practice.
Y
N
Study guideline describing modules and lessons.
Study guidelines for preparing practice frames.
Study guidelines on preparing learning objectives.
Objective created off line
Y
Use learning objective preparation worksheet.
N

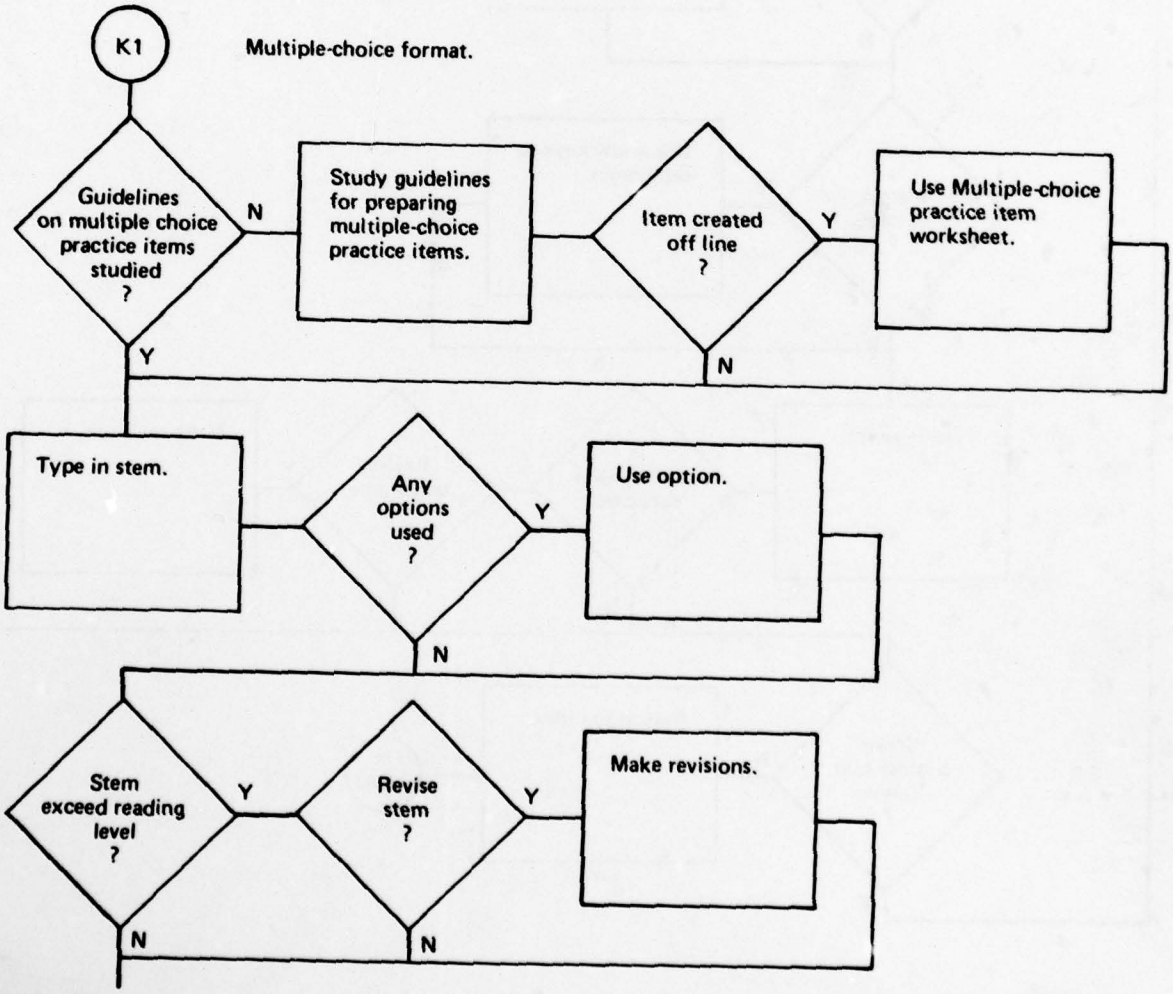

Type in learning objective.
Need assistance ?
Y
Use options listed on screen.
N
Reading level exceeded on LO ?
Y
Revise LO ?
Y
Make revisions.
N
N
H
p.C-33

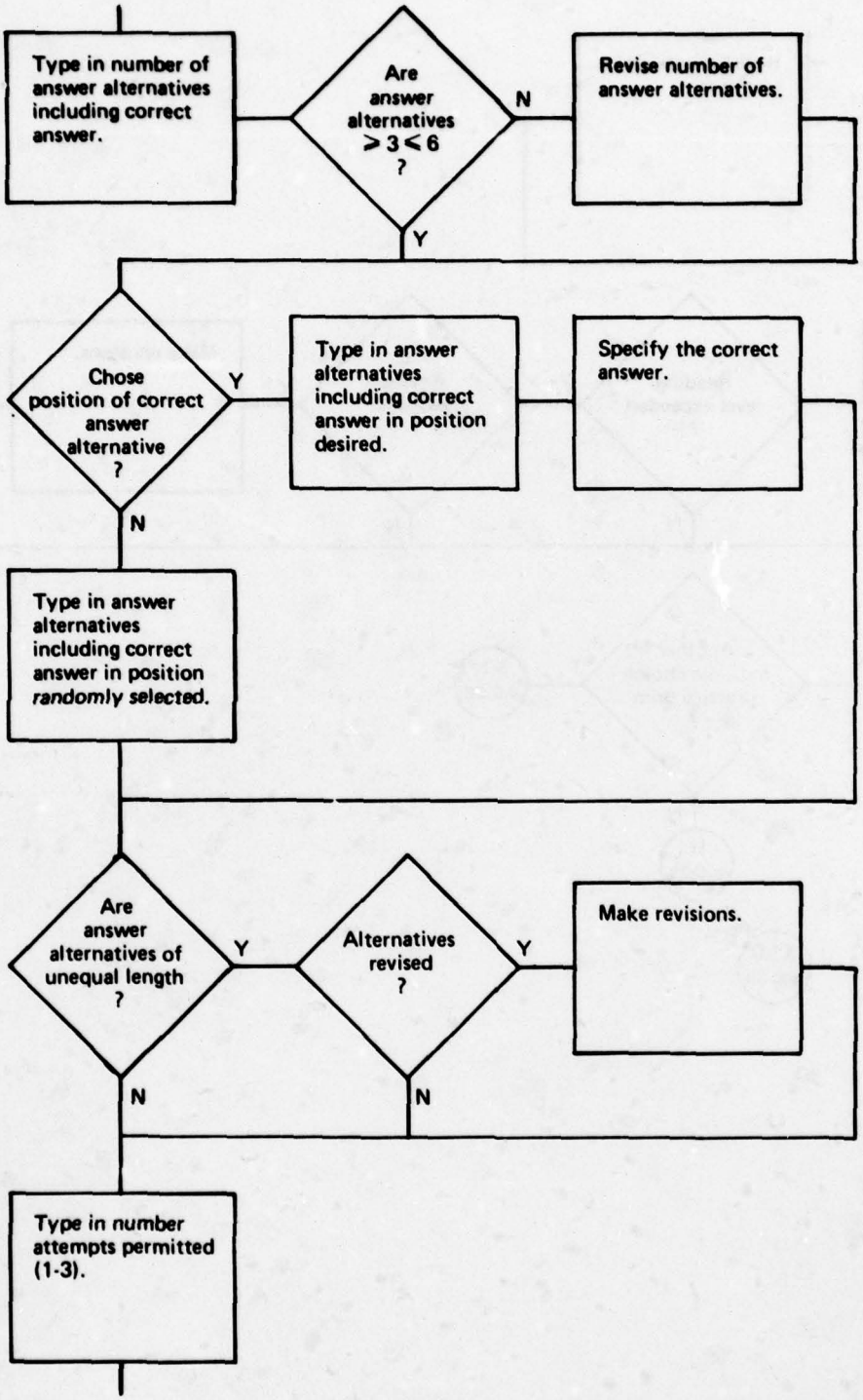

H
Text creation ?
N
Practice frame creation ?
N
Review guidelines ?
N
Start a new module ?
N
Stop temporarily ?
N
Stop ?
N
Y
Y
Y
Y
Y
Y
G p.C-34
K p.C-36
L p.C-51
M p.C-50
N p.C-52
F p.C-53

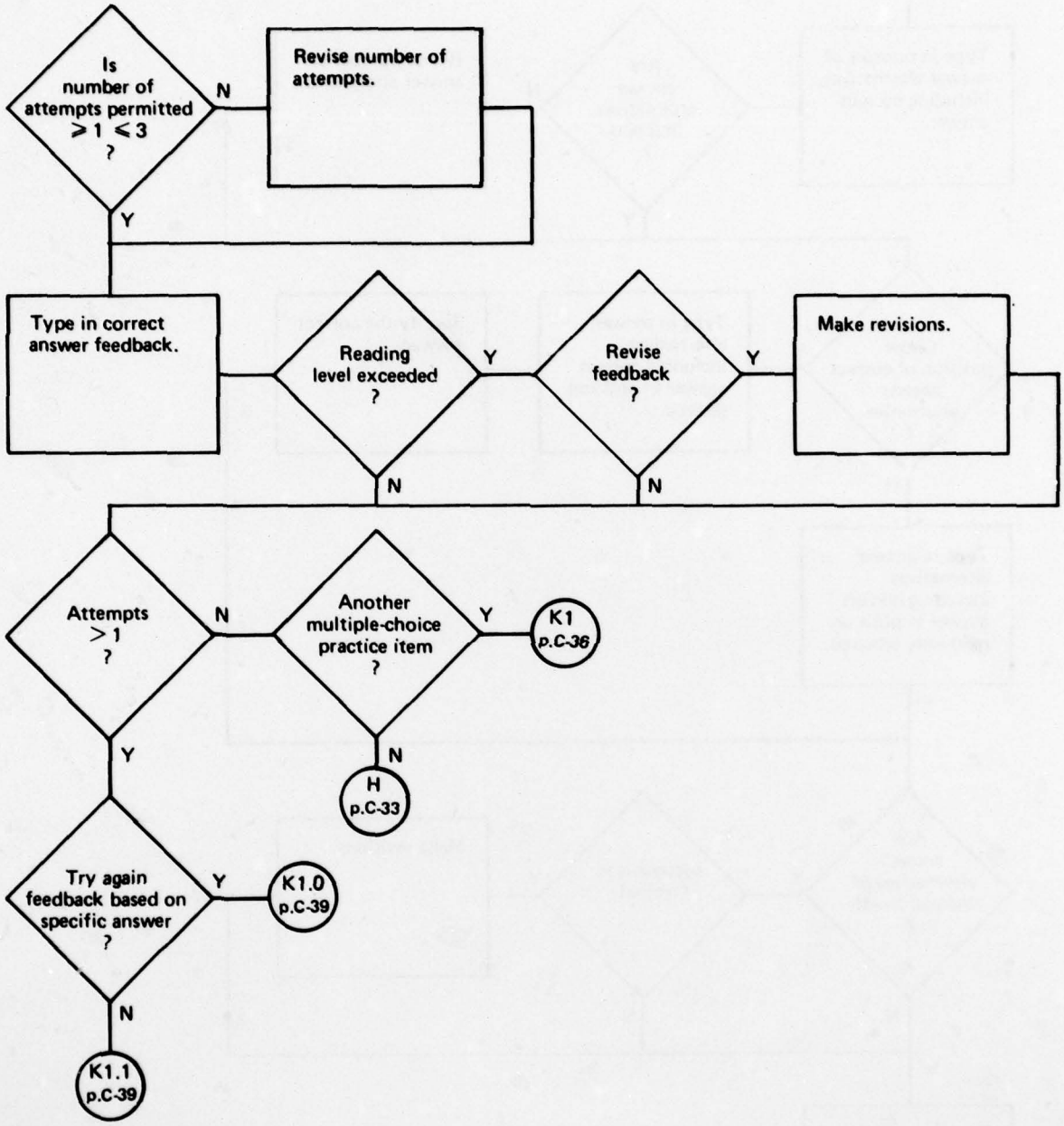

G
Text creation
Guidelines on text creation studied ?
Y
I p.C-35
N
Study text frame preparation guidelines.
Create outline for instruction.
List points to be covered.
Are points related to learning objective ?
N
Revise outline.
Y
Has text been created off-line ?
Y
Use text preparation worksheets for off-line creation.
N
Set margin. (Use the arrow keys)
J p.C-35

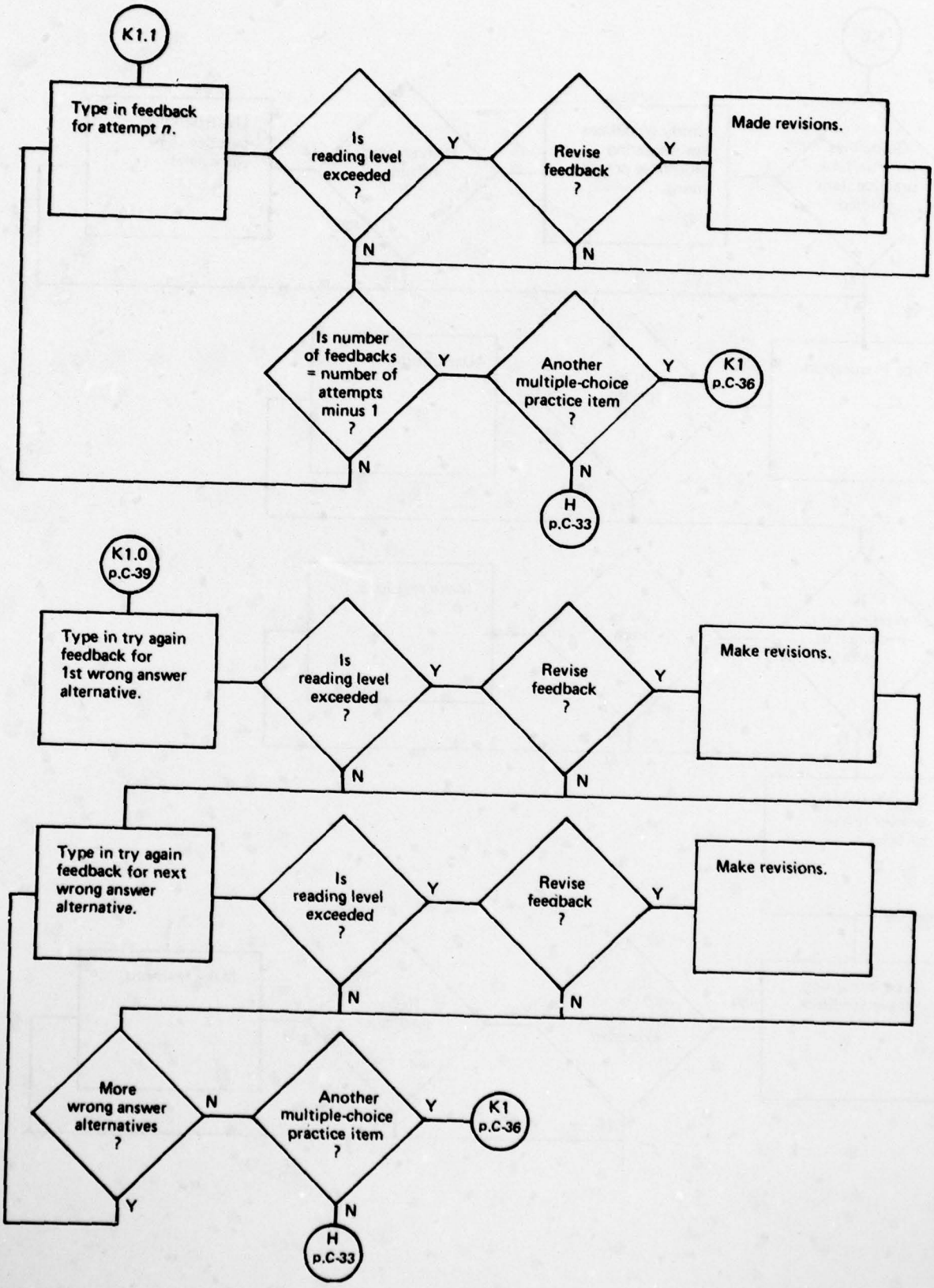

I
Has text been created off-line ?
Y
Use text preparation worksheets.
N
J
Are options to be used ?
Y
Use option.
N
Is margin correct ?
N
Use arrow keys to set margin.
Y
Type in text.
Is reading level exceeded ?
Y
Revise text frame ?
Y
Make revisions
N
N
Create another text frame ?
N
Return to index
H
p.C-33
Y

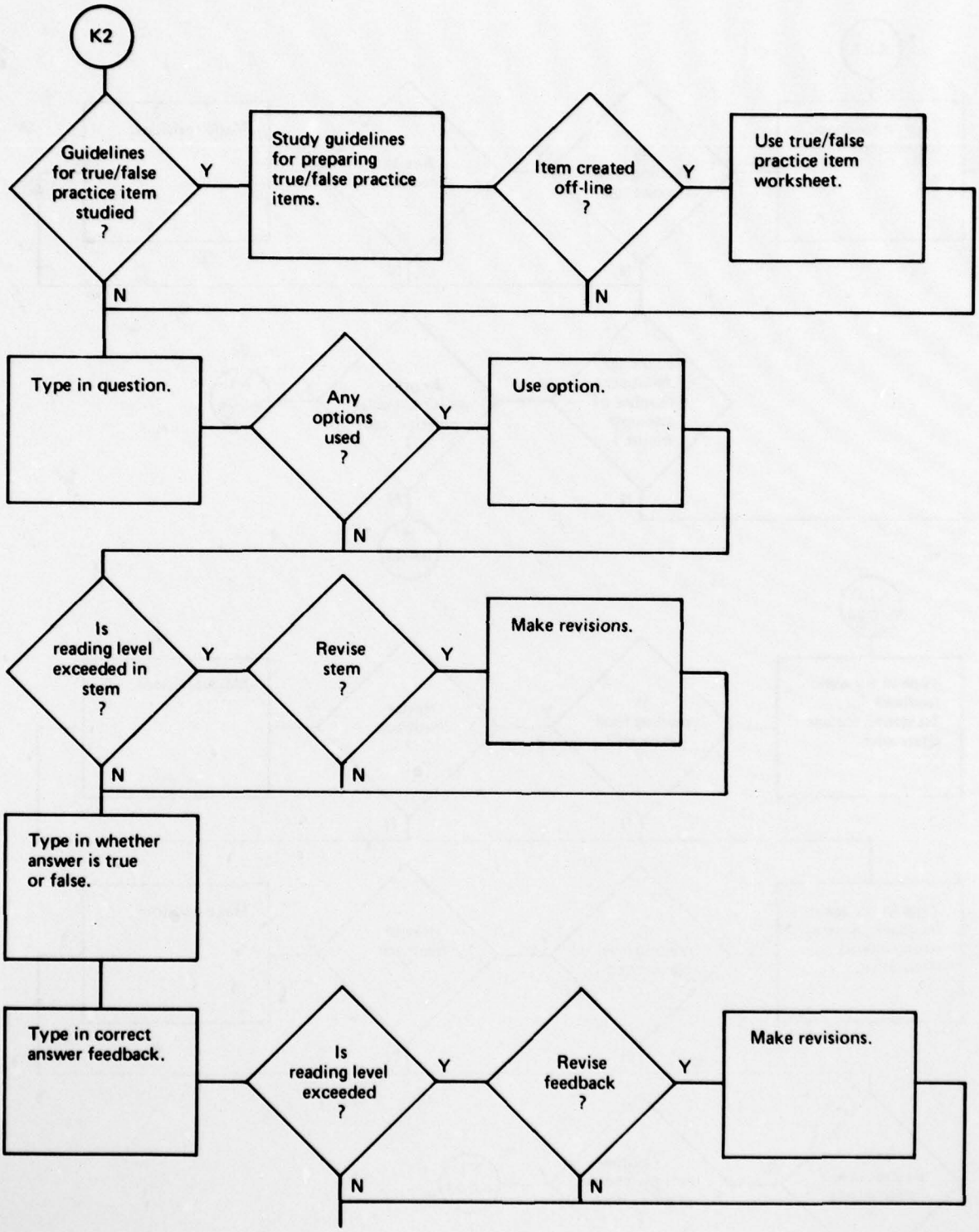

K
Practice frame creation.
Multiple choice format ?
N
True/False format ?
N
Constructed response format ?
N
Y
Y
Y
K1 p.C-36
K2 p.C-40
K3 p.C-42

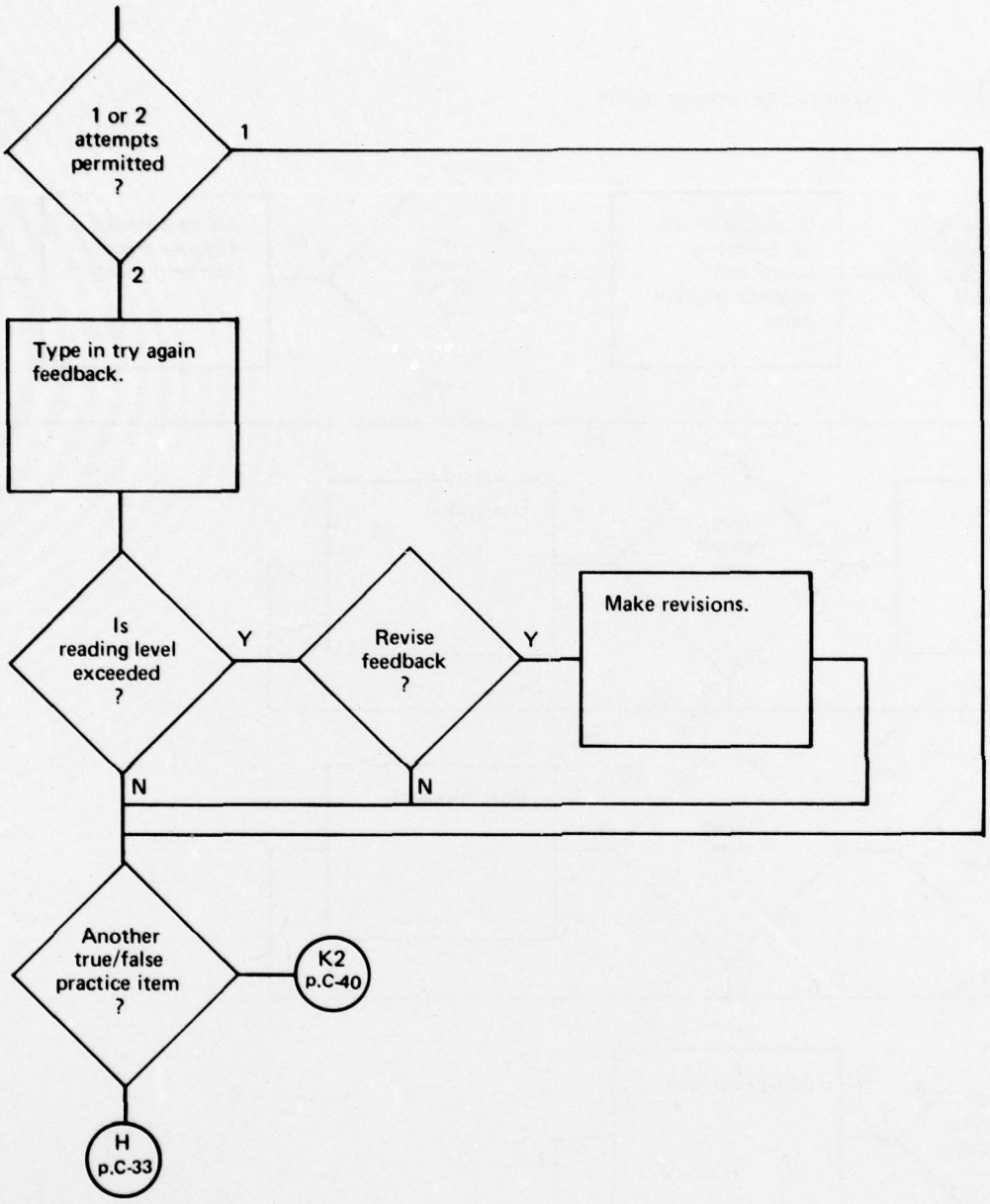

K1
Multiple-choice format.
Guidelines on multiple choice practice items studied ?
N
Study guidelines for preparing multiple-choice practice items.
Item created off line ?
Y
Use Multiple-choice practice item worksheet.
Y
N
Type in stem.
Any options used ?
Y
Use option.
N
Stem exceed reading level ?
Y
Revise stem ?
Y
Make revisions.
N
N

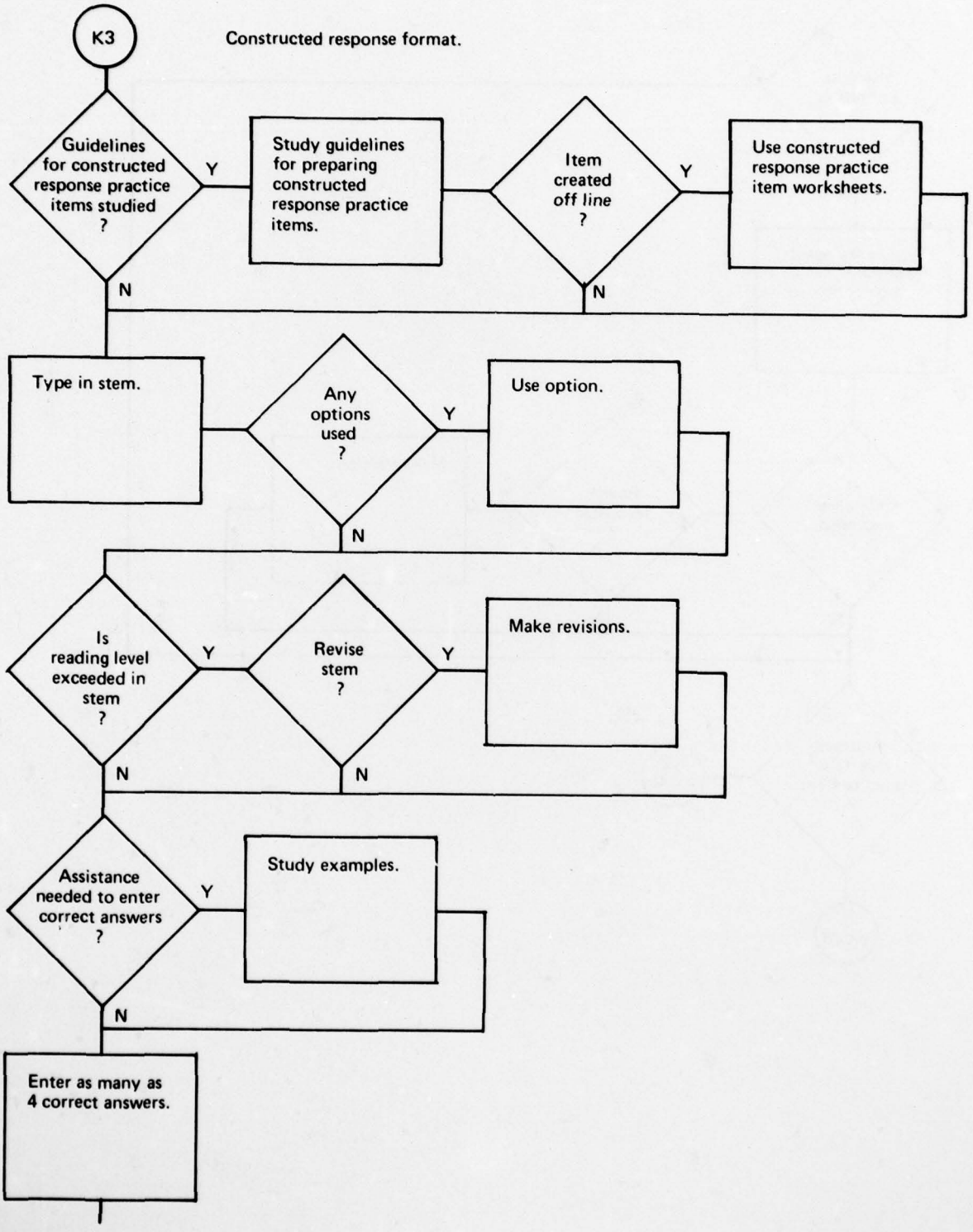

Type in number of answer alternatives including correct answer.
Are answer alternatives > 3 < 6 ?
N
Revise number of answer alternatives.
Y
Chose position of correct answer alternative ?
Y
Type in answer alternatives including correct answer in position desired.
Specify the correct answer.
N
Type in answer alternatives including correct answer in position *randomly selected.*
Are answer alternatives of unequal length ?
Y
Alternatives revised ?
Y
Make revisions.
N
N
Type in number attempts permitted (1-3).

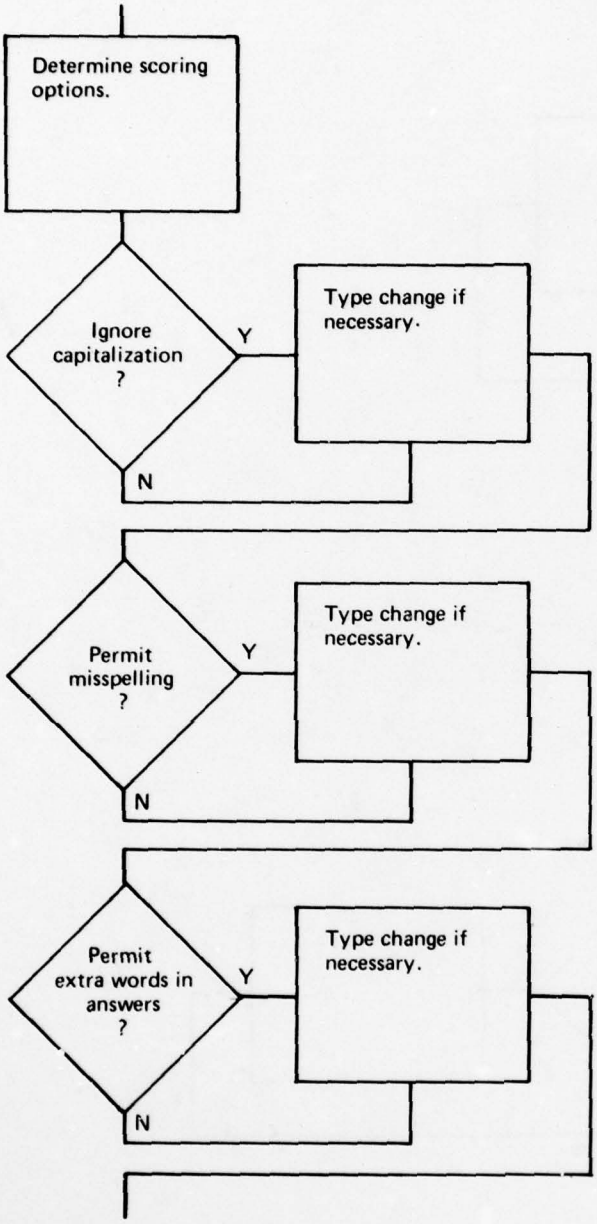

Is number of attempts permitted ≥ 1 ≤ 3 ?
N
Revise number of attempts.
Y
Type in correct answer feedback.
Reading level exceeded ?
Y
Revise feedback ?
Y
Make revisions.
N
N
Attempts > 1 ?
N
Another multiple-choice practice item ?
Y
K1 p.C-36
Y
N
H p.C-33
Try again feedback based on specific answer ?
Y
K1.0 p.C-39
N
K1.1 p.C-39

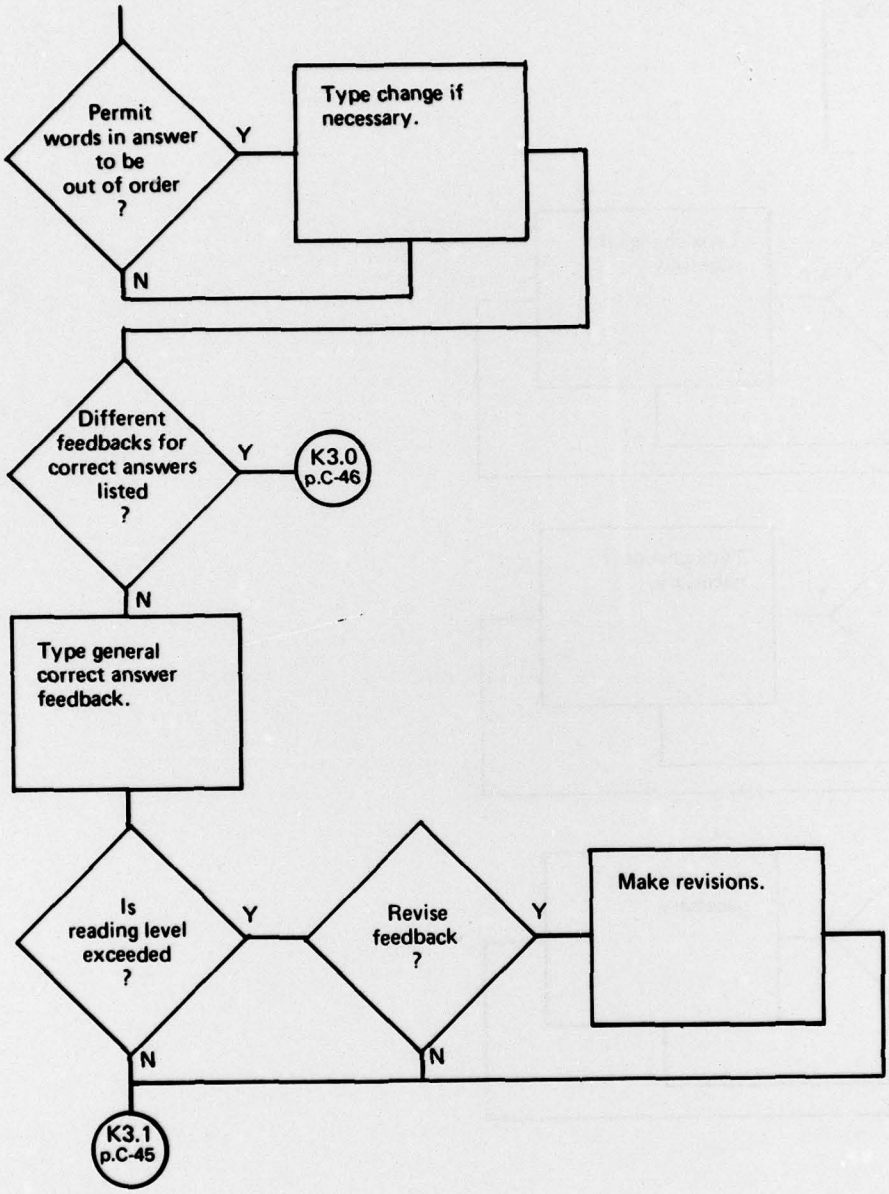

K1.1
Type in feedback for attempt *n*.
Is reading level exceeded ?
Y
Revise feedback ?
Y
Made revisions.
N
N
Is number of feedbacks = number of attempts minus 1 ?
Y
Another multiple-choice practice item ?
Y
K1 p.C-36
N
N
H p.C-33
K1.0 p.C-39
Type in try again feedback for 1st wrong answer alternative.
Is reading level exceeded ?
Y
Revise feedback ?
Y
Make revisions.
N
N
Type in try again feedback for next wrong answer alternative.
Is reading level exceeded ?
Y
Revise feedback ?
Y
Make revisions.
N
N
More wrong answer alternatives ?
N
Another multiple-choice practice item ?
Y
K1 p.C-36
Y
N
H p.C-33

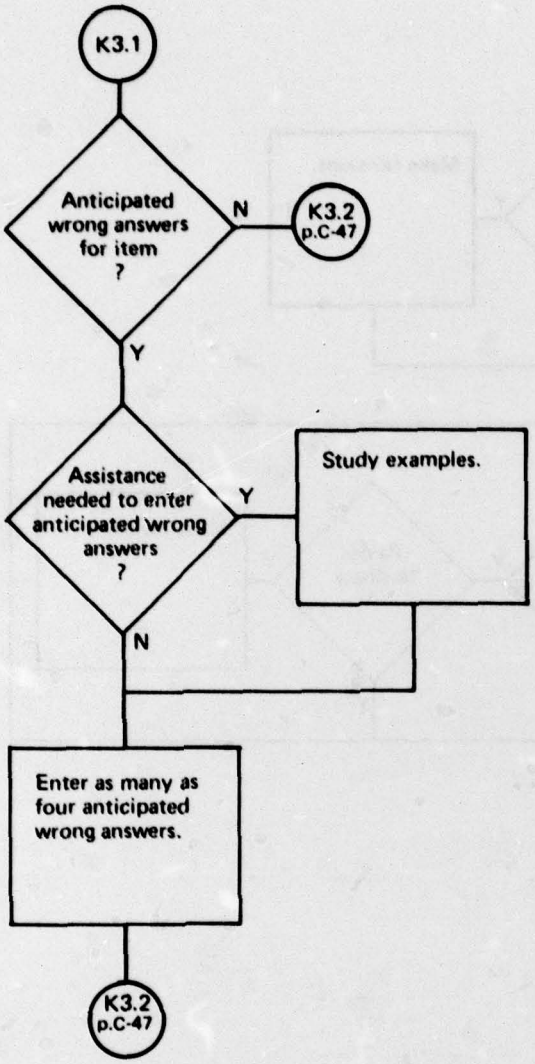

K2
Guidelines for true/false practice item studied ?
Y
Study guidelines for preparing true/false practice items.
Item created off-line ?
Y
Use true/false practice item worksheet.
N
N
Type in question.
Any options used ?
Y
Use option.
N
Is reading level exceeded in stem ?
Y
Revise stem ?
Y
Make revisions.
N
N
Type in whether answer is true or false.
Type in correct answer feedback.
Is reading level exceeded ?
Y
Revise feedback ?
Y
Make revisions.
N
N

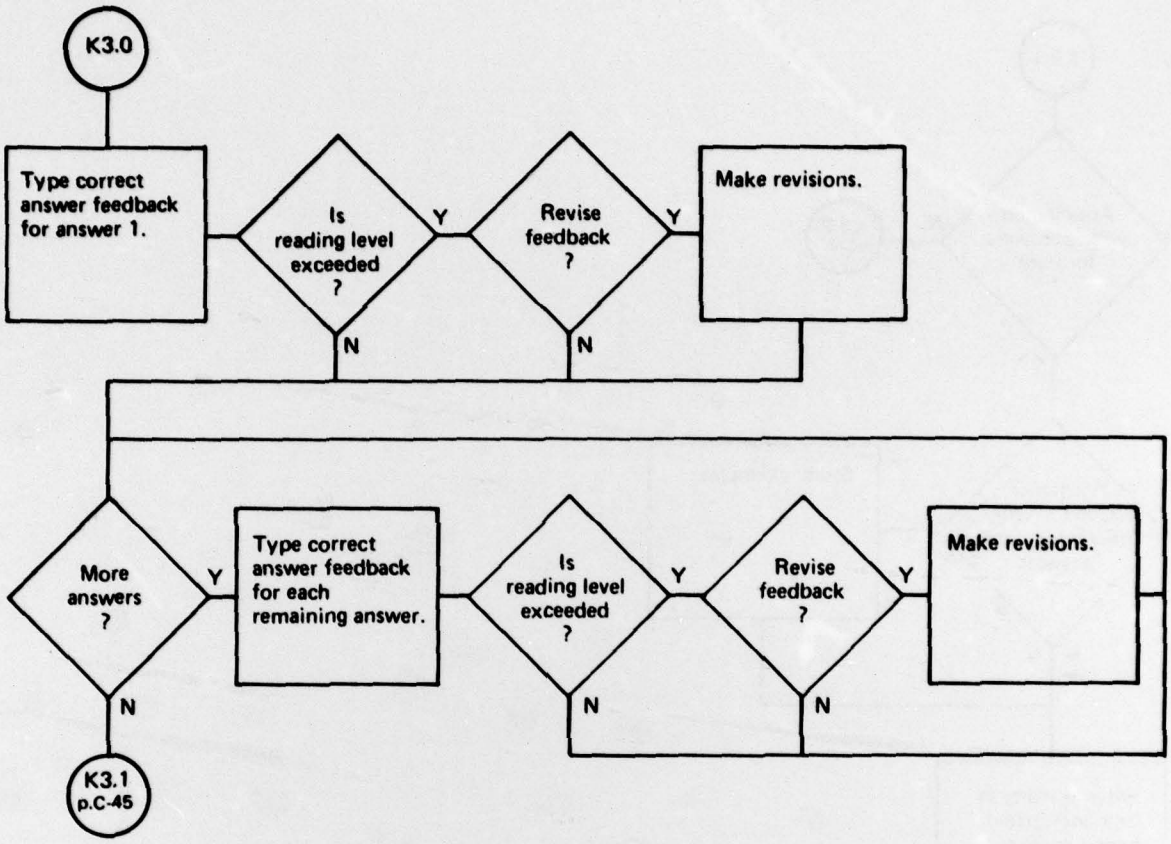

1 or 2 attempts permitted ?
1
2
Type in try again feedback.
Is reading level exceeded ?
Y
Revise feedback ?
Y
Make revisions.
N
N
Another true/false practice item ?
K2 p.C-40
H p.C-33

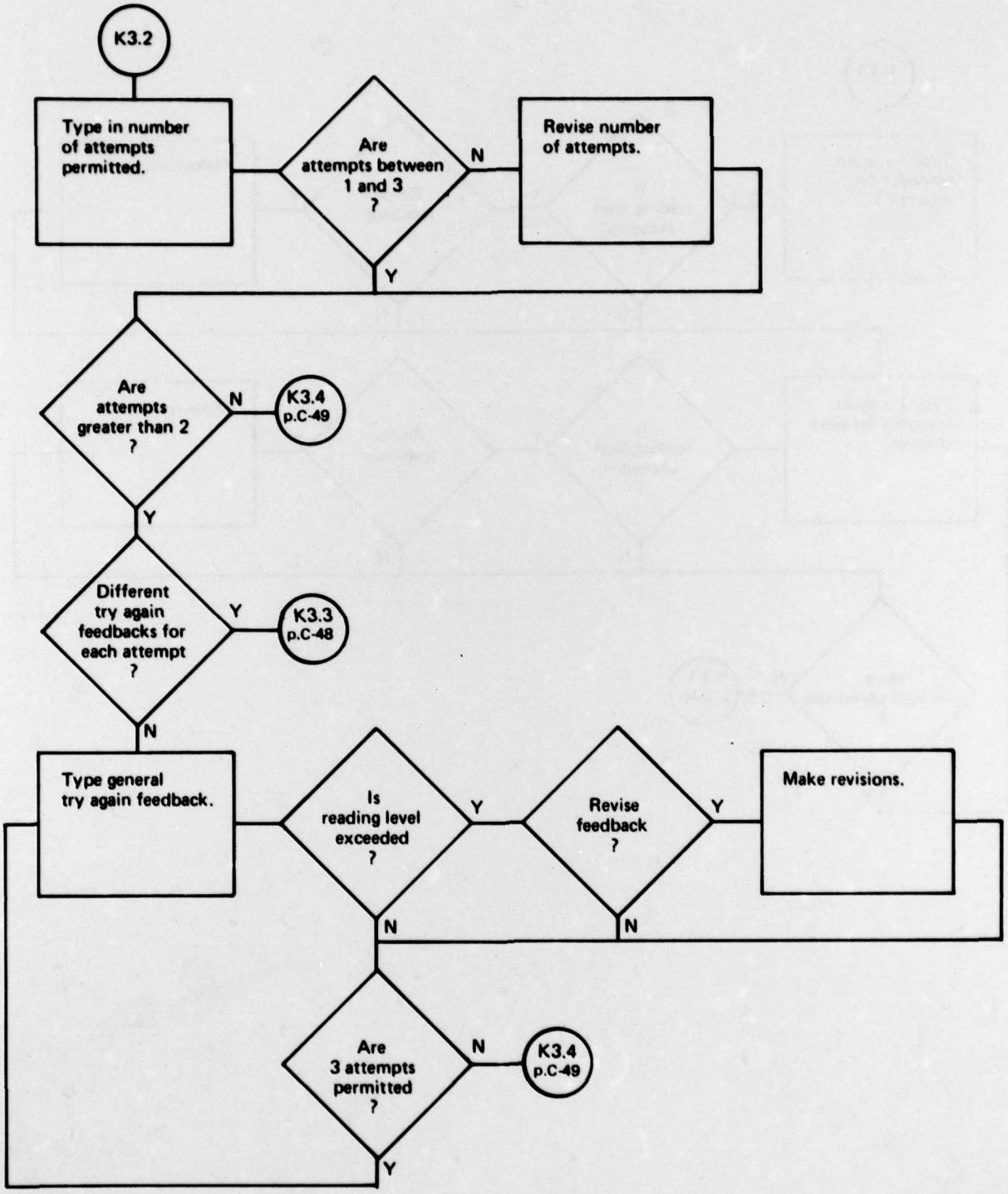

K3
Constructed response format.
Guidelines for constructed response practice items studied ?
Y
Study guidelines for preparing constructed response practice items.
Item created off line ?
Y
Use constructed response practice item worksheets.
N
N
Type in stem.
Any options used ?
Y
Use option.
N
Is reading level exceeded in stem ?
Y
Revise stem ?
Y
Make revisions.
N
N
Assistance needed to enter correct answers ?
Y
Study examples.
N
Enter as many as 4 correct answers.

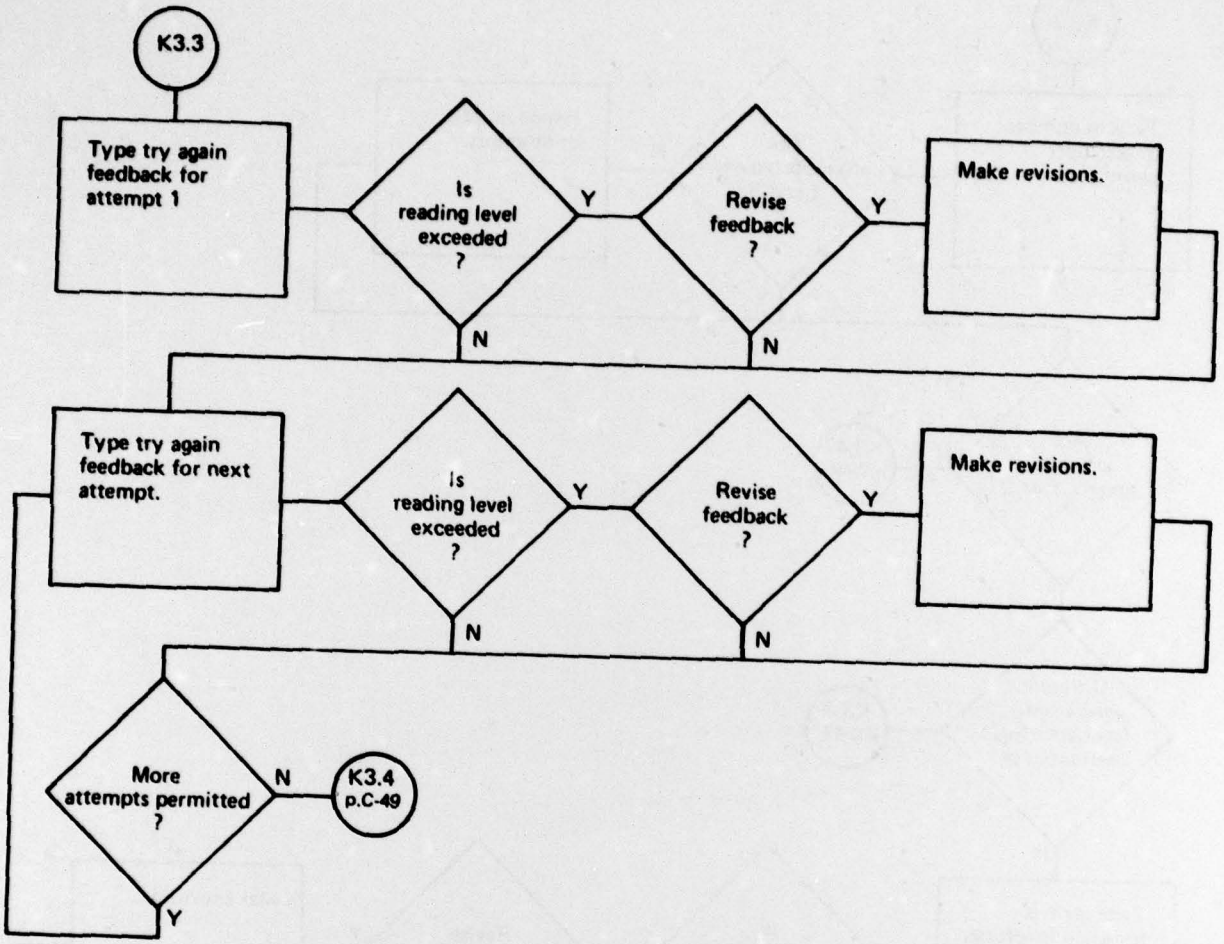

Determine scoring options.
Ignore capitalization ?
Y
N
Type change if necessary.
Permit misspelling ?
Y
N
Type change if necessary.
Permit extra words in answers ?
Y
N
Type change if necessary.

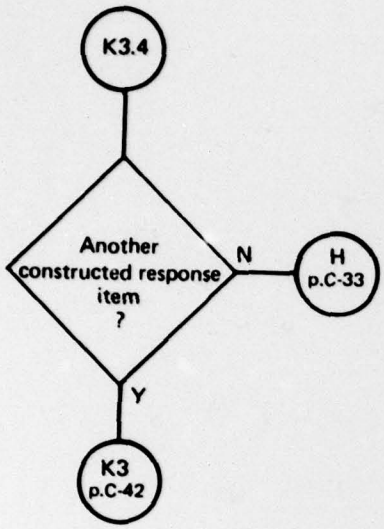

Permit words in answer to be out of order ?
Y
N
Type change if necessary.
Different feedbacks for correct answers listed ?
Y
K3.0 p.C-46
N
Type general correct answer feedback.
Is reading level exceeded ?
Y
N
Revise feedback ?
Y
N
Make revisions.
K3.1 p.C-45

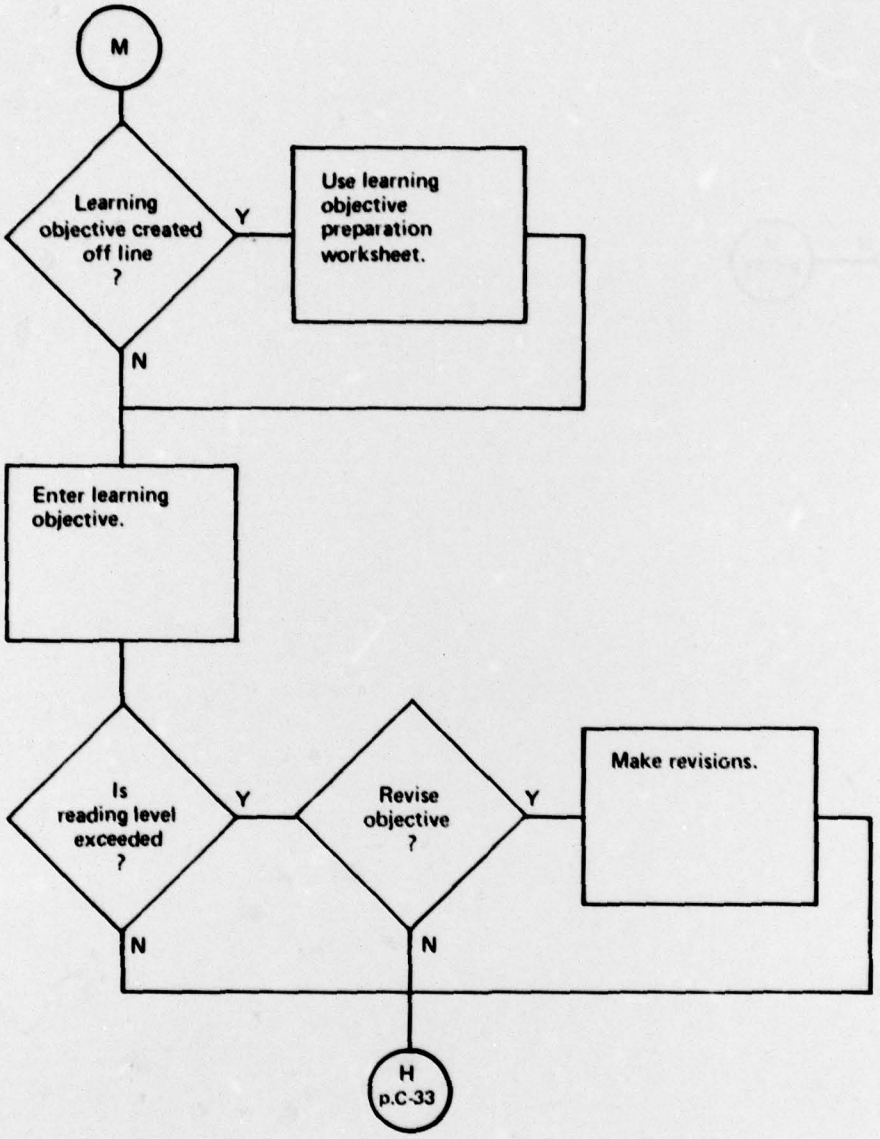

K3.1
Anticipated wrong answers for item ?
N
K3.2 p.C-47
Y
Assistance needed to enter anticipated wrong answers ?
Y
Study examples.
N
Enter as many as four anticipated wrong answers.
K3.2 p.C-47

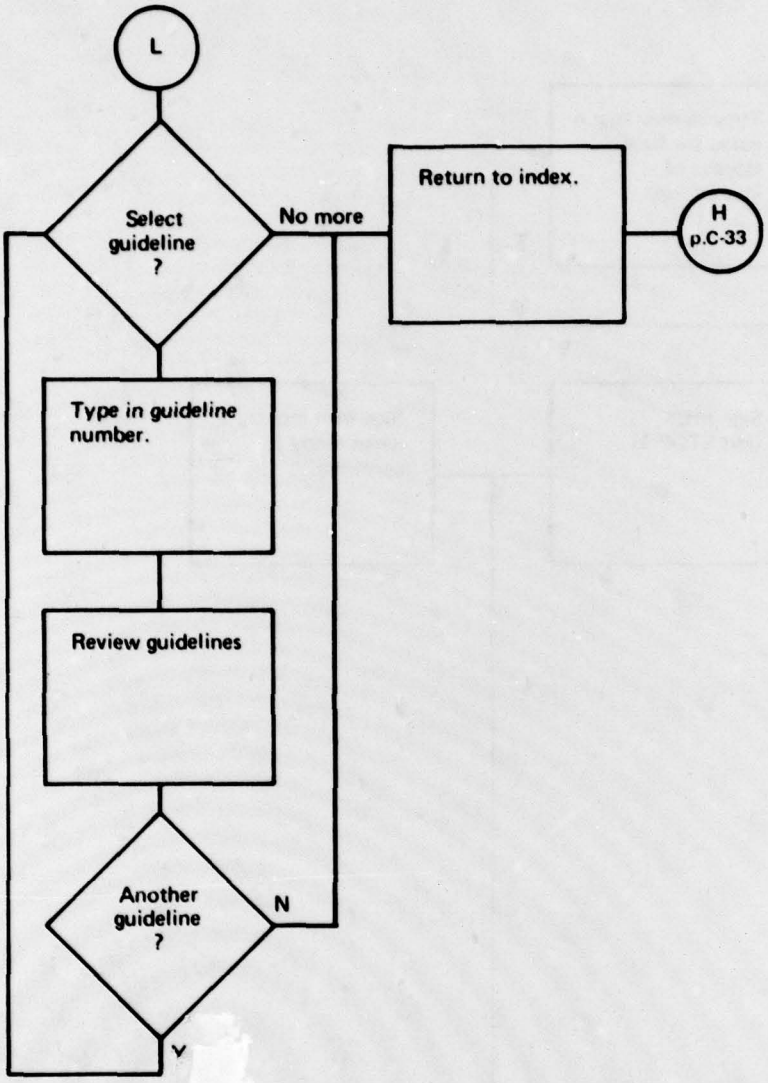

K3.0
Type correct answer feedback for answer 1.
Is reading level exceeded ?
Y
Revise feedback ?
Y
Make revisions.
N
N
More answers ?
Y
Type correct answer feedback for each remaining answer.
Is reading level exceeded ?
Y
Revise feedback ?
Y
Make revisions.
N
N
N
K3.1
p.C-45

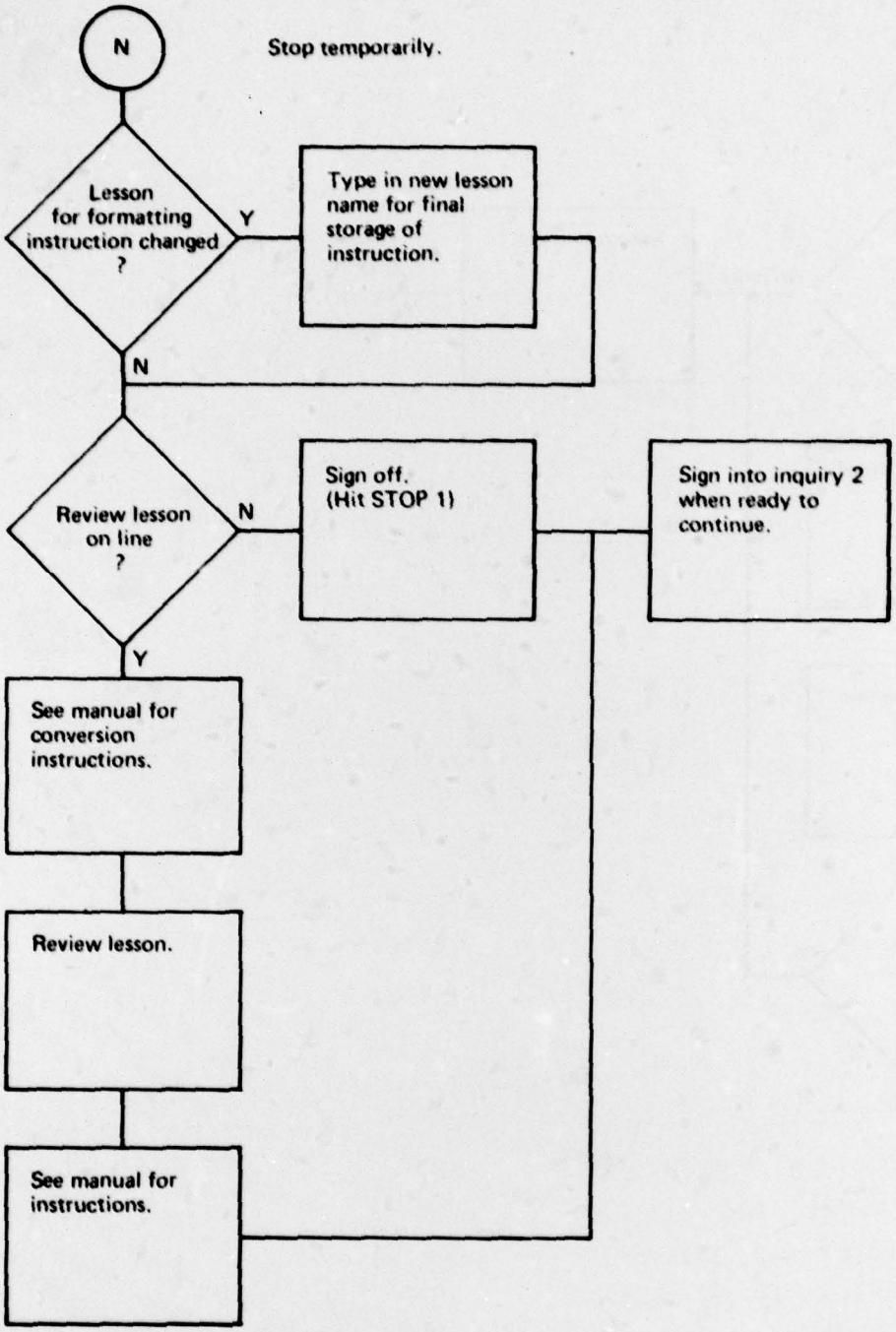

K3.2
Type in number of attempts permitted.
Are attempts between 1 and 3 ?
N
Revise number of attempts.
Y
Are attempts greater than 2 ?
N
K3.4 p.C-49
Y
Different try again feedbacks for each attempt ?
Y
K3.3 p.C-48
N
Type general try again feedback.
Is reading level exceeded ?
Y
Revise feedback ?
Y
Make revisions.
N
N
Are 3 attempts permitted ?
N
K3.4 p.C-49
Y

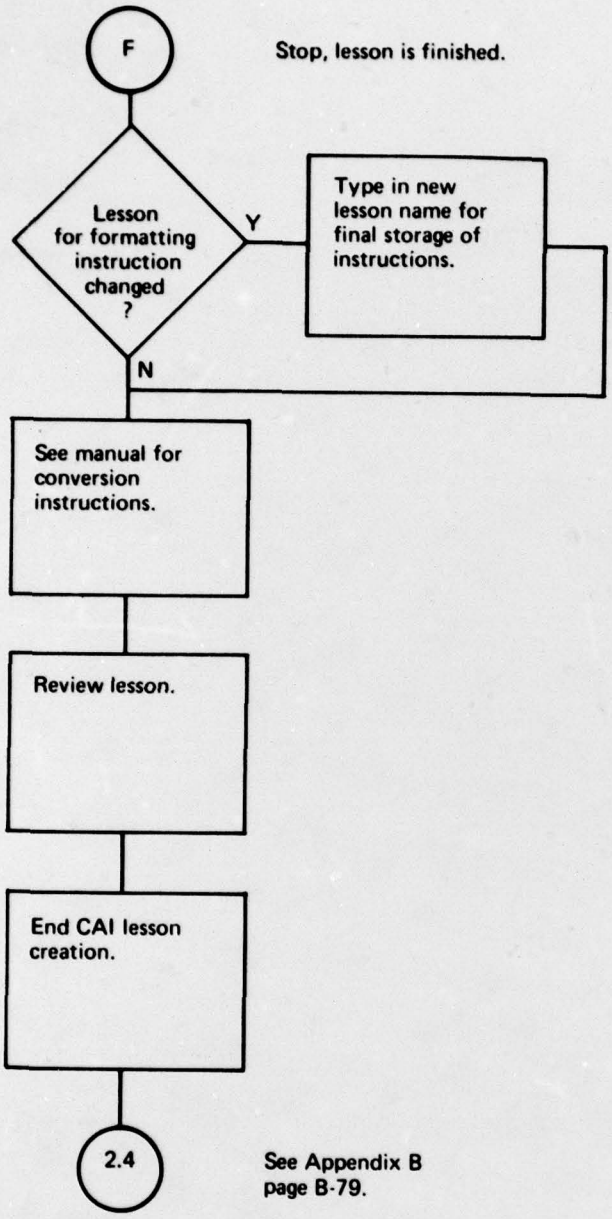

K3.3
Type try again feedback for attempt 1
Is reading level exceeded ?
Y
Revise feedback ?
Y
Make revisions.
N
N
Type try again feedback for next attempt.
Is reading level exceeded ?
Y
Revise feedback ?
Y
Make revisions.
N
N
More attempts permitted ?
N
K3.4 p.C-49
Y


K3.4
Another constructed response item ?
N
H
p.C-33
Y
K3
p.C-42


M
Learning objective created off line ?
Y
Use learning objective preparation worksheet.
N
Enter learning objective.
Is reading level exceeded ?
Y
Revise objective ?
Y
Make revisions.
N
N
H
p.C-33


L
Select guideline ?
No more
Return to index.
H
p.C-33
Type in guideline number.
Review guidelines
Another guideline ?
N
Y


N
Stop temporarily.
Lesson for formatting instruction changed ?
Y
Type in new lesson name for final storage of instruction.
N
Review lesson on line ?
N
Sign off. (Hit STOP 1)
Sign into inquiry 2 when ready to continue.
Y
See manual for conversion instructions.
Review lesson.
See manual for instructions.


F
Stop, lesson is finished.
Lesson for formatting instruction changed ?
Y
Type in new lesson name for final storage of instructions.
N
See manual for conversion instructions.
Review lesson.
End CAI lesson creation.
2.4
See Appendix B page B-79.

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