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DEVELOPING AND VALIDATING CRITERIA FOR THE PRODUCTION OF
COMPUTER-BASED INSTRUCTIONAL COURSEWARE

The Ohio State University

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Chapter I
INTRODUCTION

Background

High quality of learning, mastery, and teaching effectiveness is the main concern of educators. But how can most students achieve mastery? If mastery means the achievement of all objectives of any instructional unit, then most teachers will not expect all of their students to demonstrate mastery on time schedules decided by those teachers, because students differ in such basic characteristics as experience, intelligence, motivation, creativity, and speed of learning.

However, if students were normally distributed on aptitude and each learner received optimal quality of instruction and the learning time required, then a majority of students could be expected to attain mastery (Romiszowski, 1981).

Most students can attain a high level of learning capability if instruction is approached sensitively and systematically, if students are helped when and where they have learning difficulties, if they are given sufficient time to achieve mastery, and if there is a clear criterion of what constitutes mastery (Bloom, 1976, p.4).

In recent years there has been increased emphasis on individualized instruction and computer
technology to facilitate learning at all levels of education and training. The discipline that supports this activity is Computer-Based Instruction (CBI) (O'Neil, 1981, p.1).

What is computer-based instruction? What is courseware? Can courseware instructional units of high educational quality be produced? Are there certain factors that could be identified to form basic criteria for the design and production of courseware?

The term Computer-Based Instruction (CBI), or Computer-Based Interactive Instruction, refers to two instructional strategies: tutorial instruction (frequently referred to as Computer-Assisted Instruction, CAI), and drill and practice. Tutorial instruction (CAI) assumes that the learner is approaching the content to be learned for the first time. Drill and practice assumes that the learner has learned certain facts or concepts prior to using the computer program. Therefore the program does not present new content, but rather, through a series of questions and responses, provides an opportunity for practicing what has already been learned. Courseware may be defined as the materials that provide instruction to learners (Hall, 1982, p.354).

Bunderson (1981) explains courseware as that term which implies a product definition: it refers to the materials of instruction that constitute application programs administered by the computer delivered software system. Briefly, a courseware unit is the subject matter content with teaching methodology.
Considering the term "courseware" as the product of the two components, content material and teaching methodology, it should be possible to identify factors that affect the quality of courseware.

**Statement Of The Problem**

The purpose of this study will be to identify, develop, and validate criteria for well-prepared computer courseware. If we consider efficient learning as a function of two main factors, the learner's attitudes and the courseware instructional unit (content material with methodology), then carefully designed and well produced courseware becomes a necessary condition for a successful teaching-learning situation.

What does the courseware writer need to know? Does courseware development necessitate that special kinds of guideposts to be considered? What factors does the courseware developer have to refer to in order to develop well-prepared courseware?

Research suggests that most of the existing courseware is of low educational quality. Hall, et al (1982, p.1) states:

Perhaps some of the most powerful suggestions for improving the quality of CBE courseware can be derived from observing the origins and characteristics of existing courseware. Historically, when involvement in CBE was restricted to a few centers across the country, considerable improvement in the quality of courseware could be observed over
time as the developers became more experienced and as knowledge of the characteristics of effective courseware began to accumulate and impact new courseware development. However, courseware development is now the purview of any one with a microcomputer, many of whom are ill-prepared to develop quality materials.

The low quality of the existing courseware could be attributed to the following two factors:

1. The poor training of courseware writers.

2. The lack of design criteria for high quality and well prepared courseware that could be used by courseware writers during the courseware development process.

Gleason (1981, pp.11-12) describes some of the available courseware as follows:

Many of the available educational programs are "junk" and are virtually "devoid" of any instructional value, and in many cases are acting as deterrents to the widespread acceptance of Computer-Based instruction.

The problem of improving the quality of courseware is of extreme importance to the field of computer education. In fact, "...there is agreement among instructional computing experts that the future success or failure of microcomputers as a medium of instruction hinges largely on the availability of quality courseware,"(Robleyer 1981, p. 243).
It is postulated that well-developed courseware is not produced impromptu. Criteria must be developed and validated and become available as hallmarks for the courseware writer. The courseware developer will have to refer to these guideposts during the courseware development process and meet certain standards.

**Rationale And Need For The Study**

The role of computers in education is a topic that has been frequently discussed in the literature of education. Computer-Based Instruction is one aspect of computer effects on education. It is generally believed that CBI has the following advantages:

1. Computer-Based Instruction has the potential to be a highly individualized method of instruction. Students can proceed at their own pace and can respond to questions without the fear of embarrassing failure. In addition students can receive important individualized feedback regarding progress being made (Dence, 1980, pp. 50-54).

2. As opposed to traditional modes of instruction, the learner is rarely able to be such a totally passive
receiver of information. When using a CBI program, the student is generally an active participant in the learning process (Chambers and Sprecher, 1980, pp.332-342).

3. When computers are used as an aid to instruction, classroom teachers can become "facilitators" of instruction rather than lecturers. In addition, teachers generally have more free time to devote to dealing with students in a more personal and meaningful manner (Chambers and Sprecher, 1980).

4. Students can simulate or explore situations which would be too dangerous, expensive, difficult, or time consuming to undertake in the real world (Gaede, 1979).

5. The computer evaluates a student's performance in a completely objective manner, and the possibility of unconscious teacher bias is eliminated (Clement, 1981).

Looking at the problem from an administrative point of view, we see that Computer-Based Instruction is a worthwhile aspect of education. To initiate and conduct a study for establishing criteria for the design and production of courseware of high quality is important. In fact, there are
many factors that support the need for adopting computer-based instruction. Some of these factors are the following:

1. The future shortage of available trained human resources, especially in different disciplines for post secondary education.

2. The increasing technological sophistication of the present society, which requires individuals to master an increased variety of complicated subject material to cope with social requirements.

3. The continuously increasing trend in cost of education, most of which is used to pay professionals' salaries. These factors are supported by O'Neil (1981, p.2):

For postsecondary education and training, the most obvious problem for the future is the decreasing quantity and quality of available human resources. For example, it is expected that the available labor pool (i.e., quantity) will be 25-30% smaller in 1995 than in 1979 (National Center For Educational Statistics, DHEW). The product of the civilian educational systems, that is, the intellectual skills of high school graduates, is assumed to be lower than in the past ("decreasing quality"). Compounding these problems is consistent political pressure to reduce education and training budgets....

In addition, the increasing technical sophistication of our society will require people to master an increased variety of complicated subject material, to master an increased set of sophisticated skills, and to perform these skills at higher standards of performance. We expect
that these trends will continue, and that there will be an increased need to develop such instructional systems that lead to more proficient performance at reduced cost.

Most of the direct costs of education and training are associated with instructor and administrator salaries and benefits. In training environments such as industry and military, students are also paid. For these reasons, in training environments the relationship between time and costs is direct one. Costs can be reduced to the extent that reductions in instructional time can be achieved. A major advantage of CBI systems is that they can reduce instructional time while maintaining equivalent levels of performance when compared to traditional type of lecture discussion techniques.

In an article entitled "Computer-Based Instruction is A Solution," O'Neil concludes that the adoption of CBI techniques will increase the cost effectiveness of education:

The application of CBI techniques is one way of increasing the cost effectiveness of education and training systems. Instruction with high quality is possible with computers (i.e. by eliminating variability caused by differences between instructors). With this technology, a long term goal of educators and trainers can be realized by distributing instruction to students rather than by distributing students to instruction (O'Neil, 1981).

4. The fourth factor is based upon the fact that, during the last few years, microcomputers have been introduced in many classrooms in a relatively wide-scale way, and are being used for instructional purposes.
Many enthusiastic but untrained and inexperienced teachers have begun to write their own courseware.

Courseware development requires specialized knowledge, skill, experience, and time that are not readily available to every one who might want to use Computer-Based Education (Hall, 1982, p.356).

Therefore, it is obvious that there is an urgent need to develop, validate, and make available a set of criterion items to serve as references for courseware writers.

5. Fifth, there are individual differences in learning, both quantitative (related to learning speed) and qualitative (related to learning style), that can be coped with by using individualized instruction through the use of Computer Based Instruction, where each student can learn at his own pace. The literature is full of evidence regarding this issue.

If it is possible to develop and validate criteria for the production of computer-based instruction, such criteria should be helpful to educators in several ways:

1. Courseware writers, especially teachers, will be able to refer to those criteria when preparing their own courseware.
2. School administrators and subject supervisors will be able to use the criteria when evaluating the quality of already produced courseware.

3. If the proposed criteria would be in a structured format for the design and production of courseware to implement curriculum, over time they could have an effect on curriculum development, starting from the instructional unit and going to the classroom.

4. Those who will use the criteria will become more trained, knowledgeable, and discriminating, and continue to raise the quality of their own Computer-Based Instructional courseware.

**Objectives Of The Study**

The objective of this study is to develop and validate a list of criterion items that would form a suitable reference for classroom teachers for the design and production of computer instructional courseware of educational worth.

The compilation process of the criterion elements will involve investigating those areas or attributes that would have a potential impact upon learning during the instructional process, and are clearly distinguishable in a courseware program, so that a courseware writer can assess their presence or absence during the courseware production process.
The main objective of this study is to come up with a valid list of criterion items for the design and production of courseware that could be used mainly by classroom teachers who are interested in producing their courseware in their own school settings.

Summary

High quality of learning and teaching effectiveness form a main concern of educators today. Educators are always called upon to meet the demands of their societies so that individuals in those societies will have access to education commensurate with their diversified desires and their different abilities. To cope with such demands, the educators' role is to persist on research aiming at continuous curriculum developments, improvements in methods of instruction, better instructional materials, and new media of instruction.

During the last few years, there has been a phenomenal rise in the use of microcomputers in schools as a new instructional medium. In order to avoid the misuse while optimizing the use of this instructional medium requires special, well-produced instructional programs called instructional software, or "courseware". Achieving this aim necessitates developing and validating criteria for courseware production. The purpose of this study will be to develop a list of criterion items by reviewing the literature to
determine specific criteria, then validate these criteria through experts in the field. The objective is to come up with a guide for courseware production that will be used in the main by classroom teachers who are interested in producing their own courseware in their schools.

Chapter II will deal with related literature from different points of views. CBI development as well as the two learning theories which influenced CBI will be discussed. Courseware produced during the last twenty years will be looked at from researchers' evaluative points of views. Also, certain research findings, which have impact on courseware production, will be highlighted.
Since the main purpose of this study is to develop and validate criteria that classroom teachers might use for the production of computer based instructional courseware, it is especially important to look at related literature from different perspectives. In this chapter, research in the area of computer-based instruction (CBI) will be reviewed from four points of views:

1. The historical development of CBI.
2. The main learning theories related to CBI.
3. An assessment of CBI during the last two decades.
4. Some research findings.

**Historical Development Of CBI**

The roots of Computer-Based Instruction concepts (or Computer Assisted Instruction-CAI, according to some writers), go back far in history to the era of Plato and Aristotle, where the implications of Aristotle's ideas of association were used to develop concepts to explain forgetting, memory, and learning. The following quote by Blaisdell (1976) supports this historical point:
The roots of CAI probably reach as far back in history as Plato and Aristotle. Certainly, many of the ideas and techniques practiced two thousand years ago are prevalent today. In more recent times, investigations and theoretical extensions of the Platonic and Aristotelian ideas provided contributions of both the theory and practice of education and training. For example, the implications of Aristotle's ideas of association were used to develop concepts to explain forgetting, memory, and levels of consciousness, and learning. From the early Nineteenth Century onward, research and theory in psychology and education developed explanations, predictions, and measuring devices for the investigation of learning and memory of verbal, mental and motor skills.

In the Twentieth Century, CBI goes back to the time of Sidney Pressy of The Ohio State University, who in 1926 broke the first ground in the automation of instruction when he developed the first "teaching machine", not for the purpose of instruction, but for the purpose of test-automation to reduce the burden of grading papers, (Blaisdell, 1976).

However, the origin of CBI in its recent form was a natural development of programmed instruction, where the content to be taught is programmed by breaking it down into small sections or frames and presented to the learner one section at a time. The following three different references may give a clear idea about the turning events of CBI in the second half of this century.

However, it is probably true to say that CAI, as originally conceived, was a direct descendent of programmed instruction, and many of the early uses of computers for teaching purposes constituted adaptations of the teaching machine. Here the computer serves as an electronic tutor, and took the student, frame by frame, through the course material (Knapper, 1980, p.27).
Skinner integrated the mechanization concepts of the German tradition with sound psychological principles in his first teaching machines. He wrote programmed texts which systematically applied principles of human learning and retention. Skinner's approach markedly differed from that of Pressey's as he did not initially view his apparatus as a mere presentation device but more as a means of controlling and recording behavior. In addition, Skinner's "program" was not conceived as a test but as instruction. Accordingly, he developed the concept of a frame which featured a displayed unit of instruction to the student. This unit essentially paired a conditioned stimulus with a conditioned response if it were a teaching frame.... Skinner provided cues to aid in student recall and frequent opportunities to practice. As behavior was "shaped" and "controlled" to the desired reliability in responding, Skinner reduced the amount of stimuli to the student. Collectively, these techniques were known as "programming" and represented the first necessary breakthrough to automatic instruction by mechanical devices (Blaisdell, 1976, p.164).

The first computer-based instructional language, known as "coursewriter" was developed by the International Machine Corporation (IBM) in 1960 to enable educators to develop their instructional modules (Suppes and Macken, 1978).

In this section, a brief description of CBI development was presented. In the following section, the two learning theories which influenced computer based instruction will be discussed.

The Main Learning Theories Related To CBI

The design and production of effective courseware needs to be accomplished so it will cause the desired kind of
change (learning) in the student, and this requires a learning theory. That is, courseware as content and methodology, in order to be well-produced, necessitates specific suggestions about instruction derived from learning theories. It is essential that a prospective courseware writer should have a sound background in both educational theory and practice. In particular, a knowledge of theories regarding the process of learning is important. In fact, as Gagne and Briggs (1974, p. 19) pointed out, "designing instruction must be based upon knowledge of how human beings learn." A courseware writer must know how learning takes place if the intended courseware is to be effective.

Most educational theorists agree that learning involves changes in behavior. Disagreement arises when the problem of whether this behavioral change is external and easily observable or whether the behavioral change is internalized (thinking, considering) and not so easily observable. There are many learning theories, and each one can provide a model, but taking into account the above problem, learning theorists fall into two main classes. (1) The stimulus-response (S-R) theorists, who emphasize the notion of learning as observable and somewhat predictable. (2) The cognitive-theorists, on the other hand, place emphasis on the role of perception in learning, and they "do not accept the S-R theorists' view of the learner as a mechanistic and predictable organism" (Crawford, 1981, p. 10).
In general, the two learning theorists who have had the greatest impact upon CBI during the last two or three decades are probably Skinner and Gagne.

**Skinner's Theory**


Skinner's work has been concerned with an analysis of the effects of reinforcement in learnings, and the designing of techniques by which reinforcement can be manipulated with considerable precision. He believes that in order to take advantage of recent advances in the study of learning, the teacher must have the help of mechanical devices.

The main factors in Skinner's analysis of instruction are that motivation should be available in the student's environment, the student should exhibit a change in behavior in terms of a response, and that behavior should have consequences in terms of reinforcement.

The following quotes by Skinner focus around the main points of his theory:
Special techniques have been designed to arrange what are called "contingencies of reinforcement" -- the relations which prevail between behavior on one hand and the consequences of that behavior on the other -- with the result that a much more effective control of behavior has been achieved....

Recent improvements in the conditions which control behavior in the field of learning are of two principal sorts. The Law Of Effect has been taken seriously; we have made sure that effects do occur and that they occur under conditions which are optimal for producing the changes called learning. Once we have arranged the particular type of consequence called a reinforcement, our techniques permit us to shape up the behavior of an organism almost at will....

In spite of great phylogenetic differences, all these organisms show amazingly similar properties of the learning process. It should be emphasized that this has been achieved by analyzing the effects of reinforcement and by designing techniques which manipulate reinforcement with considerable precision. Only in this way can the behavior of the individual organism be brought under such precise control. It is also important to note that through a gradual advance to complex interrelations among responses, the same degree of rigor is being extended to behavior which would usually be assigned to such field as perception, thinking, and personality dynamics (Skinner, 1954, pp. 86-97).

Gagne explains Skinner's theory in the following main points:

Skinner's analysis of instruction assumes that motivation must be present, that the student must make a response, and that this response needs to have consequences which are reinforcing. The increased specificity of Skinner's suggestions center around the principle of stimulus control (Gagne, 1970).

In Gagne's point of view, Skinner suggested three principles of controlling the learning process by suitable arrangements of the contingencies of reinforcement:
1. The principle of "shaping", applicable to the learning of motor acts.

2. The principle of successive approximation of stimulus control, in which a response which was originally "promoted" comes to be given properly even when the prompt has been progressively "faded".

3. The principle of chaining, which describes the conditions of reinforcement by means of which a lengthy procedure is learned.

Thus, it may be seen that the learning theory of Skinner leads to some relatively specific suggestions about the design of instruction. It gives us practical procedures for shaping motor responses, for establishing discriminations by successive approximations of stimuli, and for chaining together the steps in complex procedures (Gagne, 1970).

Romoszowski (1981, p.166), in an analysis of some learning theories, comments on Skinner's theory and its effects on courseware writing in the following words:

The behaviorist position as exemplified by Skinner is based on a definition of learning as an observable change in behavior (not caused by physical motivation or growth)... Desired behaviors are taught by a series of successive approximations, beginning from an already established behavior and working towards the desired behavior. The process is based on the principle of reinforcement expounded by Skinner, a somewhat more precise restatement of Thorndike's Law Of Effect (1927).

Skinner defined reinforcement of behavior as the applying of a reinforcer in order to increase the probability of given behavior being exhibited. Therefor, the teacher (courseware writer) has to:
1. Arrange the stimulus,
2. Observe the learners response,
3. Reinforce desired responses and withhold reinforcement if responses are not desired.

Thus, Skinner's theory of instruction requires no theory of learning process. Using systems terminology, it is an input-output learning theory, treating the learner as a "black box".

Hattingh (1976), in his appraisal of Skinner's theory and method of programming, has a somewhat different point of view. He comments in the following words, as well as listing Skinner's laws of behavior:

Skinner's essential view of learning is that it is inculcation (by means of conditioning and reinforcement as a technique of behavioral adaptation) of new modes of behavior and the building up of complex behavioral structures. According to this author, it can be of service to education since the adult is the principal product of his experiences which condition and reinforce behavior, to which he is subject from the day of his birth. What he consequently becomes can be predicted and controlled on condition that cognizance is taken of the variables which control his behavior in scientific manner. Learning or education is "shaping of behavior" (Hattingh, 1967, pp. 34-44).

The following are Skinner's laws of behavior:

1. Behavior is a response or reaction to a stimulus.
2. A response tends to repeat itself. That is, the mere fact one acted in such a way in a particular situation (to Skinner, a situation is always a stimulus
constellation) strengthens the possibility that one will repeat this behavior in a similar situation. Behavior or response is consequently "learning" in itself.

3. Each repetition of a response reinforces the possibility that the response will repeat itself in a similar situation. A person learns a mode of behavior by virtue of its repetition.

4. A response which has pleasant results is more likely to be repeated than one with unpleasant effects. That is, pleasant results reinforce behavior, whereas unpleasant results strengthen the possibility that a mode of behavior will not be repeated; it will be forgotten.

5. A situation which cannot itself elicit a particular mode of behavior later obtains that power if it has acted a number of times in conjunction with another stimulus which does in fact elicit the behavior. It is consequently a conditional stimulus.

6. Effects which, in themselves, do not initially reinforce behavior, eventually obtain a power which reinforces and elicits behavior after it has acted a number of times in conjunction with a behavioral booster.

7. "Intermittent Reinforcement", according to particular schedules, may sometimes have greater reinforcing
power than regular reinforcement. If, for instance, food is offered as a reward for a particular response on ten consecutive occasions, the probability is not so great that the response concerned will act in a week's time as when those ten rewards are distributed, that is when each response is not rewarded individually.

**Gagne Theory**

The ideas of Gagne regarding the learning process are more specific than Skinner's. Gagne distinguishes between eight major kinds of mental processing, each of which has a different set of conditions for its optimum occurrence (Gagne, 1970).

Romiszowski (1981), in his explanation of Gagne's hierarchical list of eight categories of learning, describes these categories as follows:

The list is hierarchical in the sense that it proceeds from very simple conditioning of learning up to complex learning such as that involved in problem solving. It is also hierarchical in the sense that lower levels of learning are prerequisite to higher levels. The eight types of learning are:

1. Signal Learning.
2. Stimulus-Response Learning.
3. Chaining.
6. Concept Learning
8. Problem Solving.

To Romiszowski, Gagne's model embraces the models of Skinner and of Gilbert. It also includes the very primitive type of Pavlovian conditioning, which is only of marginal concern to teachers above kindergarten level. For higher intellectual learning, Gagne presents two alternative strategies: (1) the Expository (from rule to example) strategy, and (2) the Guided-Discovery (from example to rule) strategy.

The literature contains a number of attempts to describe different types or levels of learning such that they are both useful and practical from the point of instruction. The most famous of these is Bloom's Taxonomy Of Educational Objectives. The taxonomy gained much publicity for its concreteness and practicability for instructional development purposes. The following situations support this point:

The idea of the classification system which came to be known as Bloom's Taxonomy Of Educational Objectives, originated with a group of college examiners who expressed a need for a theoretical framework to facilitate communication among examiners. The Taxonomy has proved useful for test development purposes and has also been widely accepted as an instruction and curriculum development tool, (Hall, et al, 1982, p.12).

Bloom's attempt at a classification of learning process has proved extremely valuable, and has been adopted by many educationalists. Strictly speaking, Bloom's is a taxonomy of learning objec-
tives, rather than learning itself. However, it provides a worthwhile classification system for both.... A teacher designing a piece of instruction can consult the list to help identify which type or types of learning are involved in the particular material or tasks to be taught (Knapper, 1980, p.70).

In this section, the two learning theories that affected computer based instruction were presented. Evaluative points of views of courseware produced during the previous twenty years will be discussed in the following section.

An Assessment Of CBI During The Last Two Decades

The assessment of the existing courseware must be looked at in two ways. The first way deals with the teaching effectiveness of courseware as a new medium of teaching compared to traditional methods of teaching. This aspect of CBI as a method of teaching is not of concern in this particular study. Most research done in this area actually shows that the educational outcomes of computer-based instruction method, using professionally developed courseware, are superior to the traditional teacher-centered methods of teaching.

The second aspect of assessing the existing courseware looks at the quality of production and the instructional worth of most of the courseware produced in the 1960's, the 1970's, and the early 1980's. The following is presented in order to give an idea of the main functions of a CBI courseware lesson.
Computer-Based Instruction involves the learner in a tutorial interaction with programmed instruction. The instructional computer program (courseware lesson) is capable of recognizing the present level of knowledge attained by the learner through a diagnostic pretest, providing an optional-track of learning which is commensurate with this level of knowledge through branching, and directing the student towards educational objectives selected by the teacher who designed and produced the courseware instructional unit. Also, CBI provides immediate feedback to the learner's responses, provides assessment to his or her accomplishment at the moment, and an overall evaluation of the learner's outcomes of that unit through a posttest. These instructional materials may be revised at any time, but they do not require the time consuming rewriting and reprinting, as do printed materials.

In early 1967, the effects of computer technology on education led to a study involving ten educators and scientists who formed a travelling seminar to inspect the state of the art for Computer-Assisted Instruction at seven research and development centers throughout the United States. The panel agreed on the following four principles to aid policy development for use of computers in education, and at the same time to give an indication of the existing courseware up to that time (Morgolin and Misch, 1967):

1. A systematic approach to the achievement of educational goals is required.
2. The development of models is useful for the synthesis, presentation, and testing of new systems.
3. The computer has vast potential as an administrative aid to education.

4. The introduction of computers into the schools to deal with clerical and administrative problems will lead to use of computers in an instructional capacity.

The Advisory Committee On Issues In Educational Technology, (Heath, 1974, pp.37.43), under "Courseware Improvement", refered to the existing courseware status up to the early 1970's as follows:

Fundamental to the application of any new media to education are the quality and content of courseware materials. To win acceptance in schools and colleges the materials must be consistently of high quality, and until now this has not been the case.

Out of seven major technical issues and needs that most involve high technology, the same source lists the following two issues that deal with courseware in the main:

1. Courseware improvement through the development of consistently high quality learning materials.
2. Establishment of consumer and information standards to resolve hardware and software compatibility problems, and to assure that only validated courseware materials are disseminated to users.

The committee recommended that the most productive avenue to the design of courseware for individualized instruction
development is a systems approach, which includes considerations of the following:

1. Analysis of learners' background in terms of previous knowledge or skills, educational goals, and interests.

2. Specification of competencies to be acquired by the learners and development of the means for assessing achievement of these competencies.

3. Development of diagnostic entry tests.

4. Development of subject content.

5. Specification of teaching-learning activities, including the possibility of options for individual students.

6. Production of appropriate learning resources.

7. Pilot testing as a basis for revision.

8. Overall evaluation of the new courseware in terms of its acceptability, effects on learning, and cost-effectiveness.

This approach implies a shift from an emphasis on teaching to one on learning, the design of courseware primarily for use by the learner rather than the teacher, and for use by individuals as well as groups.

Commenting on the courseware bottleneck, the same committee recommended practical measures to improve the quality of courseware:
Some of the major efforts in this direction should include the development of some prototype systems of instructional courseware such as the Physical Science Study Committee (PSSC) and the Biological Science Curriculum Committee (BSCS) material and in a number of computer-assisted instruction projects...

In general, the lack of good courseware has been a bottleneck in the past in many instructional areas. On the other hand, improved hardware design could greatly facilitate the production of better courseware (Heath, 1974).

Braun (1980) pointed out the low quality of existing courseware in the context of establishing three reasons for the minimal application of computers in the instructional process:

1. A lack of high quality courseware.
2. A lack of trained teachers and instructional designers in the field of computers in education.
3. The previously high cost of providing computing to most schools.

Although the development of inexpensive microcomputers has eliminated the cost factor as a deterrent to computers in the schools, the lack of good courseware and the lack of trained teachers and administrators are still compelling issues.

Hall, et al (1982, p.1) give a clear picture about the low quality of courseware up to early 1980's, and at the same time point out the weak method followed by teachers and computer people who are frequently the courseware producers:
However, courseware development is now the purview of anyone with a microcomputer, many of whom are ill-prepared to develop quality materials.

Teachers and "computerists" are frequently the authors of CBI courseware. Teachers primarily focus on the act of teaching and the role of the teacher in the process. Typically their experience includes "explaining" and "telling" 20 students simultaneously.

Dwyer (1980), in the following quote, gave a general definition to courseware, and at the same time he pointed to one of the poor aspects, by which available courseware is characterized:

Computer courseware will be one of the major focuses of researchers in the next few years. Computer courseware is that material which has been designed to be used on a computer and to help teachers use the computer for instruction. A large amount of this material takes the form of prepackaged teaching programs that ignore the built-in inventive streak found in most students (Dwyer, 1980, pp.72-84).

Chambers and Bork (1980) divided current courseware into three areas and maintained that more than 45 percent of this courseware is written by computer vendors and non-specialized persons:

At the present time, the courseware available falls into three main areas: (1) games and simulations, (2) drill and practice, (3) tutorial.... In addition, more than 45 percent of these packages are developed and distributed by computer vendors and have not been produced by instructional designers (Chambers and Bork, 1980).
The above discussion focussed the light on assessing already produced courseware up to early 1980's. The following section will present certain features and criterion elements, which are identified in literature, and have their impact on courseware production.

**Research Findings**

Computer based instruction, like any other discipline, is a broad field. Recent literature contains many research studies which deal with various aspects of CBI. The aspect of research findings which highlights the features, attributes, and criterion elements in courseware production is one of the concerns of this study.

The original development of the courseware criteria, in the present study, was based mainly upon a thorough review of literature in the fields of computer based instruction, instructional design, and learning theories. This activity involved investigating those features, characteristic areas, and attributes that would have a potential impact on learning during the instructional process.

The features and characteristic areas may range from correct coding, which allows the lesson to execute properly, to pedagogical features, which contribute to effective instruction. Pedagogical features might include screen layout, goals and objectives, pretest and posttest, interaction be-
tween the student and the computer, questioning and feedback, text structuring, motivators, graphics, sound, and individual differences among learners, among other things.

This section presents the research findings of some of these features which are assumed to have the most powerful impact on the learning process.

1. Design Procedures

It is the teacher who is a courseware writer who needs to be trained to analyze the learning situation and derive appropriate objectives, and it is the teacher as courseware writer who needs to be trained to "design" appropriate "instructional strategy" for a courseware unit.

The word "design" is a flexible term. It has different levels of meanings to different writers. Mast (1978, p.337), in his paper, "A Modular CBI System", uses the term "design" to involve most of the major steps in CBI production.

We mean with the "design" the completion of the process of making a lesson, i.e.

1. Formulating the objectives.
2. Structuring the courseware material.
3. Choice of the educational strategy.
5. Compilation or translation into a final shape.

With the "presentation" of a lesson we mean:
1. Presenting the instructional material.
2. Analysis of the responses from the students.
3. Deciding on the processing of the lesson.

While "recording" consists of the storage of:
1. All responses of students.
2. The response times.
3. The path followed through the lesson.

To other writers the term "design" contains more detailed steps and appears to be more comprehensive. Briggs and Wagner (1931, p.5) refer to the number of stages involved in this term, which in fact form a complete cycle for instructional units.

Each author describing a systems-model for "design" of instruction may use somewhat different terminology and may list varying numbers of stages in the work. Also, any one author may present a somewhat different list of stages to different audiences upon various occasions over a period of time. The following list shows the major stages in the design of instruction:

2. Prepare tests over the objectives.
3. Analyze objectives for structure and sequence.
4. Identify assumed entering competencies.
5. Prepare pretests and remedial instruction; or plan an adaptive program; or plan a dual track program.

6. Select media and write prescriptions.

7. Develop first-draft materials.

8. Small-group tryouts and revisions.

9. Classroom tryouts and revisions.


Rowntree (1979, p. 132) suggests a list of steps for the design of instruction as follows:

1. Articulating aims and objectives for any course (or unit) you prepose to produce.

2. Identifying the prerequisite skills and knowledge you are assuming of students for your course (or unit).

3. Selecting content for your unit and organizing it into a "learnable" sequence of lessons or modules.

4. Identifying the teaching media available for your course (or unit) and determining the role each is to play.

5. Structuring each self-instructional lesson, unit, or module so as to enable your students to learn most effectively.

6. Designing assessment tests or methods that give a true indication of what each student has learned from your course as a whole and from individual lessons, units, or modules.
7. Evaluating your self-instructional course (or unit) by critical analysis and by trying it out on students, and thus identifying its effects and effectiveness.

8. Improving your course in the light of evaluation.

As we notice, "design" is generally a flexible activity. The courseware writer may list varying numbers of steps in the work. The important thing which should be remembered is that the essential elements in the whole process should be included somewhere in the appropriate step of any proposed list.

2. Student Interaction

Interaction is at the heart of the educational process. The quality and frequency of such interaction have been the subject of much research and the source of much controversy.

At the heart of interaction is adaptability. "Adaptive instruction has become a way of conceptualizing what we are trying to do in designing powerful computer based instructional materials," (Tennyson and Park, 1981). Tennyson has been developing some sophisticated models for adaptive instruction using Bayesian statistical techniques. This form of instruction uses the power of the computer to monitor the moment-by-moment interaction with the student so that the instructional delivery can be altered according to student's
needs. From a "human factors" standpoint, adaptive instruction can offer one-to-one interaction with greater frequency and variance than can an individual teacher.

Mitzel (1970) describes providing an "adaptive education" for school and college learners. He defines adaptive education as the "tailoring of the subject matter presentations to fit requirements and capabilities of each learner." He sets forth five concepts which lead toward adaptive education:

1. Instruction is individual when the learner is allowed to proceed through content materials at a self-determined pace that is comfortable to him.
2. The learner should be able to work at convenient times.
3. The learner should begin instruction in a given subject at a point appropriate to past achievement.
4. Learners are inhibited by a small number of easily identifiable skills or knowledges; identification and prescriptive remediation will eliminate the difficulty.
5. Individualization can be achieved by furnishing the learner with a wealth of instructional media from which to choose.

Mitzel identified computer based instruction as the media which will most likely contribute more to adaptive education than other instructional modes.
3. Questioning And Feedback

Questioning and feedback are interrelated. A question is a mental construct that educators have devised, and about which little is known and a lot is assumed. "One of the CBI goals is to get students to focus on their depth of processing via questioning at various levels," (Andre, 1977). According to Andre, two problems have existed in the art of questioning:

6. The information sought did not go beyond the factual level.
7. There was an improper match between the form of the question and the anticipated response, that is, the question was either poorly worded, or it did not reveal the nature of the problem.

Bloom's taxonomy has received a lot of attention in the development of courseware, since it deals with different levels of learning, including questioning.

Hall, et al. (1982,p.15) in their comparison of Bloom's, Gagne's, and Merrill's taxonomies, came up with the following conclusions:

Although none of the existing taxonomies exhibited all of the desired characteristics, Bloom's taxonomy meets more of the criteria than any of the others and was therefore selected for scaling levels of learning.
Bloom's taxonomy will provide three important functions for courseware improvement: (1) establish a standard range of levels of learning (objectives), (2) raise author's consciousness of the range of instructional objectives and the improved quality of courseware when higher levels are included, and (3) provide course authoring prescriptions to produce courseware which will cause learners to perform at each level.

Feedback can be classified into two types: "reinforcement feedback", and "performance feedback".

**Reinforcement Feedback**

Since reinforcement increases the tendency of the student to make correct responses in subsequent trials, the correct response is instrumental in eliciting praise (reinforcement) from the courseware writer.

Crawford (1981, pp. 7-8) stresses the importance of reinforcement in CBI production and distinguishes between primary and secondary reinforcements:

Reinforcement plays a major role in this type of conditioning (operant conditioning). In CAI development it is therefore crucial that incorrect responses are not positively reinforced.... It is important for the courseware designer to distinguish between primary and secondary reinforcement. Primary reinforcers are effective purely on their own merit. Secondary reinforcers, on the other hand, are only capable of generating a reinforcing effect if the student has previously associated them with other primary reinforcers....

Reinforcement in CAI need not follow every correct response (continuous reinforcement), but can, instead, be applied discontinuously by means of various reinforcement schedules, such as fixed-ratio, fixed-interval, variable-ratio, and variable-intervals.
Performance Feedback

Performance feedback simply provides the learner with information about performance and progress results. If the student is suitably motivated, performance feedback can serve as an important source of positive reinforcement.

Studies indicate that students learn more from courseware when they are provided with feedback than they do when no feedback is given (Tait, Hartly, and Anderson, 1974).

Performance feedback may be provided immediately following a response. It has been demonstrated that the efficiency of learning is often increased when students are provided with test scores immediately following completion of the test. In fact, it has been stated that "immediate feedback is one of the most powerful tools in the arsenal of instructional design," (Kulhavy, p.526).

4. Content Structure

Content material has to be presented and used most carefully and effectively. It should employ a structure that reveals, either explicitly or implicitly, the relationships among concepts.

Merrill and Tennyson (1977), Reigeluth and Merrill (1979), and Tennyson and Park (1980) have conducted research in developing useful concept hierarchies designed in the form of
superordinates, coordinate, and subordinate relationships. Scrutinizing these relationships forces the courseware writer to clarify the critical and variable attributes that have to be presented to the student in the courseware unit. Concepts can be built in a tree-like structure. A main or a superordinate concept might be Mammals, with Homo-sapins forming one subordinate branch, and Whales another. Critical attributes of each branch, such as using oxygen, make these two branches coordinate one to another, while both branches are subordinate to the main concept. Variable attributes, such as means of locomotion, differentiate between them. For more discriminations and generalizations to be made, more and more branching in the tree-like structure could be developed.

Gow (1980) points to certain criterion areas in organizing content material. One of these areas is the content structure, with emphasis on the importance of the sufficient and appropriate examples in concept-teaching.

The construct, structure, is an extremely important one and is supported in the research literature.... Without carefully structured scope and sequence, adaptability to individual needs is impossible. Appropriateness of content sequencing is judged simply by the logical ordering of content (i.e., temporally; simple to complex; concrete to abstract; familiar to unfamiliar; etc.) and the match of step size to target population.

Since each student's experiences are different, when a new concept is introduced, examples of concepts are best chosen from instances that it is safe to assume nearly all students will have encountered. Early in instruction, concept examples
should also be the most characteristic examples. That is, they should be examples which have the fewest irrelevant attributes. The range of examples should be extended as instruction continues. If a new concept is introduced with very few or inappropriate examples, the student may under- or over-generalize. Such instruction does not provide the student with opportunity to learn (Gow, 1980).

5. Objectives And Goals

The objectives of any instructional unit are tackled frequently in research literature. Some writers are convinced of the importance of listing the objectives explicitly at the outset of the courseware unit (e.g. MicroSIFT), while others want the objectives to be available either explicitly or implicitly.

The starting place being the instructional objectives. Based on these objectives, the student using the instructional package should learn what the material sets out to teach, rather than merely being engaged in the process (MicroSIFT, 1982, p.16).

Objectives, expressed or implied, are used to construct the framework of the curriculum structure. If made available to the students, objectives tell them what they must do, under what conditions and how well... In any purposful instruction, the objectives should be constructed to proceed from the entering behavior to the terminal behavior in small steps, so that the needs of all students may be met (Gow, 1980, p.10).

Winfield (1978, p.168) listed eight steps covering the instruction cycle built on the work of Gagne and Briggs (1974), in which the second step confirms informing the learner with the objectives:
1. State the objectives of the instruction.
2. Inform the learner of the objectives to be realized.
3. Provide learning guidance.
4. Learning guidance: providing a verbal definition.
5. Learning guidance: providing a variety of examples.
6. Present the stimulus and elicit the performance.
7. Provide feedback.
8. Assess attainment of objectives.

6. Motivators

Motivation is one of the essential pillars in the teaching learning process. The literature is rich in research papers and studies which maintain the importance of motivation in learning. Courseware writers are encouraged to consider motivators in their produced courseware.

Gow (1930) refers to a number of concepts which she considers as motivators if they are observed in a courseware unit as follows:

Self-direction, selection, and evaluation are motivators which may be highlighted in an instructor's manual.... A range of options and attention to site-specific interests are possible motivators, as is the knowledge that the instruction has utility in the student situation. Novelty and change are motivating too (Gow, 1980, pp.9-10).

MicroSIFT guide (1982) list nine criterion-items that should be available in a courseware package in order that courseware material be characterized by motivation:
1. Students are effectively addressed in a personal style.

2. Narratives in the program use humor and conversational manner.

3. The overall tenor of interaction is warm, friendly, and helpful.

4. A variety of responses to student inputs are used.

5. Reinforcement is positive and dignified.

6. A student is left with a desire to use the package again, or to pursue the topic in other ways.

7. The package provides for a variety of student response and response modes.

8. A student is left with a positive attitude about the experience.

9. Using the package is a pleasant experience.

7. Optimizing The Use Of Computer Features

Since the computer, as a hardware system, has tremendous features that could be exploited in different degrees if intended, it is recommended to optimize the use of all available features of the computer in problem-solving, in dealing with both learning and remedy of basic skills, as well as in effective evaluation procedures. Kurshan (1981), in the following quote, maintains these points of views:

Three areas of critical significance in the courseware development procedure should be especially relevant for instructional designers. First, courseware should use the inherent traits
of the computer as a tool for problem-solving. The computing process should be emphasized in programs which stimulate problem solving situations. Second, designers should use the computer for teaching and remediation of basic skills. The computer's patience is ideal for repetitive and hierarchical instructional sequence. Finally, courseware should be written with effective evaluation procedures. The unique capability of the computer to record all data related to student interactions can be used to review question validity, boredom, test results, time sequences, and student satisfaction. The interactive mode of the computer allows for truly impersonal interviews and responses from learners (Kurshan, 1981, p.30).

8. Testing And Implementation

The courseware development process cannot be considered complete until it has been fully tested and objectively evaluated. Field implementation, testing, and evaluation is a mandatory requirement prior to final release of the courseware package. Gerhold (1979, p.21) stresses the fact that "evaluation of courseware for the purposes of editing and improvement of that particular course is mandatory".

Examining the findings of objective evaluations, which result from the field testing, is the most efficient way by which the courseware writer can determine whether the courseware instructional unit actually realizes the broad and specific goals initially defined for that unit. In fact, this step will help the courseware writer observe which features were effective and which features were not, and to diagnose in order to make the necessary modifications.
Careful analysis of formal courseware evaluations can help the design team discover what features in the package were particularly effective and which features were ineffective. It may be necessary after examining the results of a courseware evaluation to make revisions in the package (Crawford, 1981, p.58).

Field testing and evaluation may be divided into two stages: "developmental testing", and "validation testing". The first stage should be conducted after the initial unit of instruction has been developed. This step serves the courseware developer to assess problems with the materials. Problems with vocabulary, pacing, and assumptions about every level skill can be determined. This process should be repeated until it is concluded that the instructional unit achieves its intended objectives. Moore, et al maintain these points in the following quote:

A two stage process is necessary in the validation of instruction. The first, developmental testing, is particularly sensitive and crucial.... What we are looking for in this stage of the validation process is how well we are communicating the concepts. We also look for voids in the instruction where we are not doing what we intend to do. In summary we are looking for weaknesses in the instruction.... During the developmental testing process the teacher should look for the difficulties that the student encounters and make notes so that the problems can be remedied (Moore, Beditent, and Scholes, 1978,p.296).

The second stage of field testing and evaluation is "validation testing", where the instructional unit should be tested and revised as needed on a group which is representative of a full range of the target population and under
classroom conditions. Of course this stage should permit a thorough analysis of what was intended, how well was it accomplished, and what modifications are needed to strengthen the produced courseware unit.

The final step in the validation process is validation testing under real classroom conditions with a full range of target population. If the developmental testing stage of validation has been appropriately executed, the revisions at the validation testing stage should usually be minor (Moore, et al., 1978, p.279).

9. General Criterion Elements

Before ending this section, it might be useful to cite briefly a list of general criterion elements maintained by Jelden (1981) which cover, in a broad sense, a courseware production cycle:

1. The content of instruction should be determined through content analysis and should be specified in terms of student performance objectives consisting of terminal performance and enabling objectives.

2. The pace of instruction should be controlled by the individual student to the maximum extent consistent with effective education practice.

3. Individual differences among students should be taken into account to provide the most effective and efficient learning paths in line with student aptitudes and needs.

4. Extensive use should be made of information feedback to assure response sensitive instruction.

5. The instruction should be presented in a modified single mainline track. Branching, looping and other techniques should be used
to promote efficiency and effectiveness of instruction, particularly for slow learners. Forward branching should be used to increase the efficiency of instruction for fast learners and others with prior knowledge of the subject matter.

6. A system should be established to evaluate student performance in terms of mastery of objectives.

7. Knowledge of results should be provided to the student. Correct answers should be confirmed and incorrect responses should be followed by immediate remediation.

8. Progress to a new increment of instruction should not be permitted unless a correct answer is obtained from the prior question.

9. Students should be afforded the opportunity to recycle through those portions of the instruction in which failure to meet objectives is evident.

10. The mainline sequence of instructional frames should be designed to achieve 85 percent correct responses by all students on the first try. Achievement of this objective should be determined through analysis of student performance data by trial and error in sample programs.

11. Effective use should be made of the instructor to assist students who encounter difficulty during instruction. The need for instructor assistance should be determined under program control by failure of the student to meet specified performance criteria. In addition, instructor assistance should be made available whenever requested by the student.

12. The instruction should consist of practical (hands-on) training to the extent dictated by the objectives.

13. Verbal and practical (hands-on) training should be integrated carefully to provide variety in presentation modes and to avoid over-dependence on verbal comprehension for mastery of concepts and skills.
14. The major portion of the subject matter should be converted to a CAI format. However, care must be exercised to avoid the use of CAI for instruction that can be presented just as effectively by more economical self-paced methods.

15. Liberal use should be made of graphics diagrams, schematics, etc., in conjunction with verbal presentation of subject matter. These will be assembled into a diagram book.

16. Vocabulary control should be exercised to keep reading comprehension requirements generally consistent with the reading ability of typical students. All programs should be written for the 10th grade level or below as determined by the FOG readability index.

17. Care should be taken to avoid lengthy presentations prior to a call for student response. No more than three frames should be presented without some student response, exceptions being review modules (U. S. Continental Army Command, May 1971, pp. 3-19).

Summary

Chapter II presented a historical background about the development of computer based instruction, brief description of two learning theories upon which CBI is mostly based, an assessment of courseware produced during the last two decades, and finally some research findings.

The research findings section examined the most important areas or attributes that would have a potential impact upon learning during the instructional process. Some areas and some general criterion elements for courseware production
based upon research studies and learning theories were identified.

The low quality of the present courseware should motivate concerned people to do their best through exploiting all facilities required in order to raise the standard of courseware. One available means to achieve this goal is the development and validation of criteria for courseware production.

In the next chapter, methodology procedures will be presented. That will include a description of how the criteria were developed and validated, how the sample of experts was selected, and how the data were collected and analyzed.
Chapter III
METHODOLOGY

Overview Of Method

The basic purpose of this study is to develop and validate criteria for the design and production of computer based instructional courseware. In an effort to achieve this purpose, a seven phase procedure was employed: First, related research was reviewed in an effort to identify the major areas, as well as the criterion elements in each area, that would form the initial criteria. Next, the identified major areas and their item elements were compared to Bloom's levels of learning. Each area or criterion element was retained if it appeared that it would be required to realize at least one of Bloom's six levels of learning. Third, questionnaire-type items consisting of the major areas and the specific criterion elements were prepared in a Likert-Scale format. Fourth, the questionnaires were subjected to a pilot validation process by a group of faculty members from The Ohio State University who were considered authorities in the field. For the purpose of this study, each faculty member whose interest was individualized instruc-
tion, programmed instruction, or computer based instruction was included in the pilot validation process and asked to verify each item. Fifth, following that initial determination by authorities at the Ohio State University, the criteria were revised according to those authorities' judgments and suggestions, to come up with a revised version of the criteria. Sixth, the revised version of the criteria was submitted to persons around the United States, who are known to be authorities in the field, for their validation. Seventh, the validated major areas and the specific criterion-items that achieved 90 percent or more agreement by authorities formed the final criterion-instrument or guide for courseware production. The following section will present an elaboration of how the criteria were developed and validated.

The Criteria Sources

The starting point was to compile a list of areas and criterion items from the literature that would form the needed criteria for courseware production. This involved investigating those areas and attributes which would have a potential impact upon learning during the instructional process and are clearly observable in a courseware instructional unit, so that a courseware writer can assess their presence or absence during the courseware development process. The first step in the activity was to compile an initial
list of criteria which attempted to specify those areas and attributes that are necessary to be considered in the design and production of courseware. Three sources were consulted during this process:

1. The first source for developing the criteria was the research findings that were obtained from a thorough review of literature in the areas of computer based instruction, instructional design, and learning theories. A number of areas as well as a set of criterion elements in each area were identified.

2. The second source was the evaluation manuals or guides of computer based instruction. In fact, there are few manuals for evaluating existing courseware packages which describe for the user the main features that should be observed before adopting ready made courseware packages. Although the evaluative criteria do differ from the developmental criteria in some aspects, the two sets of criteria still have some aspects in common.

3. The third type of source for developing and compiling the criteria was the subject matter experts. Those form the first group of authorities who performed the pilot validation process. In addition to validating the list of criterion items sent to them in questionnaire-type, those people were asked to suggest any criterion item that he or she would suggest be added to the list.
The Development Of The Criteria

Having reviewed the literature, singled out the areas and the criterion elements in each area, and compiled the initial list of criteria, the first phase was considered done.

The development of the criteria covered two phases out of the seven-phase process; phase two and phase three. Phase two of the process was devoted to assessing each of the identified areas and the criterion items in each area. It was assumed that the development process of the major areas and the items in each area would take into consideration two dimensions simultaneously. The two dimensions consist of the major areas and Bloom's six levels of learning. Appendix A shows the suggested matrix-table which consists of the areas along the table against Bloom's six levels of learning across the table. In order to establish the left column of the table, which consists of the major areas and their item elements, the following procedure was followed.

Each recommended area that had been identified from literature and evaluation manuals, was taken and placed temporarily in a cell of the left column of the table and passed horizontally against each level of Bloom's six levels of learning to see if that area was needed for that level of learning. If that particular area is really needed to realize at least one of Bloom's six levels of learning, during the learning process, it was retained in the list.
The same procedure was followed in developing the item elements in each area. That is, each suggested criterion item was passed horizontally against Bloom's learning levels, and if that particular item was really needed to realize at least one of Bloom's six levels of learning, during the learning process, it was retained in that area.

The above mentioned procedure was considered to form the logical conceptual framework behind the development of the major areas and the criterion elements in each area prior to the pilot validation process, in which faculty members from The Ohio State University were asked to make their judgments.

The third phase in this process was to form questionnaire-type items for the identified major areas and the specific criterion items in each area, which were designed in a Likert-Scale format. The resulting item-type questionnaire forms the preliminary criteria instrument, in which each criterion item is followed by six-point scale: strongly agree (SA), agree (A), mildly agree (MA), mildly disagree (MU), disagree (D), and strongly disagree (SD).

Validating The Criteria

The validation process of the criteria covers the fourth, fifth, sixth, and the seventh phases of the whole activity.
In the fourth phase the questionnaires resulting from phase three were subjected to a pilot validation process by a group of faculty members at The Ohio State University who were considered authorities in the field. Each member was asked to indicate the extent to which he or she would agree or disagree that the criterion item was appropriate and important, according to the scale provided. Appendix B shows the covering letter, as well as the initial criteria prior to the pilot validation process.

The fifth phase of this activity resulted in reproducing a revised version of the criteria according to authorities' judgments obtained in the fourth phase.

In phase six, the revised version of these criteria were used in the final validation process. Copies of these criteria, in a questionnaire-type format, were sent to 327 persons from around the United States, who were known to be authorities in the field, for their validation. A more complete description of the sample will be presented in the Sample Selection section. The set of criteria in questionnaire-type format that was mailed out to the sample members is reported in Appendix C.

The seventh phase of this process consisted in analyzing the data contained in the returned questionnaires. Each item that obtained: (1) 90 percent agreement or more in
both the "frequency method" and the "weighted-scale method", (2) an average of 2.00 points, (3) a standard deviation equal to 1.10 or less, and (4) a standard error of the mean less than or equal to 0.10 was considered a valid item and retained in the final criterion instrument. A more detailed description of the analysis procedure will be presented in the "Data Analysis" section.

Having described the development and validation stages of the criteria, the following section will explain how the experts were selected.

Sample Selection

It was mentioned earlier that the criteria, in their two versions, were submitted to two samples of experts in the validation process. The first sample consisted of faculty members of The Ohio State University, who were considered authorities in at least one of the following fields: individualized instruction, programmed instruction, or computer based instruction. The 27 members, who were selected to participate in the pilot validation process, formed that sample.

To validate the final revised version of the criteria, a second sample of authorities from around the United States was selected. This sample consisted of persons from the following three distinct population groups.
1. The MicroSIFT members: MicroSIFT stands for Microcomputer Software Information for Teachers, and is a project of the Computer Technology Program of the Northwest Regional Educational Laboratory. MicroSIFT coordinates the systematic evaluation of educational courseware aimed at elementary and secondary classrooms. This group consists of 26 members, all of whom were included in the sample.

2. Special Interest Groups in the Association for the Development of Computer Based Instructional Systems (ADCIS): Those people are involved in research and development related to design and development of computer software for instruction. The list of addresses received from a concerned source consists of 450 members, of which 150 members were randomly selected for the sample.

3. The American Educational Research Association (AERA): Members of Group C (Learning and Instruction) add up to about 6500 people, according to the AERA 1983 Catalogue. Out of this population, 151 members were selected randomly.

Adding up the above selected subsamples, the resulting sample size for validating the revised version of the criteria was 327 members.
The last section described the two samples of authorities involved in the two validation processes and how the members of experts were selected. The next section of this chapter will describe how the data were collected and analyzed.

**Instrumentation And Data Analysis**

Summing up briefly some of what was mentioned earlier: the main objective of this study was to develop and validate criteria for computer courseware production. Main areas or attributes that would have a potential impact upon learning during the instructional process as well as criterion items were identified through a review of literature. To form the initial criteria, a compilation procedure was adopted by checking each area and the criterion elements in that area against Bloom's six levels of learning. The obtained areas and criterion items were organized in an item-type questionnaire, with six-point scale, to form the preliminary criteria instrument.

In the pilot validation process on the initial criteria, and in the last validation stage on the final revised version of the criteria, authorities were asked to respond to each criterion element by indicating the extent of their agreement or disagreement on a six-point scale: strongly agree (SA), agree (A), mildly agree (MA), mildly disagree (MD), disagree (D), or strongly disagree (SD) as it appears in the following figure:
In order to identify the criterion items that were of statistical significance, the following five conditions should be met simultaneously:

1. 90 percent agreement or more should be obtained by an item using the "frequency method".
2. 90 percent agreement or more should be obtained by an item using the "weighted-scale method".
3. A mean value of 2.00 points or more should be obtained by that item.
4. A standard deviation of 1.10 or less for the distribution of that item.
5. A standard error of the mean equal to or less than 0.10.

Justifications for selecting these five conditions will be explained in Chapter IV. The following paragraph will describe how the two percentages of agreement were calculated.

Since the proposed six-point attitudinal scale is continuous in nature, which ranges from strongly agree on one end of the line to strongly disagree on the other end of the continuum, the obtained categorical data for each item were assumed to fall in one of the two parts: the "agreement
part", or the "disagreement part", and were treated on this basis. In fact, the following two approaches were used in calculating the percentage of experts' agreement, and in analyzing the significance of each criterion item.

1. The frequency approach: In this procedure, the frequencies of respondents corresponding to any of the three levels of agreement (strongly agree, agree, and mildly agree) were added up to form the total frequency of the "agreement part" for that item. Also, the frequencies of respondents corresponding to any of the three levels of disagreement (mildly disagree, disagree, or strongly disagree) were added up to give the total frequency of the "disagreement part" for that item. Relating the frequency of the "agreement part" to the sum of the two frequencies for any particular item, the percentage of experts who were in favor of that item was obtained.

2. The weighted-scale approach: In this approach, the six levels of the scale -- strongly agree, agree, mildly agree, mildly disagree, disagree, and strongly disagree -- were given the scale weights +3, +2, +1, -1, -2, and -3 respectively. The frequencies of the three levels of the "agreement part" were multiplied by their corresponding weights and added up to give the total weighted-scale value for that part. The
same calculation procedure was followed to obtain the weighted-scale value for the "disagreement part" of that item. Then the percentage of respondents who were in favor of any item was determined by relating the weighted-scale value of the "agreement part" to the sum of the absolute value of the two weighted-scale values for that item.

Summary

Chapter III explained the methodological procedures followed in this study where a seven-phase procedure was employed. One section described the sources of the criteria and how the criterion items were identified. Another section elaborated the phases through which the criteria were developed, by reviewing literature and using the Bloom's six levels of learning. A third section traced the phases through which the two validating processes were conducted. The sample selection section defined the two samples of experts who participated in the two validation processes. The last section of this chapter explained how the data were collected and analyzed.

Chapter IV will deal with data analysis. It will explain how statistical significance was determined for each single criterion item using the obtained two agreement percentages of experts, the average points obtained by each item, the
standard deviations, as well as the standard errors of the means. Of course, the necessary statistical tables will be presented.
Chapter IV

DATA ANALYSIS AND DISCUSSION

Chapter III presented the methodological procedures followed in this study. It explained how the criterion items were identified from three different sources, how they were compiled, and how they were developed. The two validation processes, the "pilot validation" process and the "final validation" process, were also described. The two samples of subject matter experts who participated in the two validation processes were defined. Finally, a brief idea about how the data were collected and analyzed was presented.

Chapter IV deals with data analysis. It tackles the statistical significance of each criterion item, as those items were perceived by experts in the field. The five conditions adopted as standards for deciding whether a criterion item is valid are defined and justified. Valid criterion items that met the five screening conditions are identified, listed, and discussed by area and phase of the courseware development process. Appendix E shows the number of each item of the criteria, as well as the five statistics corresponding to that item before applying the five screening conditions.
Returned Questionnaires

It was mentioned earlier that the final revised version of the criteria, designed in a questionnaire-type format, was sent to a second sample of 327 authorities from around the United States. In all, 112 questionnaires out of 327 were answered and returned in the prescribed time as follows:

1. 13 questionnaires, out of 26, were received from the MicroSIFT group, forming a 50 percent return.

2. 51 questionnaires, out of 150, were received from the Special Interest Group in the Association for the Development of Computer Based Instructional Systems (ADCIS), giving a 34 percent return.

3. 48 questionnaires, out of 151, were received from the American Educational Research Association (AERA), giving a 35 percent return.

4. The total number of questionnaires received in time, which is 112 out of 327, gives a 34 percent return.

Fourteen more questionnaires were received after the deadline. Those returns were not considered.
Conditions Adopted For Valid Items

Since the study aims at validating the criterion items according to experts' judgments, the five conditions which were employed as a set of standards in order to decide whether an item is valid or not are the following:

1. A 90 percent agreement or more obtained by an item using the "frequency method".

2. A 90 percent agreement or more obtained by an item using the "weighted scale method".

3. A mean value of 2.00 points or more obtained by an item.

4. A standard deviation of 1.10 or less for the distribution of that item.

5. A standard error of the mean equal to 0.10 or less.

The rationale behind adopting these five screening conditions is as follows:

Regarding the 90 percent agreement or more, an item was singled out in the questionnaire-type format to determine the percentage of agreement recommended by experts. That item contains the following five options: 60%, 65%, 70%, 75%, and 80% or more. The "80% or more" option obtained the highest frequency. It has been concluded that the "80% or
more" option had obtained the highest frequency because it was the highest available option, and if an option such as "90% or more" was available in that item, the "90% or more" would probably have obtained the highest frequency. Therefore, the 90 percent agreement or more was adopted as a necessary, but not sufficient, condition for a valid item.

To justify a mean value of 2.00 points or more, a reference to the six-point attitudinal scale in pages 57-58 may be helpful. That scale ranges from "strongly agree" on one end of the line to "strongly disagree" on the other end of the continuum. The three levels of agreement -- strongly agree, agree, and mildly agree -- were given the scale weights +3, +2, and +1 respectively. The mean value or centroid of these three scale-weights equals to +2. This logic is assumed to be a sufficient justification for selecting 2.00 as a necessary, but not sufficient, condition for a criterion item to be valid.

Determining the critical values of the fourth and fifth conditions, that is, the standard deviation and the standard error of the mean, such ideas are inherent in the internal features of the criterion items reflected in experts' responses. A mean value of 2.00 was considered the basis for this determination. Looking at Tables 2 and 3 and the bar-graph in Figure 1, we come to the following conclusions:
1. 99 percent of the items which have mean values 2.00 or more have standard deviations less than or equal to 1.10, and they also have standard errors of the mean less than or equal to 0.10 (82 out of 83 items).

2. 95 percent of the items which have mean values less than 2.00 have standard deviations greater than 1.10 and standard errors of the mean greater than 0.10 (18 out of 19 items).

3. One percent of the items (one item out of 83) which has a mean value less than 2.00 has a standard deviation less than 1.10 and standard error of the mean less than or equal to .10.

Taking the critical values 1.10 or less for the standard deviations and 0.10 or less for the standard errors of the means, in addition to the above mentioned three conditions, will help in separating the sheeps from the goats. That is, it will result in an optimum categorization of valid items versus non-valid ones.

Meeting any one of the above described five standards is a necessary but not sufficient condition for an item to be valid. In order for a criterion item to be valid, it has to meet all of the above five screening conditions simultaneously.
### TABLE 1

**Frequency Distribution Showing the Mean Intervals, Standard Deviations, and the Standard Errors Of Means**

<table>
<thead>
<tr>
<th>Mean Intervals $\leq \bar{x} &lt;$</th>
<th>S.D. &lt; 1.10 And $\bar{x} &lt; 0.10$</th>
<th>S.D. &gt; 1.10 And $\bar{x} &gt; 0.10$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.80 $\leq \bar{x} &lt; 2.90$</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>2.70 $\leq \bar{x} &lt; 2.80$</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>2.60 $\leq \bar{x} &lt; 2.70$</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>2.50 $\leq \bar{x} &lt; 2.60$</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>2.40 $\leq \bar{x} &lt; 2.50$</td>
<td>14</td>
<td>-</td>
</tr>
<tr>
<td>2.30 $\leq \bar{x} &lt; 2.40$</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>2.20 $\leq \bar{x} &lt; 2.30$</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>2.10 $\leq \bar{x} &lt; 2.20$</td>
<td>15</td>
<td>-</td>
</tr>
<tr>
<td>2.00 $\leq \bar{x} &lt; 2.10$</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>1.90 $\leq \bar{x} &lt; 2.00$</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>1.80 $\leq \bar{x} &lt; 1.90$</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>1.70 $\leq \bar{x} &lt; 1.80$</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>1.60 $\leq \bar{x} &lt; 1.70$</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>1.50 $\leq \bar{x} &lt; 1.60$</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>1.40 $\leq \bar{x} &lt; 1.50$</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>0.90 $\leq \bar{x} &lt; 1.00$</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total** 83 18

### TABLE 2

**Four-Cell Distribution Showing Frequencies Within Mean Intervals Against Standard Deviations And Standard Errors Of Means**

<table>
<thead>
<tr>
<th>S.D. &lt; 1.10 And $\bar{x} &lt; 0.10$</th>
<th>S.D. &gt; 1.10 And $\bar{x} &gt; 0.10$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00 $\leq \bar{x} &lt; 2.9$</td>
<td>82</td>
</tr>
<tr>
<td>$\bar{x} &lt; 2.00$</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total** 83 18
FIGURE 1: A Bar-Graph Showing How The Criterion Items Are Divided Into Two Categories According To The Mean Values, Standard Deviations, And The Standard Errors Of The Means.
Screening The Valid Items

It should be recalled that the criterion items in the questionnaire-type format were grouped logically under different areas of the three major phases assumed for courseware production; the "analysis and design phase", the "production phase", and the "testing and evaluation phase".

In order to present statistical data clearly and meaningfully, a device has been followed such that the numbers of valid items in each phase are listed in a table which shows the item number and the five statistics corresponding to that item: that is, the two agreement percentages obtained by each item, the average of points obtained by each item, the standard deviation of the distribution of that average, and the standard error of the mean. In addition to the five corresponding statistics of each valid item, the statements of the valid items in each phase are listed in the same table, by number. Discussions highlighting the effect of valid criterion items on courseware production are presented.

I. Analysis And Design Phase

The development of computer based instructional courseware is not a simple activity. It requires a systematic approach which consists of the specific, well-related steps that should be followed to be sure that all components are designed to fit with each other, and identifies sequences of
activities designed to achieve the instructional goals. The
systems approach for computer courseware production may be
employed by an individual or a small team of individuals.
In this study the systems approach for developing instruc­
tional courseware was assumed to consist of three phases:
the "Analysis And Design Phase", the "Courseware Production
Phase", and the "Testing And Evaluation Phase". Each one of
these three major phases was subheaded by a number of areas.
Identified valid items in each area are discussed.

TABLE 3

The Five Statistics And The Statement Of Each Valid Item
In The Area "Setting The Objectives" Of The
"Analysis And Design Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage</th>
<th>Percentage</th>
<th>Mean Value</th>
<th>S.O.</th>
<th>S.E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>99%</td>
<td>98%</td>
<td>2.60</td>
<td>.7007</td>
<td>.0662</td>
</tr>
<tr>
<td>2.</td>
<td>98%</td>
<td>98%</td>
<td>2.25</td>
<td>.8623</td>
<td>.0815</td>
</tr>
<tr>
<td>3.</td>
<td>95%</td>
<td>91%</td>
<td>2.07</td>
<td>1.0243</td>
<td>.0968</td>
</tr>
</tbody>
</table>

1. Determine the unit of instruction to be taught.

2. Identify the primary objectives for learners in
   behavioral terms, for example, according to the
   six levels of Bloom's Taxonomy Cognitive Domain:
   Knowledge, Comprehension, Application, Analysis,
   Synthesis, and Evaluation.

3. Analyze the Instructional Objectives into more
   narrow performance objectives.

Table 3 lists the five corresponding statistics and the
statement of each valid item in the area "Setting The Objeec-
tives" of the "Analysis And Design Phase" by number.
This table contains three valid criterion items, each of which met the five screening conditions adopted to validate the criteria. The five corresponding statistics calculated for those items were as follows: the percentages of agreement varied between 91 percent and 99 percent, the mean value of the scale points ranged between 2.07 and 2.60. The standard deviation varied between 0.7007 and 1.0243, and the standard error of the mean ranged between 0.0662 and 0.0968.

Table 4 lists the five corresponding statistics and the statement of each valid criterion item in the area "Unit Breakdown And Task Analysis" of the "Analysis And Design Phase" by number.

This table consists of four valid items, out of five items listed under this area, each of which met the five screening conditions assigned to validate the criteria. The five statistics calculated for those items changed as follows: the percentages of agreement varied between 96 percent and 99 percent, the mean value ranged between 2.15 and 2.49, the standard deviation changed between 0.6779 and 0.9415, and the standard error of the mean varied between 0.0640 and 0.0889.
TABLE 4

The Five Statistics And The Statement Of Each Valid Item
In The Area "Unit Breakdown And Task Analysis" Of
The "Analysis And Design Phase", By Number

<table>
<thead>
<tr>
<th>Item Percentage</th>
<th>Percentage</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>No (Frequency)</td>
<td>(Wtd. Scale)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>------------</td>
<td>------------</td>
<td>------</td>
<td>-----</td>
</tr>
<tr>
<td>4.</td>
<td>99%</td>
<td>99%</td>
<td>2.49</td>
<td>.6779</td>
</tr>
<tr>
<td>5.</td>
<td>98%</td>
<td>98%</td>
<td>2.15</td>
<td>.8579</td>
</tr>
<tr>
<td>6.</td>
<td>96%</td>
<td>96%</td>
<td>2.41</td>
<td>.9415</td>
</tr>
<tr>
<td>7.</td>
<td>99%</td>
<td>99%</td>
<td>2.41</td>
<td>.7025</td>
</tr>
<tr>
<td>8.</td>
<td>98%</td>
<td>98%</td>
<td>2.31</td>
<td>.8334</td>
</tr>
</tbody>
</table>

4. Breakdown the unit into topics (or modules).

5. Identify the type of learning of each module
(whether it is discrete information, concepts,
principles, skills, attitudes, ...or any combination.

6. Determine the instructional-learning strategy to be
adopted (tutorial, drill and practice, simulation,
problem solving, etc.) in the courseware development.

7. Examine closely each objective to determine the steps
that learners must follow to realize that objective.

8. In the process of instructional task analysis, ask
repeatedly a question such as the following: "What
does the student need to know in order to realize
each objective?"

The analysis part of this phase is the first step in any
courseware development process. It must be employed to
determine the scope and the nature of the instructional ma-
terials required to meet and satisfy the given set of educa-
tional needs.

Having determined the courseware unit to be taught, the
courseware writer has to move to the assessment of needs,
goals, and priorities. The definition and the analysis of needs and constraints indicate which specific tasks must be learned in order that the student reaches the desired performance. Typical goals and objectives should be defined. Subgoals and sub-objectives in the student's behavioral terms, using Blooms' levels of learning, for example, should be described. According to the nature of the identified primary terminal objectives, a learning strategy should be selected, whether that strategy is tutorial, drill and practice, problem solving, or simulation. Dividing the unit into subunit components or modules is also essential. Having completed and documented the components of this phase, the courseware writer can move to the next phase, which is the "Courseware Production Phase".
II. Courseware Production Phase

The "production phase", in courseware development, follows the "analysis and design phase". In this study, this phase has been divided into a number of distinct areas or activities. To each activity a set of criterion elements has been assigned in order to control and optimize the courseware development process. During this phase, all initial drafts of instructional materials and tests specified in the analysis and design phase should be prepared.

Tables 5 to 18 list the numbers of the 68 valid items in the "Courseware Production Phase", the five corresponding statistics calculated for each item, as well as the statement of each item, by area. Of course, each item of those 68 criterion items had met the five screening conditions prescribed to test the validity of the criteria. The percentages of agreement obtained by those items ranged between 92 percent, and 100 percent. The mean values of scale points obtained by those items ranged between 2.01 and 2.85. The standard deviations varied between 0.3620 and 1.1020, and the standard errors of the means took values between 0.0342 and 0.1042.

1. The Unit-Title, Target Population

Table 5 shows the five statistics and the statement of each valid item in this area of the "Courseware Production
Phase". There are four valid criterion items contained in this area. All the four items which were initially listed under this area met the five conditions adopted for validating the criteria. The values of the five corresponding statistics calculated for those items varied as follows: the percentages of agreement ranged between 95 percent and 100 percent, the mean values were between 2.04 and 2.76, the standard deviations varied between 0.5234 and 1.0037, and the standard errors of the means ranged between 0.0495 and 0.0948.

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>Percentage (Wtd. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>96%</td>
<td>97%</td>
<td>2.13</td>
<td>.8750</td>
<td>.0827</td>
</tr>
<tr>
<td>11.</td>
<td>96%</td>
<td>96%</td>
<td>2.37</td>
<td>.9810</td>
<td>.0927</td>
</tr>
<tr>
<td>13.</td>
<td>96%</td>
<td>95%</td>
<td>2.04</td>
<td>1.0037</td>
<td>.0948</td>
</tr>
<tr>
<td>14.</td>
<td>100%</td>
<td>100%</td>
<td>2.76</td>
<td>.5234</td>
<td>.0495</td>
</tr>
</tbody>
</table>

10. The unit title, when displayed, should precede the courseware instructional unit.

11. The learner should be briefed on what is to be learned.

13. The specific competencies required as prerequisites for students to learn that unit should be described.

14. Instructions should be stated clearly.
Those criterion items refer to some important points that should be considered during courseware production. The title of the courseware unit should be displayed and precede the text of that unit. A brief idea informing the student about what is to be learned should be displayed. If that unit requires certain experiences and competences as prerequisites for learning that unit, they should be listed and displayed clearly. Those preliminary things are important, since they stimulate the student interest and create readiness on the part of the learner. He or she may begin reviewing some of the prerequisites before starting to learn that unit.

2. Displaying The Objectives

Table 6 presents the five statistics and the statement of each valid item in this area of the "Courseware production Phase." Three valid criterion items are listed under this area. Those items, three out of five items were listed under this area, met the five conditions selected for validation. The values of the five corresponding statistics calculated for each item ranged as follows: the percentages of agreement ranged between 95 percent and 98 percent, the mean values ranged between 2.13 and 2.54, the standard deviations varied between 0.7272 and 1.0328, and the standard errors of the means took values between 0.0687 and 0.0976.
TABLE 6

The Five Statistics And The Statement Of Each Valid Item In The Area "Objectives And Instructional Goals" Of The "Courseware Production Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>Percentage (Utd. Scale)</th>
<th>Mean Value S.I.</th>
<th>S.D.</th>
<th>Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.</td>
<td>96%</td>
<td>95%</td>
<td>2.17</td>
<td>1.0328</td>
<td>.0976</td>
</tr>
<tr>
<td>16.</td>
<td>98%</td>
<td>98%</td>
<td>2.54</td>
<td>.7272</td>
<td>.0687</td>
</tr>
<tr>
<td>17.</td>
<td>96%</td>
<td>95%</td>
<td>2.13</td>
<td>1.0323</td>
<td>.0975</td>
</tr>
</tbody>
</table>

15. Specific objectives of the unit should be displayed to the student.

16. Objectives-statements should be clear without multiple meanings or ambiguity.

17. Objectives should be stated in terms of expected student behavior.

The main purpose of the valid items in this area is to inform the learner of the specific objectives to be achieved at the end of learning that unit. The statements of the specific objectives should be clear, meaningful, in terms of the student's performance behavior, and they should be displayed to the student before displaying the text. For example, if the unit is about "Celsius and Fahrenheit", and if one of the listed objectives is, "the student should be able to convert any degree from either scale to the other", then the learner will store in his or her mind a target (among other targets) that he or she should be able to convert any given degree in either scale to its equivalent in the given second scale. It should be obvious that displayed specific
performance objectives will function as light-posts in the learning process on the part of the learner and encourage the student to realize these objectives.

3. Pretest And Review Areas:

Table 7 shows the five statistics and the statement of the valid item in this area of the "Courseware Production Phase". This area contains only one valid item, out of three items listed under this area, that met the five conditions already prescribed for validating the criteria. The five corresponding statistics obtained by that item were as follows: the percentages were 96 percent and 95 percent, the mean was 2.04, the standard deviation was 1.0126, and the standard error of the mean happened to be 0.0957.

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage</th>
<th>Percentage (Wtd. Scale)</th>
<th>Mean</th>
<th>S.D.</th>
<th>Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.</td>
<td>96%</td>
<td>95%</td>
<td>2.04</td>
<td>1.0126</td>
<td>0.0957</td>
</tr>
</tbody>
</table>

21. The pretest questions should cover the prerequisite knowledge necessary for learning new material.
The main objective of this area is that, if the courseware writer decides to make a pretest for diagnostic purposes, the pretest questions should cover the necessary prerequisite knowledge and competencies for learning that unit. The hidden purpose behind that is either to branch the learner to review some of the prerequisites in the same unit, or to ask him or her to go and review the prerequisite knowledge from another source. In either case, the purpose is to be sure that the learner's background is sufficient to qualify him or her to learn that unit successfully and start on a solid basis for mastering that unit.

4. Previous Experience:

Table 8 presents the five statistics and the statement of each valid item in the "Previous Experience" area of the "Courseware Production Phase". There are four valid criterion items listed under this area. These items, four out of five items originally listed, met the five standards adopted to validate the criteria. The values of the five corresponding statistics calculated for those four items were as follows: the percentages varied between 94 percent and 98 percent, the mean values ranged between 2.01 and 2.19, the standard deviations ranged between 0.7822 and 1.0287, and the standard errors of the means took values between 0.0739 and 0.0972.
The Five Statistics And The Statement Of Each Valid Item In The Area "Previous Experience" Of The "Courseware Production Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>Percentage (Wtd. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.</td>
<td>98%</td>
<td>98%</td>
<td>2.19</td>
<td>.7822</td>
<td>.0739</td>
</tr>
<tr>
<td>24.</td>
<td>96%</td>
<td>95%</td>
<td>2.15</td>
<td>.9279</td>
<td>.0877</td>
</tr>
<tr>
<td>25.</td>
<td>96%</td>
<td>95%</td>
<td>2.05</td>
<td>1.0250</td>
<td>.0969</td>
</tr>
<tr>
<td>27.</td>
<td>96%</td>
<td>94%</td>
<td>2.01</td>
<td>1.0287</td>
<td>.0972</td>
</tr>
</tbody>
</table>

23. In general, the previous experience level of the typical target population should be considered.

24. Specifically, the material to be taught should be related to the width and depth of what the learner already knows.

25. Prerequisite concepts, ideas, principles, etc. should be reviewed.

27. Known situations should be used to explain unknown ones using inductive reasoning.

The main purpose of this area is that the experience level of the target population for which the courseware unit is being produced should be carefully considered. The new material to be taught should be related to, and built upon, what the learner already knows. If certain concepts, ideas, or principles of previous experience are needed, it is preferable to be reviewed in the proper place. The inductive principle of reasoning should be adopted whenever necessary, where known situations are used to explain the unknown ones.
Table 9 presents the five statistics and the statement of each valid item in this area of the "Courseware Production Phase". This area contains eight valid criterion items. These eight items, out of ten items listed under this area, met the five conditions selected for validating the criteria. The values of the five corresponding statistics calculated for those items were as follows: the percentages ranged between 95 percent and 100 percent, the mean values ranged between 2.10 and 2.85, the standard deviations took values between 0.3620 and 1.0319, and the standard errors of the means varied between 0.0342 and 0.0975.

This area mainly stresses the validity of the content matter. The displayed text statements should be clear and meaningful. The unit should be divided into subunits or subtopics in a well-organized shape, in order to be controlled and mastered by the learner. Concerning the validity of information, the content material used in the courseware unit should be accurate, true, reliable, not outdated, and not improperly used. It may happen that the courseware writer finds in some textbooks, used as references for preparing the content matter, inaccurate scientific concepts or distorted historical events. In such cases, carefulness becomes imperative. Using more than one reference for the same topic is useful.
### TABLE 9

The Five Statistics And The Statement Of Each Valid Item In The Area "Text-Clarity, Format, And Accuracy Of Content" Of The "Courseware Production Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage</th>
<th>Percentage</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>S X</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Frequency)</td>
<td>(Wtd. Scale)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.</td>
<td>99%</td>
<td>99%</td>
<td>2.71</td>
<td>.8720</td>
<td>.0824</td>
</tr>
<tr>
<td>31.</td>
<td>97%</td>
<td>97%</td>
<td>2.10</td>
<td>.8462</td>
<td>.0799</td>
</tr>
<tr>
<td>32.</td>
<td>100%</td>
<td>100%</td>
<td>2.85</td>
<td>.3620</td>
<td>.0342</td>
</tr>
<tr>
<td>33.</td>
<td>96%</td>
<td>95%</td>
<td>2.36</td>
<td>1.0319</td>
<td>.0975</td>
</tr>
<tr>
<td>34.</td>
<td>100%</td>
<td>100%</td>
<td>2.68</td>
<td>.4906</td>
<td>.0464</td>
</tr>
<tr>
<td>35.</td>
<td>100%</td>
<td>100%</td>
<td>2.74</td>
<td>.5500</td>
<td>.0520</td>
</tr>
<tr>
<td>36.</td>
<td>100%</td>
<td>100%</td>
<td>2.75</td>
<td>.4559</td>
<td>.0431</td>
</tr>
<tr>
<td>37.</td>
<td>100%</td>
<td>100%</td>
<td>2.60</td>
<td>.5428</td>
<td>.0513</td>
</tr>
</tbody>
</table>

28. Instructions should be clear and meaningful.

31. Labels or headings should precede the different parts of the unit to identify them.

32. Content material should be accurate and error-free.

33. Content terminology should be consistent with those terms generally encountered by the student.

34. Content material should not be outdated.

35. Historical concepts in content material should be true and reliable.

36. Scientific concepts in content material should be accurate and clear.

37. Content material should not be improperly or invalidly used.
Table 10 presents the five statistics and the statement of each valid item in this area of the "Courseware Production Phase".

This area contains ten valid criterion items. All the ten items originally listed in this area met the five screening conditions adopted for validating the criteria. The percentages of agreement calculated for those items ranged from 93 percent and 100 percent. The mean values of scale points obtained by those items varied from 2.02 to 2.40. The standard deviations took values between 0.5728 and 1.1020, and the standard errors of means varied between 0.0541 and 0.1042.

The content structure activity is one of the most important activities in the courseware production process. It covers many tasks and subtasks that need extreme care. Naturally, the content structure should reflect the type of courseware under production, whether it is tutorial, drill and practice, simulation, problem solving, etc. If the nature of the courseware requires definitions, examples, counter examples, and explanations, they should be presented whenever necessary. The sequence of information should be organized in a logical way such that basic skills should be acquired by the learner before moving to more advanced work. Student's progress from simple basic concepts to cognitive
structures must go smoothly. Sufficient examples should be used in explaining concepts, then they could be organized and combined into principles and generalizations. Practice and applications are important. In order to create interest on the part of the learner, various types of questioning formats such as multiple choice, matching, true or false, yes or no, or completion should be used. To help the student organize what he or she has learned, summaries, reviews, and restatements of important concepts should be provided. Adaptive structuring, where the student can branch according to his or her progress, should be considered if the courseware writer is experienced and capable of doing that. Although adaptability is sophisticated and needs a high level of expertise, it should be considered and tried out as much as possible.
### TABLE 10

The Five Statistics And The Statement Of Each Valid Item In The Area "Structure And Sequence Of Presentation" Of The "Courseware Production Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>Percentage (Wtd. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.</td>
<td>100%</td>
<td>100%</td>
<td>2.40</td>
<td>0.5728</td>
<td>0.0541</td>
</tr>
<tr>
<td>39.</td>
<td>96%</td>
<td>96%</td>
<td>2.25</td>
<td>0.9126</td>
<td>0.0663</td>
</tr>
<tr>
<td>40.</td>
<td>99%</td>
<td>99%</td>
<td>2.28</td>
<td>0.7248</td>
<td>0.0685</td>
</tr>
<tr>
<td>41.</td>
<td>96%</td>
<td>97%</td>
<td>2.02</td>
<td>0.9353</td>
<td>0.0884</td>
</tr>
<tr>
<td>42.</td>
<td>99%</td>
<td>99%</td>
<td>2.34</td>
<td>0.7156</td>
<td>0.0676</td>
</tr>
<tr>
<td>43.</td>
<td>93%</td>
<td>93%</td>
<td>2.02</td>
<td>1.1020</td>
<td>0.1042</td>
</tr>
<tr>
<td>44.</td>
<td>99%</td>
<td>99%</td>
<td>2.28</td>
<td>0.8368</td>
<td>0.0649</td>
</tr>
<tr>
<td>45.</td>
<td>96%</td>
<td>97%</td>
<td>2.13</td>
<td>0.9438</td>
<td>0.0892</td>
</tr>
<tr>
<td>46.</td>
<td>98%</td>
<td>98%</td>
<td>2.19</td>
<td>0.8848</td>
<td>0.0647</td>
</tr>
<tr>
<td>47.</td>
<td>98%</td>
<td>98%</td>
<td>2.35</td>
<td>0.8757</td>
<td>0.0827</td>
</tr>
</tbody>
</table>

38. Definitions, variety of examples, counter-examples and explanations should be used and presented whenever necessary.

39. The instruction should be sequenced by logical ordering.

40. The instruction should be organized so that the learner acquires basic skills before attempting more advanced skills.

41. Student's progress from simple concepts to cognitive clusters must go smoothly.

42. Examples and explanations should be related to the same topic and relevant to the point of instruction.

43. Concepts should be explained and organized first, then combined into principles, generalizations, and constructs.

44. Practice and applications using concepts, principles, and knowledge should be considered.

45. Variety of questioning formats such as multiple choice, matching, true or false, completion, or yes or no should be utilized.

46. To reinforce learning, restatement of important concepts should be provided.

47. Summaries, reviews or outlines should be provided to help the student organize the key ideas of the unit.
7. Level Of Easiness And Difficulty:

Table 11 shows the five statistics and the statement of each valid item in the area "Level Of Easiness And Difficulty" of the "Courseware Production Phase". This area contains four valid items. Those four items, out of the five items originally listed under this area, met the five screening conditions adopted for validating the criteria. The values of the five corresponding statistics calculated for those items varied as follows: the percentages of agreement took values between 94 percent and 100 percent. The mean values varied between 2.00 and 2.46. The standard deviations ranged between 0.6097 and 1.0000, and the standard errors of the means varied between 0.0576 and 0.0945.

The courseware instructional materials will be used by individual learners, most of the time in the absence of the teacher. If the vocabulary is beyond the student level, the sentence construction is poor, and or the text readability is low, it will be a disaster for the student. Therefore, the student target population should be the axis of the whole process. Multiple levels of instruction should be integrated in the courseware unit to accommodate the range of individual differences, in order to make branching to more difficult concepts available for ambitious students to meet their needs.
TABLE 11

The Five Statistics And The Statement Of Each Valid Item
In The Area "Level Of Easiness And Difficulty" Of The
"Courseware Production Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>(Wtd. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>99%</td>
<td>99%</td>
<td>2.46</td>
<td>.7174</td>
<td>.0678</td>
</tr>
<tr>
<td>49</td>
<td>100%</td>
<td>100%</td>
<td>2.46</td>
<td>.6097</td>
<td>.0576</td>
</tr>
<tr>
<td>50</td>
<td>96%</td>
<td>94%</td>
<td>2.00</td>
<td>1.0000</td>
<td>.0945</td>
</tr>
<tr>
<td>52</td>
<td>98%</td>
<td>98%</td>
<td>2.38</td>
<td>.7840</td>
<td>.0741</td>
</tr>
</tbody>
</table>

48. The vocabulary, sentence construction, and readability of the instruction text should be consistent with the expected ability of the target population.

49. Examples, counter-examples, explanations, and graphic illustrations should suit the target student level.

50. The time required for relevant cognitive activities should be judged on the basis of the target population range.

52. Multiple levels of instruction should be integrated to consider individual differences in target population so that abnormal students can branch to difficult concepts to meet their educational needs.

8. Motivators:

Table 12 presents the five statistics and the statement of each valid item in the "Motivators" area of the "Courseware Production Phase". There are six valid criterion items in this area. All of the items originally listed in this area met the five screening conditions considered for validating the criteria. The values of the five corresponding statistics obtained by those items were as follows: the percentages of agreement varied between 96 percent and 100
percent, the mean values ranged between 2.01 and 2.56, the 
standard deviations took values between 0.5688 and 0.9112, 
and the standard errors of the means varied between 0.0537 
and 0.0861.

TABLE 12

The Five Statistics And The Statement Of Each 
Valid Item In The Area "Motivators" Of The 
"Courseware Production Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>Percentage (Wtd. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>53.</td>
<td>99%</td>
<td>99%</td>
<td>2.11</td>
<td>0.8058</td>
<td>0.0761</td>
</tr>
<tr>
<td>54.</td>
<td>96%</td>
<td>96%</td>
<td>2.01</td>
<td>0.9112</td>
<td>0.0861</td>
</tr>
<tr>
<td>55.</td>
<td>97%</td>
<td>97%</td>
<td>2.12</td>
<td>0.9026</td>
<td>0.0853</td>
</tr>
<tr>
<td>56.</td>
<td>99%</td>
<td>99%</td>
<td>2.56</td>
<td>0.6625</td>
<td>0.0626</td>
</tr>
<tr>
<td>57.</td>
<td>100%</td>
<td>100%</td>
<td>2.37</td>
<td>0.6253</td>
<td>0.0591</td>
</tr>
<tr>
<td>58.</td>
<td>100%</td>
<td>100%</td>
<td>2.39</td>
<td>0.5688</td>
<td>0.0537</td>
</tr>
</tbody>
</table>

53. Content material should include selective instructional activities.

54. Student's self evaluation should be integrated in the courseware unit.

55. The courseware language should be presented in a warm, friendly, and conversational manner.

56. Student interaction should take a major part of the courseware, in terms of answering questions, solving problems, etc.

57. Various responses of student's input should be considered.

58. Whenever necessary, opportunity for practice should be provided.
Motivation is an essential factor for learning effectiveness. The more the courseware writer is able to hold the attention of the learner, to present various instructional activities in a warm and friendly manner, to integrate the student participation in terms of answering questions, solving problems, and practicing, the more effective the learning will be. Student self evaluation is a motivating factor in learning by computer. Motivators are like appetizers and spices. Variety and moderation in using those motivators is a wise strategy.

9. Student's Creativity:

Table 13 shows the five statistics and the statement of each valid item in the area "Student's Creativity" of the "Courseware Production Phase". This area contains five valid items. Those items, five out of seven that were listed under this area, met the five screening conditions adopted for validation. The values of the five corresponding statistics calculated for those items were as follows. The percentages of agreement ranged between 96 percent and 100 percent. The mean values varied between 2.13 and 2.68. The standard deviations took values between 0.5587 and 0.9343, and the standard errors of the means varied between 0.0528 and 0.0883.
TABLE 13

The Five Statistics And The Statement Of Each Valid Item In The Area "Student's Creativity" Of The "Courseware Production Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>Percentage (Wtd. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>Skx</th>
</tr>
</thead>
<tbody>
<tr>
<td>59.</td>
<td>100%</td>
<td>100%</td>
<td>2.68</td>
<td>.5587</td>
<td>.0528</td>
</tr>
<tr>
<td>62.</td>
<td>96%</td>
<td>96%</td>
<td>2.13</td>
<td>.9343</td>
<td>.0883</td>
</tr>
<tr>
<td>63.</td>
<td>98%</td>
<td>98%</td>
<td>2.48</td>
<td>.7681</td>
<td>.0726</td>
</tr>
<tr>
<td>64.</td>
<td>98%</td>
<td>98%</td>
<td>2.18</td>
<td>.8557</td>
<td>.0808</td>
</tr>
<tr>
<td>65.</td>
<td>99%</td>
<td>99%</td>
<td>2.36</td>
<td>.7517</td>
<td>.0710</td>
</tr>
</tbody>
</table>

59. Courseware instruction should involve the student in a continuous active manner rather than a passive one.

62. The student should be provided with opportunities to answer open-ended questions and clues to decide upon his or her responses.

63. A wide range of possible responses should be anticipated by the courseware writer.

64. Some areas of further exploration should be suggested in courseware instruction.

65. Alternative paths through the instructional material should be presented to accommodate a range of individual differences.

Creativity is one of the important dimensions of human ability which should be encouraged. Courseware could be mixed with many creativity-encouraging ingredients. Involving the student in a continuously active manner will arouse and polish his or her talents. Providing the student with opportunities to answer open-ended questions will awaken and develop the hidden creative abilities. To avoid frustration on the part of the student, a wide range of the student's
possible responses should be anticipated by the courseware writer in order to match those responses. Some areas of further exploration should be suggested so as to give the student an opportunity to extend his or her imagination. To accommodate the needs of the wide range of different individuals, alternative branches in courseware material should be considered.

10. Interaction And Feedback

Table 14 presents the five statistics and the statements of each valid item in the area "Student's Interaction And Feedback Of Responses" of the "Courseware Production Phase". There are six valid criterion items belong to this area. Those six items, out of seven items which were listed under this area, passed the critical values assigned for the five screening conditions of validating the criteria. The values of the five corresponding statistics calculated for those items were as follows: the percentages of agreement took values between 92 percent and 100 percent, the mean values varied between 2.01 and 2.72, the standard deviations ranged between 0.4428 and 1.0870, and the standard errors of the means varied between 0.0418 and 0.1020.

Interaction is at the heart of the educational process, and adaptability is at the center of interaction. The courseware unit should not be an image of a chapter or a
### TABLE 14

The Five Statistics And The Statement Of Each Valid Item In The Area "Student Interaction And Feedback" Of The "Courseware Production Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>Percentage (Wtd. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>66.</td>
<td>100%</td>
<td>100%</td>
<td>2.48</td>
<td>.5830</td>
<td>.0551</td>
</tr>
<tr>
<td>67.</td>
<td>100%</td>
<td>100%</td>
<td>2.72</td>
<td>.4428</td>
<td>.0418</td>
</tr>
<tr>
<td>68.</td>
<td>98%</td>
<td>98%</td>
<td>2.45</td>
<td>.8190</td>
<td>.0774</td>
</tr>
<tr>
<td>70.</td>
<td>96%</td>
<td>97%</td>
<td>2.11</td>
<td>.8799</td>
<td>.0831</td>
</tr>
<tr>
<td>71.</td>
<td>97%</td>
<td>92%</td>
<td>2.01</td>
<td>1.0870</td>
<td>.1020</td>
</tr>
<tr>
<td>72.</td>
<td>100%</td>
<td>100%</td>
<td>2.47</td>
<td>.6091</td>
<td>.0576</td>
</tr>
</tbody>
</table>

66. Instructional courseware should require the student to participate and interact in most input activities.

67. There should be relevant feedback to student responses.

68. Feedback should be given immediately after the student's responses.

70. If the student fails to give the correct response, a hint, a cue, or a reference should be provided.

71. If the student's response in the last allowable trial is incorrect, a remedial answer should be displayed.

72. Flexibility in expecting and accepting the learner's different responses, especially synonyms, numerals, and words, should be considered.

section in a textbook. It should be full of liveliness and animation, and at the same time involve the student in a two-way participation. Learning progress should depend upon the student's responses and input activities. Relevant feedback after the student responds is essential to keep the
learning process continuous and interesting. In case the student's response does not match the correct answer, a hint, cue, review branching, or reference should be provided. The courseware writer should consider a wide range of student's responses to accommodate synonyms, words, and numerals. If the student fails to provide the correct answer in the last allowable trial, a remedial answer should be provided.

11. Learning Rate And Student Self Control:

Table 15 presents the five statistics and the statement of each valid item in the area "Learning Rate And Student Self-Control" of the "Courseware Production Phase". This area contains six valid criterion items. Those six items, out of the eight items that were originally listed under this area, met the critical values of the five screening conditions adopted to validate the criteria. The values of the five corresponding statistics obtained by those items were as follows: the percentages of agreement took values between 94 percent and 100 percent, the mean values varied between 2.02 and 2.39, the standard deviations ranged between 0.7060 and 1.0730, and the standard errors of the means varied between 0.0667 and 0.1014.

The fact that individuals are different leads to different learning rates. The student should have control over
The Five Statistics And The Statement Of Each Valid Item In The Area "Learning Rate And Student Self-Control" Of The "Courseware Production Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>Percentage (Utld. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>73.</td>
<td>100%</td>
<td>100%</td>
<td>2.39</td>
<td>.7060</td>
<td>.0667</td>
</tr>
<tr>
<td>74.</td>
<td>97%</td>
<td>96%</td>
<td>2.38</td>
<td>.9295</td>
<td>.0878</td>
</tr>
<tr>
<td>75.</td>
<td>96%</td>
<td>95%</td>
<td>2.23</td>
<td>1.0099</td>
<td>.0954</td>
</tr>
<tr>
<td>76.</td>
<td>98%</td>
<td>98%</td>
<td>2.02</td>
<td>.8137</td>
<td>.0769</td>
</tr>
<tr>
<td>77.</td>
<td>97%</td>
<td>97%</td>
<td>2.32</td>
<td>.9079</td>
<td>.0858</td>
</tr>
<tr>
<td>79.</td>
<td>94%</td>
<td>94%</td>
<td>2.16</td>
<td>1.0730</td>
<td>.1014</td>
</tr>
</tbody>
</table>

73. The student should have the option to start at a point appropriate to his or her previous experience.

74. The student should have control over the rate of displaying material to enable himself or herself to acquire the information at his or her pace.

75. The student should have control over the time allowed for solving problems or other learning activities in order to accelerate or slow the rate as necessary.

76. The courseware unit should have a provision for pre-review on instructions initiated by the learner.

77. The courseware unit should have key functions for student options such as: HINT, HELP, REVIEW, REFERENCE, RESTART, etc.

79. Courseware should be designed so that the student controls the program, not the program controls the student.

the rate of displaying material, according to one's ability of acquiring information and learning. To start at a point appropriate to the learner's previous experience should be
under the student's self control. The student should have control over the time limits assigned for all learning activities in order to accelerate or slow the rate of learning as necessary. In other words, most of the activities in the courseware unit should be under the student's control. The courseware writer should integrate into the courseware instructional unit some key-functions (subroutines) to facilitate the learning process, such as: Hint, Help, Review, Reference, Restart, Quit, etc.

12. Evaluation And Student Feedback:

Table 16 shows the five statistics and the statement of each valid item in the area "Evaluation And Student Feedback" in the "Courseware Production Phase". This area contains one valid item. This item, out of three originally listed under this area, met the five critical values of the five screening conditions adopted to validate the criteria. The five corresponding statistics calculated for this item were as follows: the percentages of agreement were 99 percent and 99 percent, the mean value was 2.25, the standard deviation was 0.7635, and the standard error of the mean was 0.0721.

The main purpose of this item is to insure that, although the student has control over the learning process at his or
TABLE 16

The Five Statistics And The Statement Of The Valid Item In The Area "Evaluation Of Student Feedback" Of The "Courseware Production Phase", By Number

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Percentage</th>
<th>Percentage</th>
<th>Mean</th>
<th>S.D.</th>
<th>Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>83.</td>
<td>99%</td>
<td>99%</td>
<td>2.25</td>
<td>.7635</td>
<td>.0721</td>
</tr>
</tbody>
</table>

83. A cumulative record for each student should be devised for teacher follow-up which shows the student's performance and progress.

her pace, the teacher should have an indirect "advisory control" according to the student's progress. That is, the courseware program should have a monitoring subroutine which creates a cumulative record of the student's major activities and progress for the teacher's follow-up purposes. For example, a record of the progress of each student (see Table-17) may give the teacher enough information to follow-up his or her students.

TABLE 17

STUDENT FOLLOW-UP RECORD

<table>
<thead>
<tr>
<th>Student Name ..................................................</th>
<th>........................</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time spent on this unit ....................................</td>
<td>40 minutes</td>
</tr>
<tr>
<td>Total number of questions attempted ........................</td>
<td>12</td>
</tr>
<tr>
<td>Number of correct responses on 1st attempt ..................</td>
<td>9</td>
</tr>
<tr>
<td>Number of correct responses on 2nd attempt ..................</td>
<td>1</td>
</tr>
<tr>
<td>Percentage score for this session ...........................</td>
<td>75.00%</td>
</tr>
</tbody>
</table>
13. **Posttest:**

Table 18 presents the five statistics and the statement of each valid item in the area of "Posttest" in the "Courseware Production Phase". This area consists of three valid criterion items. All the three items which were listed under this area met the five conditions adopted for validating the criteria. The values of the five statistics calculated for those items were as follows: the percentages of agreement were between 96 percent and 98 percent, the mean values varied between 2.09 and 2.35, the standard deviations ranged between 0.8011 and 0.9381, and the standard errors of the means were between 0.0757 and 0.0886.

**TABLE 18**

The Five Statistics And The Statement Of Each Valid Item In The "Posttest" Area Of The "Courseware Production Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>Percentage (Wtd. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>84.</td>
<td>96%</td>
<td>96%</td>
<td>2.33</td>
<td>.9202</td>
<td>.0869</td>
</tr>
<tr>
<td>85.</td>
<td>97%</td>
<td>97%</td>
<td>2.35</td>
<td>.8011</td>
<td>.0757</td>
</tr>
<tr>
<td>86.</td>
<td>96%</td>
<td>96%</td>
<td>2.09</td>
<td>.9381</td>
<td>.0886</td>
</tr>
</tbody>
</table>

84. A posttest should be included to determine the learner's achievement of the stated objectives.

85. The posttest questions should cover the basic concepts, skills, or knowledge of the courseware unit.

86. The learner's percentage achievement in the posttest should be provided.
The main purpose of this activity is that a posttest should be included in the courseware unit to assess the student's achievement against the stated objectives. Basically, the posttest should cover all the basic concepts, skills, or knowledge of the whole instructional unit, and the student's achievement in a percentage score should be provided.

14. Bullet-Proofing:

Table 19 presents the five statistics and the statement of each valid item in this area of the "Courseware Production Phase". This unit contains seven valid criterion items. All of the seven items which were listed under this area met the five screening conditions selected for validating the criteria. The values of the five corresponding statistics calculated for each item varied as follows: the percentages of agreement ranged between 95 percent and 100 percent, the means took values between 2.21 and 2.80, the standard deviations varied between 0.4192 and 1.0558, and the standard errors of the means ranged between 0.0396 and 0.0998.
### TABLE 19
The Five Statistics And The Statement Of Each Valid Item In The Area "Bullet-Proofing" Of The "Courseware Production Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>Percentage (Utd. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>Sξ</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>100%</td>
<td>100%</td>
<td>2.80</td>
<td>.4192</td>
<td>.0396</td>
</tr>
<tr>
<td>88</td>
<td>95%</td>
<td>95%</td>
<td>2.21</td>
<td>1.0558</td>
<td>.0933</td>
</tr>
<tr>
<td>89</td>
<td>96%</td>
<td>96%</td>
<td>2.31</td>
<td>.9714</td>
<td>.0918</td>
</tr>
<tr>
<td>90</td>
<td>100%</td>
<td>100%</td>
<td>2.55</td>
<td>.6530</td>
<td>.0617</td>
</tr>
<tr>
<td>91</td>
<td>100%</td>
<td>100%</td>
<td>2.55</td>
<td>.6530</td>
<td>.0617</td>
</tr>
<tr>
<td>92</td>
<td>97%</td>
<td>93%</td>
<td>2.44</td>
<td>.8330</td>
<td>.0787</td>
</tr>
<tr>
<td>93</td>
<td>99%</td>
<td>99%</td>
<td>2.56</td>
<td>.6624</td>
<td>.0626</td>
</tr>
</tbody>
</table>

87. If a wrong key is pressed accidently (e.g., division by zero), the program should not crash.

88. Pressing "Control C" (the escape key) should not cause the program to stop.

89. Pressing the "Reset-Key" should not cause the system to halt.

90. Leading and trailing blanks in the student's responses should not cause the system to treat them as incorrect responses.

91. Alternate responses should not cause courseware disruptions (e.g., five instead of 5).

92. Mixing of upper and lower case characters in the student's responses should not cause problems.

93. The student should be able to use the backspace, delete, or rubout keys in order to correct responses prior to pressing the "RETURN" key.

The main purpose of this area is to insure that the courseware program will handle certain input errors, whether intentionally entered or accidently. Checking routines for error detection could be programmed and integrated in the
courseware unit to guard against program crashing or system halting. Checking routines can detect each non-acceptable input character, refuse such errors, and display a message for another input.

III. Testing And Evaluation

The third phase, which completes the cycle of courseware development, is "Testing And Evaluation". This phase has been divided into two stages, the "Developmental Testing", and the "Implementation Testing". In the first stage the courseware developer assesses problems with the materials such as vocabulary, concepts, level of material, etc., while in the second stage the courseware producer looks for voids in the instruction. The two stages complement each other.

1. The Developmental Testing:

Table 20 presents the five statistics and the statement of each valid item in the "Developmental Testing" area of the "Testing And Evaluation Phase" and the "Implementation Testing". In the developmental testing area there are three valid criterion items out of five that were listed under that area. Each of those three items passed the five critical values of the screening conditions assigned for validating the criteria. The values of their five corre-
TABLE 20

The Five Statistics And The Statement Of Each Valid Item In The "Developmental Testing" Area Of The "Testing And Evaluation Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>percentage (Frequency)</th>
<th>percentage (Wtd. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>94.</td>
<td>99%</td>
<td>99%</td>
<td>2.50</td>
<td>.6814</td>
<td>.0644</td>
</tr>
<tr>
<td>95.</td>
<td>98%</td>
<td>98</td>
<td>2.32</td>
<td>.7810</td>
<td>.0738</td>
</tr>
<tr>
<td>98.</td>
<td>97%</td>
<td>98%</td>
<td>2.39</td>
<td>.8031</td>
<td>.0759</td>
</tr>
</tbody>
</table>

94. The courseware unit should be tested on several students of the average target population, then the problems that those students encountered should be identified through posttest results and face-to-face talking with the students.

95. Revision with suitable amendments should be introduced, and retesting should be done each time on new students of the average target population.

98. The revised version of the last step should be tried out on a cross-section of the representative student target population until it is concluded that the final version realizes the unit objectives.

Corresponding statistics calculated for each item in this area were as follows: the percentages of agreement took values between 97 percent and 99 percent, the mean values ranged between 2.32 and 2.50, the standard deviations varied between 0.6814 and 0.8031, and the standard errors of the mean ranged between 0.0644 and 0.0759.

The Implementation Testing:

Table 21 shows the five statistics and the statement of each valid item in the "Implementation Testing" area of the
"Testing And Evaluation Phase". Those three items which were listed under this area satisfied the five screening conditions assigned for validating the criteria. The values of the five corresponding statistics calculated for those items were as follows: the percentages of agreement ranged between 99 percent and 100 percent, the mean values varied between 2.45 and 2.48, the standard deviations took values between 0.5644 and 0.6915, and the standard errors of the means ranged between 0.0533 and 0.0653.

TABLE 21
The Five Statistics And the statement Of each Valid Item In The "Implementation Testing" Area Of The "Testing And Evaluation Phase", By Number

<table>
<thead>
<tr>
<th>Item No</th>
<th>percentage (Frequency)</th>
<th>percentage (Wtd. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>99</td>
<td>99%</td>
<td>99%</td>
<td>2.47</td>
<td>.6915</td>
<td>.0653</td>
</tr>
<tr>
<td>100</td>
<td>100%</td>
<td>100%</td>
<td>2.48</td>
<td>.5932</td>
<td>.0565</td>
</tr>
<tr>
<td>101</td>
<td>100%</td>
<td>100%</td>
<td>2.45</td>
<td>.5644</td>
<td>.0533</td>
</tr>
</tbody>
</table>

99. The revised version from the "Developmental Testing" should be tested under classroom conditions with a full range of the target population.

100. A thorough analysis of what was intended should be done, and any amendment to strengthen the resulting courseware should be introduced.

101. Periodic review on the package should continue so that the teacher as a courseware writer knows the effectiveness of the courseware package.
Non-Valid Items

It should be recalled that five conditions were adopted to validate the criteria. That is, each criterion item, to be considered valid, had to meet the five conditions simultaneously. Each item that failed to meet any one condition was considered a non-valid item. Adopting this screening procedure had divided the 101 criterion items into two categories: 82 valid items, and 19 non-valid ones. The valid items have been discussed in the previous sections. In the following paragraphs, a brief idea about the non-valid items will be presented.

Table 22 lists the numbers of the five corresponding statistics of the 19 criterion items which are considered non-valid ones. Excluding item number 82, which obtained the following extreme statistics -- 71 percent, 53 percent, $\bar{x} = 0.93$, S.D. = 1.7052, and Sx = 0.1611 -- the five corresponding statistics calculated for the other 18 items were as follows: the percentages of agreement varied between 79 percent and 96 percent, the mean values ranged between 1.48 and 1.95, the standard deviations varied between 0.9978 and 1.4341, and the standard errors of the means took values between 0.0942 and 0.1655.
TABLE 22

The Five Statistics Of The Nineteen Non-Valid Items Screened Out As A Result Of Applying The Five Conditions For Validating The Criteria

<table>
<thead>
<tr>
<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>Percentage (% of Std. Scale)</th>
<th>Mean Value</th>
<th>S.D.</th>
<th>STX</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>91%</td>
<td>88%</td>
<td>1.78</td>
<td>1.184</td>
<td>.1120</td>
</tr>
<tr>
<td>12</td>
<td>89%</td>
<td>85%</td>
<td>1.63</td>
<td>1.2534</td>
<td>.1184</td>
</tr>
<tr>
<td>18</td>
<td>88%</td>
<td>85%</td>
<td>1.54</td>
<td>1.2666</td>
<td>.1197</td>
</tr>
<tr>
<td>19</td>
<td>91%</td>
<td>87%</td>
<td>1.61</td>
<td>1.1766</td>
<td>.1112</td>
</tr>
<tr>
<td>20</td>
<td>92%</td>
<td>92%</td>
<td>1.93</td>
<td>1.1155</td>
<td>.1054</td>
</tr>
<tr>
<td>22</td>
<td>93%</td>
<td>92%</td>
<td>1.94</td>
<td>1.2220</td>
<td>.1155</td>
</tr>
<tr>
<td>26</td>
<td>92%</td>
<td>80%</td>
<td>1.88</td>
<td>1.2092</td>
<td>.1143</td>
</tr>
<tr>
<td>29</td>
<td>88%</td>
<td>85%</td>
<td>1.57</td>
<td>1.2296</td>
<td>.1162</td>
</tr>
<tr>
<td>30</td>
<td>92%</td>
<td>89%</td>
<td>1.80</td>
<td>1.1573</td>
<td>.1094</td>
</tr>
<tr>
<td>51</td>
<td>88%</td>
<td>83%</td>
<td>1.72</td>
<td>1.3834</td>
<td>.1307</td>
</tr>
<tr>
<td>60</td>
<td>96%</td>
<td>94%</td>
<td>1.95</td>
<td>0.9978</td>
<td>.0942</td>
</tr>
<tr>
<td>61</td>
<td>91%</td>
<td>91%</td>
<td>1.90</td>
<td>1.1322</td>
<td>.1070</td>
</tr>
<tr>
<td>69</td>
<td>86%</td>
<td>82%</td>
<td>1.52</td>
<td>1.3309</td>
<td>.1257</td>
</tr>
<tr>
<td>78</td>
<td>87%</td>
<td>79%</td>
<td>1.48</td>
<td>1.3370</td>
<td>.1311</td>
</tr>
<tr>
<td>80</td>
<td>93%</td>
<td>90%</td>
<td>1.83</td>
<td>1.1779</td>
<td>.1113</td>
</tr>
<tr>
<td>81</td>
<td>89%</td>
<td>84%</td>
<td>1.61</td>
<td>1.2923</td>
<td>.1221</td>
</tr>
<tr>
<td>82</td>
<td>71%</td>
<td>53%</td>
<td>0.93</td>
<td>1.7052</td>
<td>.1611</td>
</tr>
<tr>
<td>96</td>
<td>88%</td>
<td>81%</td>
<td>1.72</td>
<td>1.4341</td>
<td>.1355</td>
</tr>
<tr>
<td>97</td>
<td>93%</td>
<td>90%</td>
<td>1.94</td>
<td>1.2356</td>
<td>.1168</td>
</tr>
</tbody>
</table>

Table 23 lists the statements of the nineteen non-valid items by number. Those items were listed under different areas in the criteria before applying the five screening conditions. For example, item number 9 was listed under the "unit breakdown and instructional task analysis". Item 12 was listed under "the unit-title, target population, and prerequisites". Items 18 and 19 were listed under "objectives and instructional goals". Items 20 and 22 belonged to "pretest and review areas". Item number 26 was listed under
"previous experience." Items 29 and 30 were belonged to "text clarity, format, accuracy, and validity of content." Item number 51 was listed under "level of easiness and difficulty." Items 60 and 61 were contained in "student's creativity" area. Item 69 was contained in the "interaction and feedback of responses." Items 78 and 80 were in "learning rate and student's self-control." Items 81 and 82 were in "evaluation of student's feedback." And finally items 96 and 97 were listed under "developmental testing" area.

Although it is not the purpose of this study to know why those items failed to meet the adopted screening conditions. In spite the fact that they were mainly extracted from literature, there is no way to know why they failed, according to the available data. It is probable that experts really disagreed with those items because of technical reasons, but there is also a probability that other reasons exist, such as ambiguity in the statements or misinterpretation. Appendix C (the criteria before the final validation process) contains all the valid and the non-valid items by phase, area, and number. They could easily be located, read, and examined in relation to the areas where they belong.
TABLE 23

Statements Of The Nineteen Criterion Items That Failed To Meet The Five Screening Conditions And Are Considered As Non-Valid Items

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Synthesize systematically the identified teaching-learning tasks in an applicable teaching-learning plan, including a specified question-response strategy.</td>
</tr>
<tr>
<td>12</td>
<td>The general background of the student target population for learning that unit should be described.</td>
</tr>
<tr>
<td>18</td>
<td>Objectives should include what instructional problems are expected to be solved, what behaviors are to be modified, or what attitudes are to be changed.</td>
</tr>
<tr>
<td>19</td>
<td>Unit objectives should match the school objectives as well as curriculum objectives.</td>
</tr>
<tr>
<td>20</td>
<td>A courseware unit should have a pretest for diagnostic purposes at the beginning of that unit.</td>
</tr>
<tr>
<td>22</td>
<td>In light of the pretest results, prerequisite areas for review purposes should be recommended and branched to, in the same courseware unit.</td>
</tr>
<tr>
<td>26</td>
<td>Students progress from one objective to the next should depend upon the mastery of the first objective.</td>
</tr>
<tr>
<td>29</td>
<td>Double space between lines should be used.</td>
</tr>
<tr>
<td>30</td>
<td>The screen should completely clear before each new display, and frames should not roll-up line by line.</td>
</tr>
<tr>
<td>51</td>
<td>In logical processes, size of steps should suit the ability of the average student in the target population.</td>
</tr>
<tr>
<td>60</td>
<td>Control of the input variables should be by the student.</td>
</tr>
<tr>
<td>61</td>
<td>The student should be allowed to take as many input decisions as possible.</td>
</tr>
<tr>
<td>69</td>
<td>If the student gives a wrong response at the first trial, he or she should be given the chance to try at least two more times.</td>
</tr>
</tbody>
</table>
Table 23 (Continued)

Statements Of The Nineteen Criterion Items That Failed To Meet The Five Screening Conditions And Are Considered As Non-Valid Items

78. If the material appears difficult to be retained or mastered, student should be encouraged in the text to overlearn.

80. The student should have the option to exit from an activity and enter a new one if so desired.

81. Praise words or expressions such as GOOD, GREAT, or TERRIFIC should follow the correct response.

82. A quantitative feedback of the student's performance in cumulative percentage-score should follow each correct response.

96. Amendments-retesting cycle should be repeated two or three times (as necessary) so that the mean-value of the cumulative-percentage scores of the last students in the posttest is about 75%.

97. The revised version should be tried out at least twice: once on some bright students and the second time on some slow students of the same target population, and revised each time as necessary.

Summary

Chapter IV has presented the data analysis concepts in this study. The five screening conditions for validating the criterion items were determined, discussed, and defended. According to the adopted conditions for validating the criteria, valid items by phase, area, and number were identified and discussed. Non-Valid items were identified and discussed, too. Necessary tables explaining both sets of items, the valid items and non-valid ones, were presented.
A summary of the study, conclusions, recommendations, assumptions related to the criteria, general limitations, and implications will be presented in Chapter V.
Chapter V
SUMMARY, CONCLUSIONS, AND RECOMMENDATION

It is the purpose of this chapter to summarize the objectives, procedures, and findings of this study. This will be followed by a discussion of conclusions that seem warranted, based on the obtained information, the recommendations for further studies, assumptions related to the applicability of the criteria, and a general set of limitations and implications.

Summary Of The Study

It was the intent of this study to develop and validate a set of criterion items for computer based instructional courseware that might be used as references or light-posts by courseware writers, especially classroom teachers, when preparing their own courseware. There were many reasons behind this initiative. The most important reason is the fact that, during the last few years, computers have been introduced into schools and are being used for instructional purposes. This new phenomenon is expanding tremendously as a result of the rapid scientific development in computer technology and the low costs of personal and micro-computers.
Using computers for instructional purposes necessitates parallel development in instructional software (courseware) as well. To avoid harmful consequences resulting from untrained and inexperienced classroom teachers in courseware production, efforts should be made to control this phenomenon, and direct it onto the right track.

A necessary, probably not sufficient, means of having reliable courseware is to develop, validate, and make available a set of criterion items to serve as references for courseware writers, especially teachers, when preparing their own courseware in their schools.

To achieve this objective, the writer, following a thorough study of the literature, developed and compiled a list of 101 criterion items headed by certain areas to form the initial criteria. Those criteria were subjected to a "pilot validation process" by a group of subject-matter experts at The Ohio State University. Each of the 27 members were asked to agree or disagree with each item on the list. Also, each member was asked to suggest any criterion item that he or she felt should be added to the list.

The revised version of the criteria that resulted from the first validation process was prepared in a questionnaire-type format and mailed to another sample of 327 experts in the field around the United States.
The 327 members were selected randomly from three associations: 26 were members of the MicroSIFT (Microcomputer Software Information for Teachers); 150 were from one Special Interest Group in the Association for the Development of Computer Based Instructional Systems (ADCIS); and 151 were members from the American Educational Research Association (AERA), Division C, Learning and Instruction Group.

One hundred twelve questionnaires were answered and returned by the deadline. Five screening conditions for separating the valid from the non-valid items were adopted and employed. An item was considered valid if it met all the following five screening conditions simultaneously: (1) a 90 percent agreement or more using the "frequency" method; (2) a 90 percent agreement or more using the "weighted Scale" method; (3) a mean value of 2.00 scale points or more; (4) a standard deviation of 1.10 or less; and (5) a standard error of the mean equal to 0.10 or less. A set of 82 criterion items were found to be valid, and those items formed the "criteria instrument." This instrument consists of 82 valid criterion items, grouped into three major phases, and sub-headed by 18 areas. Appendix E lists the valid "criteria instrument" in the final form.

Having described the summary of the study in this section, the following section will present the major finding of this study.
A Basic Conclusion

It was the sole intent of this study to identify, develop and validate criteria for computer based instructional courseware. More specifically, this study sought to examine the possibility of answering the following question: "Is it possible to develop and validate a set of criterion items for computer based instructional courseware that could be used as references or guideposts by courseware authors, especially classroom teachers, when writing their own courseware?" The findings presented in Chapter IV fully support a "yes" answer to this question.

Recommendations

Computer based instruction is still in the cradle. This study is one attempt to generate useful information for courseware developers in the early periods of this new medium of instruction. Educational problems in this field will result in ideas and solutions. Interested people will find a fertile field for research and experimentation, since educators at the school level are introducing computers into their schools as a new instructional medium. Students who will use computers for learning would probably face problems in learning computer based instructional courseware. Teachers who will write their own courseware would also probably
face problems when writing courseware instructional units. The following recommendations are presented for consideration:

1. A concerned research thrust is required to diagnose and identify certain "problems faced by learners who use computers for learning" through experimentation, in order that the solutions for those problems can be reflected in courseware production.

2. Research is needed to diagnose and identify "problems faced by teachers who produce their own courseware," in order that the theoretical solutions for these problems can be reflected in the courseware development process.

3. Research studies are needed to identify "the pedagogical and technical ingredients needed in each area of the courseware development cycle;" for example, adaptability, questioning, content structure, student interaction, etc. Each of these areas needs special, comprehensive study in order to raise the level and quality of produced courseware.

4. A study is needed to come up with a set of standards, within the domain of certain criteria for courseware production, that should be met by a courseware unit in order to consider that unit of educational worth.
That is, what is the set of main items or attributes in the criteria that should be reflected in the produced courseware unit for each type of courseware (e.g. tutorial, drill and practice, simulation, problem solving; etc.) in order to recommend that unit for instruction?

5. Since the obtained criteria in this study were validated by heterogeneous groups of subject matter experts in different disciplines, it is recommended that a research study to be conducted to further validate those criteria by different specified groups, such as:

(1) Groups whose members specialized in different subject matter areas; i.e. a group in each of literature, mathematics, science, biology, philosophy, etc. should participate in the further validation process of the criteria.

(2) Different groups adopting different instructional strategies; i.e. each of these strategies -- tutorial, drill and practice, simulation, problem solving, etc. -- may be used by a specified group whose members will participate in the further validation process of the criteria.
(3) If possible, groups of experts from different cultures specialized in different subject matter areas and adopting different instructional strategies, should participate in the recommended further validation process.

This section has described the recommendations for further studies. The next section will present the assumptions related to the applicability of the valid criteria developed in this study, in different environments by different groups of people.

Assumptions Related To The Criteria

Because the criteria developed in this study were originally extracted from literature -- computer based instruction, programmed instruction, instructional design, and learning theory -- it was assumed that the items of those criteria were applicable in any culture, any subject matter, any mode of instruction, any educational system, and that they were independent of any computer-size being used.

The applicability of the criteria in any culture is based upon the fact that the criteria sources (the literature) are independent of any specified culture. The concepts of computer based instruction programmed instruction, instructional design, and learning theories are not derived from any specific culture. They are systematic steps that should ei-
ther be done or considered when the author of an instructional unit wants to prepare a courseware unit. No traces of any culture are reflected in any criterion item. For example, if one criterion item is selected and examined, such as: "The specific objectives of the unit should be displayed to the student," the application of such an item does not refer to any culture and is independent of the culture background. It is purely educational. All of the criterion items are of the same nature, purely educational, and have nothing to do with any specific culture.

However, this assumption could be tested by asking experts in the field of computer based instruction who come from different cultures to respond to the 82 valid criterion items in much the same way that the 112 respondents did in the present study. The responses of those people could then be examined to determine whether the criteria are applicable in different cultures. If it happened that there are no significant differences between the responses of experts who come from different cultures, then it could be concluded that the above assumption is supported.

The applicability of the criteria to all subject matters and all disciplines is based upon the assumption that, when the criterion items were compiled, no specific discipline was the main target. All subject matters in all disciplines were in mind. The criteria were compiled in a general way
so that they would satisfy all subject matter fields at different levels. One courseware writer from a given subject matter field might use more items of the criteria when writing in one area than a person from another field might use.

However, to test this assumption, it is suggested that experts from a number of different subject matter fields respond to the 32 criterion items in the same way that was used in this study. The responses of persons from different subject matter areas could then be examined to see if the criteria are equally applicable, as it is assumed. If there were no differences in the responses of experts from different subject matter fields, then it could be assumed that the 32 valid criterion items are applicable to courseware production, regardless of the subject matter area.

It was also assumed that the criteria developed in this study are applicable in any mode of instruction or instructional strategy. The courseware unit may be written in any mode of instruction, such as tutorial, drill and practice, problem solving, or simulation. Using any of these modes, the author of the courseware unit could refer to the criteria and get use of the items in different levels according to the adopted instructional strategy. However, it may be that a drill and practice courseware unit may need fewer items to be referred to than a tutorial unit. There are two reasons which support this claim, (1) the sources of the
criteria are related to literature regardless of any mode of instruction, and (2) the subject matter experts who participated in the two validation processes were selected from the field without considering any specific mode of instruction.

Again, however, this assumption could be tested by comparing the responses of persons who are experts in various instructional strategies to the 82 validated items in this study. If there were no differences in the responses of experts from instructional strategy areas, then it could be assumed that the 82 criterion items are applicable to courseware developed, regardless of methodological strategy involved.

It was also assumed that the criteria are applicable in any educational system, whether that system is centralized or decentralized. Confirmation of this assumption could be supported by explaining one major difference between who worked in two such systems and the role of the courseware writer who worked in either system.

In a centralized educational system there is usually one centralized educational administration that controls and administers the whole educational process, from the top to the bottom of the pyramid. Teachers and all other educational employees in such a system are employed and paid by that ad-
administration. In such a system, curricula, syllabi, textbooks, and instruction are administered and supervised by the center, through delegation of authority in a hierarchical manner.

In a decentralized system, on the other hand, local authorities in each community perform all of functions usually accomplished in a centralized system.

A courseware author, whether hired by a centralized or decentralized system, could use the criteria when he or she writes a courseware unit. It was assumed that such a writer would not pay attention or take any consideration of the employer system, since his or her main job is purely technical and the main purpose is to produce a good piece of instructional material. The instructional courseware unit that is produced should meet the employers' acceptance from an educational technical point of view, according to technical standards, regardless of the nature of the educational administration that runs the educational system.

Again, however, this is an assumption. Such an assumption could be tested by asking experts who work in centralized systems and experts who work in decentralized systems to respond to the 82 valid criterion items developed in this study. If there are no differences in the responses of the experts from both, the centralized and the decentralized
systems, then it could be assumed that the final valid criterion items are applicable to courseware developed, regardless of the nature of the educational system, whether it is centralized or decentralized.

The applicability of the criteria is independent of the computer size to be used. The computer may be a microcomputer, a minicomputer, a mainframe computer, or a huge sized-computer. The criteria will be used by the courseware writer to help in producing an instructional unit of educational worth. The computer, any computer, will be used to store and display the structure of that unit. Whatever the computer size is, in order to achieve the purpose, it should provide a minimum CPU storage capability to accommodate that unit and allow its display in a frame-type format, according to the learner's interaction. The courseware writer should know the operating system, the features, and capabilities of the host computer such as: memory, execution time, editing capability, and availability of color, sound, and graphics in order to have more flexibility when writing that unit. The criteria, on the other hand, play the role of raising the educational level of instructional courseware unit. It is assumed that the 82 valid criterion items developed in this study are applicable to courseware production regardless of the computer size being used.
However, this is an assumption. It could be tested by asking experts (courseware writers), who use different computer machines of different features, to judge the applicability of the valid criteria developed in this study to different machines. If it happened that there were no differences in the responses of experts who use different machines, then it would be possible to conclude that the final 82 valid criterion items, developed in this study, are applicable to courseware production, regardless of the computer size being used.

The last section explained the assumptions related to the applicability of the 82 valid criterion items in different cultures, to all subject matter areas, in any mode of instruction, in any educational system, and to any machine computer regardless of its size. The next section will present a set of limitations and implications related to the courseware writer, the host computer, and the criteria developed in this study.

General Limitations And Implications

As a result of this study, which lasted for about one year, the following set of limitations and implications seems evident. These implications have direct relationship to the courseware writer, to the host computer system, and to the developed criteria.
1. The courseware writer plays the major role in the courseware production process. This critical role necessitates that the courseware writer should have a sufficient technical and educational background. That is, he or she should have a college degree in the field of specialization, extended teaching experience, an understanding of learning theory, and have demonstrated competence in the computer language in which the courseware unit will be written. These characteristics are necessary prerequisites for a courseware writer.

2. Regarding the host computer, it will be used either in the production of the courseware unit or in learning that unit. In either case, there is one contingency to be considered. Regardless of the computer model, brand, or size, a sufficient CPU storage capacity should be provided by the computer to accommodate the courseware unit and display the content structure of that unit in a frame-type format. As far as color and sound availability are concerned, they are preferable as optional features, while the availability of graphics, on the other hand, should be considered as a basic feature in the hardware configuration.
3. Can the developed valid criteria, in this study, be translated into other languages? The developed and validated criteria for computer based instruction consist of a set of criterion items. The concepts of those items were derived from literature -- computer based instruction, programmed instruction, instructional design, and learning theories. These sources are purely educational technical terms. It is assumed that they are not confined or restricted to a specified language. Therefore, the criteria can be translated into other languages (i.e. into the Arabic language).

4. Who could use the criteria? The criteria were developed and validated to be used by a courseware writer, especially classroom teachers. The teacher may produce the courseware unit for his or her personal purposes, for a school authority, for a decentralized educational system, or for a centralized educational system.

However, if the courseware writer produces the unit for his or her own purposes, then the instructional quality of that unit depends upon the individual capability of using the criteria and checking the presence and absence of the attributes that would have impact upon learning during the instructional process.
If the courseware writer produces the courseware unit for a local school authority or for a decentralized educational system, the instructional quality of the produced unit would be judged by the concerned people who will test that unit, either by comparing it with other competitors' production or by its meeting a certain set of standards.

In a centralized educational system, courseware units are produced in different ways. One of these ways is that, committees, three subject-supervisors each, specialized in a subject matter area, are formed to produce different courseware instructional units. Referring to the criteria, members of each committee can either work together, as one team, to produce a courseware unit, or work individually, then evaluate together their production and come up with an integrated unit. Using this procedure, it is assumed that the production of each committee will be well-prepared and accepted. Multiple copies of each unit can be made and distributed to the schools of that system accompanied by evaluation forms, which cover the major attributes of that unit, for follow-up and improvement purposes. Feedback from the field to the administration would show the instructional worth of the instructional units and would insure the continuous improvement in other updated versions.
5. Computer based instruction is not intended to replace the teacher in the classroom. Its main purpose is to be used as an educational tool by both the teacher and the student. A combination of both CBI and the teacher's new role will provide a better learning environment than a teacher can provide alone. But what is the new role of the teacher in a classroom using computer based instruction?

Classroom teachers can become "facilitators" of instruction rather than lecturers or information givers. Each student can talk individually with the teacher without embarrassment. In addition, classroom teachers will have more free time to devote to educational problems and dealing with their students in a more personal and meaningful manner. Using the students' assessment follow-up records, described on page 96, Table 17, teachers can help their students in an individual and more effective manner.
APPENDIX A

The Criteria-Development Matrix Table
APPENDIX A

The Criteria-Development Matrix-Table Consists Of Bloom's Six Levels Of Learning And The Identified Areas And, The Identified Criterion Items

<table>
<thead>
<tr>
<th>THE IDENTIFIED AREAS AND THE CRITERION ITEMS</th>
<th>BLOOM'S SIX LEVELS OF LEARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KNOWLEDGE</td>
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<td></td>
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</tbody>
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APPENDIX B

Letter And The Initial Version Of The Criteria

Prior To The Pilot Validation Process
Dear Professor:

We need your help. You have been identified as a person who is especially knowledgeable about teaching and learning. We are trying to determine criteria for classroom teachers who are developing their own courseware for computer-based instruction. Would you be willing to share some of your time and expertise to help us identify criteria that would be applicable for developing computer courseware?

During the last few years, computers have been introduced into thousands of classrooms for instructional purposes. This trend will probably accelerate dramatically in the next few years. Some of the "software" programs are excellent. Some are very poor. We feel that it is important to establish criteria for courseware development that could be used by classroom teachers who want to improve the quality of courseware they develop with computers in their own school settings.

On the pages that follow are listed several criteria that have been suggested in the literature as being appropriate and important. Our concern is this: in your professional judgement, do you agree that each of the items listed is an appropriate and important criterion to be considered by computer courseware developers?

We have divided the criteria into three sections: (1) those that relate to the design phase; (2) those that relate to the production phase; and (3) those that relate to the evaluation phase of courseware development. Each of these phases has been subdivided into logical groupings.

Please read each criterion statement carefully, then indicate the extent to which you agree or disagree that the criterion described is appropriate and important, according to the scale provided.

If there are other criteria that you feel should be included, please add those at the end of our listing.

If you would like to receive a summary of the results of this study, include your name and address on a separate sheet of paper.

When you have finished, please mail your completed response back to us in the enclosed addressed, stamped envelope not later than April 25, 1983. Thank you very much for your cooperation.

Sincerely,

[Signature]

Jack Frymier, Professor of Education
M. Al-Jaberi, Ph.D. Student

College of Education
Appendix B (Continued)

Please encircle one of the following entries: A (Strongly Agree), M (Agree), N (Nidly Agree), MD (Mildly Disagree), D (Disagree), or SD (Strongly Disagree), that according to your judgement, is the most appropriate:

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<thead>
<tr>
<th></th>
<th>Agree (A)</th>
<th>Nidly Agree (N)</th>
<th>Mildly Disagree (MD)</th>
<th>Disagree (D)</th>
<th>Strongly Disagree (SD)</th>
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I. ANALYSIS AND DESIGN PHASE

Setting The Objectives
1. Determine the unit of instruction to be taught.
2. Identify the primary objectives for learners in behavioral terms according to the six levels of Bloom's Taxonomy Cognitive Domain: Knowledge, Comprehension, Analysis, Synthesis, and Evaluation.
3. Analyze the instructional objectives into more narrow performance objectives.
4. Break down the unit into topics and subtopics (or modules).
5. Identify the type of learning of each module (whether it is discrete information, concepts, principles, skills, attitudes, etc. or any combination).
6. Determine the instructional-learning strategy to be adopted (tutorial, drill and practice, simulation, problem-solving) in the courseware development.
7. Examine closely each objective to determine the stages that the learner must follow to realize that objective.
8. Sequence instructional events for each enabling objective according to each level of learning within the Cognitive and Affective domains.
9. Ask repeatedly a question such as the following, in the process of instructional task analysis: "What does the student need to know in order to realize each objective?"
10. Synthesize systematically the identified teaching-learning tasks in an applicable teaching-learning plan including a specified question-response strategy.

II. COURSEWARE PRODUCTION PHASE

The Unit-Title, Target Population, And Prerequisites
11. The unit-title, when displayed, should precede the courseware instructional text.
12. The learner should be briefed of what is to be learned.
13. Grade and age of the typical student target population for learning that unit should be described.
14. The general background of the student target population for learning that unit should be described.
15. The specific competencies required as prerequisites for students to learn that unit that are described.
16. Instructions should be stated clearly.

Objectives And Instructional Goals
17. Specific objectives of the unit should be displayed to the student.
18. Objectives statements should be clear without multiple meanings or ambiguity.
19. Objectives should be stated in terms of expected student behavior.
20. Objectives should include what instructional problems are expected to be solved, behaviors modified, or attitudes changed.
21. Unit objectives should match the school objectives as well as curriculum objectives.
22. Each concept, principle, or skill should have its own behavioral objectives.

Pretest And Review Areas
23. A courseware unit should have a pretest for diagnostic purposes.
24. The pretest questions should cover the prerequisite knowledge necessary for learning the new material.
25. In light of the pretest results, prerequisite areas for review purposes should be recommended and branched to in the same courseware unit.

Previous Experience
26. In general, the previous experience level of the typical target population should be considered.
27. Specifically, the material to be taught should be related to the width and depth of what the learner already knows.
28. Prerequisite concepts, ideas, principles, etc. should be reviewed.
29. Students progress from one objective to the next should depend upon the mastery of the first one.
30. Known situations are used to explain unknown ones using inductive reasoning.
Appendix B (Continued)

- 2 -

Text-Clarity, Format, Accuracy And Validity Of Content

31. Instructions should be clear and meaningful. (A) (M) (N) (D) (S)

32. Instruction should be organized at the level of the student. (A) (M) (N) (D) (S)

33. The screen should completely clear before each new display, and frames should not roll-up, line by line. (A) (M) (N) (D) (S)

34. Labels or headings should precede the different parts of the unit to identify them. (A) (M) (N) (D) (S)

35. Content material should be accurate and error-free. (A) (M) (N) (D) (S)

36. Content terminology should be consistent with those terms generally encountered by the student. (A) (M) (N) (D) (S)

37. Content material should not be outdated. (A) (M) (N) (D) (S)

38. Historical concepts in content material should be true and reliable. (A) (M) (N) (D) (S)

39. Scientific concepts in content material should be precise and clear. (A) (M) (N) (D) (S)

40. Content material should not be improperly or irrationally used. (A) (M) (N) (D) (S)

Structuring And Sequence Of Presentation

41. Definitions, variety of examples, counter-examples, and explanations should be used and presented whenever necessary. (A) (M) (N) (D) (S)

42. The instruction should be sequenced by logical ordering. (A) (M) (N) (D) (S)

43. The instruction should be organized so that the learner acquires basic skills before attempting application. (A) (M) (N) (D) (S)

44. Students progress from simple concepts to cognitive clusters must go smoothly. (A) (M) (N) (D) (S)

45. Examples and explanations should be related to the same topic and relevant to the point of instruction. (A) (M) (N) (D) (S)

46. Concepts should be explained and organized first, then combined into principles, generalizations, and constructs. (A) (M) (N) (D) (S)

47. Practice and applications using of concepts, principles, knowledge, etc. should be considered. (A) (M) (N) (D) (S)

48. Variety of questioning formats such as multiple choice, matching, true or false, completion, yes or no, etc. should be utilised. (A) (M) (N) (D) (S)

49. To reinforce learning, restatement of important concepts should be provided. (A) (M) (N) (D) (S)

50. Summaries, reviews or outlines should be provided to help the student organize the key ideas of the unit. (A) (M) (N) (D) (S)

Level Of Exactness And Difficulty

51. The vocabulary, sentence construction, and readability of the instruction text should be consistent with the expected ability of the target population. (A) (M) (N) (D) (S)

52. Examples, counter-examples, explanations and graphic illustrations should suit the target-student level. (A) (M) (N) (D) (S)

53. The time required for relevant cognitive activities should be judged on the basis of the target population's level. (A) (M) (N) (D) (S)

54. In logical processes, size of steps should suit the ability of both slow and fast students. (A) (M) (N) (D) (S)

55. Multiple levels of instruction should be integrated to consider individual differences in target-population so that abnormal students can branch to difficult concepts to meet their educational needs. (A) (M) (N) (D) (S)

Motivators

56. Content material should include selective instructional activities. (A) (M) (N) (D) (S)

57. The student should be personally addressed implicitly. (A) (M) (N) (D) (S)

58. Student's self evaluation should be integrated in the courseware. (A) (M) (N) (D) (S)

59. The courseware language should be presented in a warm, friendly and conversational manner. (A) (M) (N) (D) (S)

60. Student interaction should take a major part of the courseware, in terms of answering questions, solving problems, etc. (A) (M) (N) (D) (S)

61. Various responses of student's input should be considered. (A) (M) (N) (D) (S)

62. Whenever necessary, ample opportunity for practice should be provided. (A) (M) (N) (D) (S)

Student's Creativity

63. Courseware instruction should involve the student in a continuous active manner rather than in a passive one. (A) (M) (N) (D) (S)

64. Control of the input variables should be by the student. (A) (M) (N) (D) (S)

65. The student should be allowed to take any input decision as part of the process. (A) (M) (N) (D) (S)

66. The student should be provided with opportunities to answer open-ended questions and clues to decide upon his or her responses. (A) (M) (N) (D) (S)
Appendix B (Continued)

67. A wide range of possible responses should be anticipated by the courseware writer...
68. Some areas of further exploration should be suggested in courseware instruction...
69. Alternative paths through the instructional material should be presented to accommodate a range of individual differences...

Interaction And Feedback Of Responses
70. Instructional courseware should require the student to participate and interact in most input activities...
71. There should be relevant feedback to student responses...
72. Feedback should be given immediately after the student's responses...
73. The student should be given the chance to try two more times after he or she gives the first wrong response to a question...
74. If the student fails to give the correct response, a hint, cue, or a reference should be provided...
75. If the student's response in the last allowable trial is incorrect, a remedial answer must be displayed...
76. Flexibility in expecting and accepting the learner's different responses, especially synonyms, nears, and words should be considered...

Learning Rate And Student's Self-Control
77. The student should have the option to start at a point appropriate to his or her previous experience...
78. The student should have control over the rate of displaying material to enable himself or herself to acquire the information at his or her pace...
79. The student should have control over the time allowed for solving problems, or other learning activities in order to accelerate or slow the rate as necessary...
80. The courseware unit should have a provision for preview of instructions initiated by the learner...
81. The courseware unit should have key-functions for student options such as: HINT, HELP, REVIEW, REFERENCE, RESTART, etc...
82. If the material appears difficult to be retained or mastered, student should be encouraged in the text to overlearn...
83. Courseware should be designed so that the student controls the program, not the program controls the student...
84. The student should have the option to exit from an activity and enter a new one, if so desired...

Evaluation Of Student Feedback
85. Praise words or expressions such as: Good, Great, Magnificent, Fantastic, Terrible, etc. should follow the correct response...
86. A qualitative feedback of the student's performance in cumulative percentages score should follow the praise-word after each correct response...
87. Cumulative record for each student should be designed for teacher follow-up which shows the student's performance and progress...

Posttest
88. A posttest is included to determine the learner's achievement of the stated objectives...
89. The posttest questions cover the basic concepts, skills, knowledge, etc. of the courseware unit...
90. The learner's percentage achievement in the posttest is provided...

Bulletin - Proofing (Courseware should be able to handle certain errors such as)
91. If a wrong key is pressed accidently (e.g. division by zero), the program should not crash...
92. Pressing "Control C" (the escape-key) should not cause the program to stop...
93. Pressing the "Reset-Key" should not cause the system to halt...
94. Leading and trailing blanks in the student's responses should not cause the system to treat them as incorrect responses...
95. Alternate responses should not cause courseware disruptions (e.g. five instead of 5)
Appendix B (Continued)

96. Mixing of upper and lower case characters in student's responses should not cause problems.

97. The student should be able to use the backspace, delete, or rubout keys in order to correct responses prior to pressing the "RETURN" key.

III. TESTING AND EVALUATION PHASE

Developmental Testing

98. The courseware unit should be tested first on several students of the average target population and encountered problems to be identified through the posttest results and face-to-face talking with the students.

99. Revision with suitable amendments should be introduced, and retesting should be done each time on new several students of the average target population.

100. Amendments-retesting cycle should be repeated two or three times (as necessary) so that the mean-value of the cumulative-percentage scores of the last new several students in the posttest to be about 75%.

101. The revised version should be tried out at least twice once on some bright students and the second time on some slow students of the same target population, and to be revised each time as necessary.

102. The revised version of the last step should be tried out on a cross-section of the representative student target population, until it is concluded that the final version realizes the unit objectives.

Implementation Testing

103. The revised version from the "Developmental Testing" should be tested under real classroom conditions with a full range of the target population.

104. A thorough analysis of what was intended should be done, and any amendment to strengthen the resulting courseware should be introduced.

105. Periodic review on the package should continue so that the teacher as a courseware-writer knows the effectiveness of the courseware package.

NB. The following judgement-item is very important since it determines the validity of the criteria:

106. As an authority in this area, I recommend an item of this criteria should be considered to be a valid item if the percentage of respondents who are in favor of that item is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Valid Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>60%</td>
<td>Yes</td>
</tr>
<tr>
<td>65%</td>
<td>Yes</td>
</tr>
<tr>
<td>70%</td>
<td>Yes</td>
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<tr>
<td>75%</td>
<td>Yes</td>
</tr>
<tr>
<td>80% or more</td>
<td>Yes</td>
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</tbody>
</table>

Respondent's Name (optional):

Are there other criteria that you think should be added to those that have been listed above? If so, please add them here or on a separate sheet of paper.

(Thank You)
APPENDIX C

Letter And The Revised Version Of The Criteria

Prior To The Second Validation Process
Dear member:

We need your help. You have been identified as a person who is especially knowledgeable about teaching and learning. We are trying to determine criteria for the production of Computer-Based Instruction courseware that could be used by classroom teachers who are interested in producing their own courseware. Would you be willing to share some of your time and expertise to help us do this job?

As you know, during the last few years computers have been introduced into thousands of classrooms for instructional purposes. This trend will probably accelerate dramatically in the next few years. Some of the "courseware programs" are excellent while others are poor. We feel that it is important to establish criteria for courseware production that could be used by classroom teachers who may be interested in producing their courseware in their own school settings.

Although different types of courseware (e.g., tutorial, drill and practice, problem-solving, simulation) may sometimes require different criteria, we are trying to identify general criteria that could be helpful in most types.

On the pages that follow are listed several items that have been suggested in the literature as being appropriate and important. Our concern now is this: in your professional judgement, do you think that each of the statements listed is an appropriate and important item to be considered by computer courseware writers?

The attached list has been divided into three sections: (1) the first precedes the criteria, which consists of procedure-items that relate to the design phase; (2) those that relate to the production phase; and (3) those that relate to the evaluation phase of courseware production. Each of these phases has been divided into logical groupings.

Please read each item statement carefully, then indicate the extent to which you agree or disagree that the item described is appropriate and important, according to the scale provided.

If there are other criterion-items that you feel should be included, please add those at the end of our listing or on a separate sheet of paper.

When you have finished, please mail your completed response back to us in the enclosed addressed, stamped envelope not later than September 30, 1983. Thank you very much for your cooperation.

Sincerely,

Jack Fryeir
Professor

M. Jaberi, Ph.D. Candidate

College of Education
Appendix C (Continued)

Please encircle one of the following entries: SA (Strongly Agree), A (Agree), MA (Mildly Agree), MD (Mildly Disagree), D (Disagree), or SD (Strongly Disagree), that according to your judgment, as the most appropriate:

<table>
<thead>
<tr>
<th>1. ANALYSIS AND DESIGN PHASE (elements of this phase relate to procedure)</th>
<th>Strongly Agree (SA)</th>
<th>M.Mildly Agree (MA)</th>
<th>M.Mildly Disagree (MD)</th>
<th>Disagree (D)</th>
<th>Strongly Disagree (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting The Objectives</td>
<td>SA</td>
<td>A</td>
<td>MA</td>
<td>MD</td>
<td>D</td>
</tr>
<tr>
<td>Determine the unit of instruction to be taught.</td>
<td>SA</td>
<td>A</td>
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<tr>
<td>Identify the primary objectives for learners in behavioral terms, for example, according to the six levels of Bloom's Taxonomy Cognitive Domain: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.</td>
<td>SA</td>
<td>A</td>
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<tr>
<td>Analyze the instructional objectives into more narrow performance objectives.</td>
<td>SA</td>
<td>A</td>
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</tr>
<tr>
<td>Unit Breakdown And Instructional Task Analysis</td>
<td>SA</td>
<td>A</td>
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</tr>
<tr>
<td>Break down the unit into topics and subtopics (or modules).</td>
<td>SA</td>
<td>A</td>
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<td>Identify the type of learning of each module (whether it is discrete information, concepts, principles, skills, attitudes, etc. or any combination.</td>
<td>SA</td>
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<tr>
<td>Determine the instructional-learning strategy to be adopted (tutorial, drill and practice, simulation, problem-solving, etc. in the courseware development.</td>
<td>SA</td>
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<tr>
<td>Examine closely each objective to determine the steps that the learner must follow to realize that objective.</td>
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<td>In the process of instructional task analysis, ask repeatedly a question such as the following: &quot;What does the student need to know in order to realize each objective?&quot;</td>
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<tr>
<td>Synthesize systematically the identified teaching-learning tasks in an applicable teaching-learning plan, including a specified question-response strategy.</td>
<td>SA</td>
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<tr>
<td>11. COURSEWARE PRODUCTION PHASE</td>
<td>SA</td>
<td>A</td>
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<tr>
<td>The Unit-Title, Target Population, And Prerequisites</td>
<td>SA</td>
<td>A</td>
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<tr>
<td>10. The unit-title, when displayed, should precede the courseware instructional text.</td>
<td>SA</td>
<td>A</td>
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<td>11. The learner should be briefed on what is to be learned.</td>
<td>SA</td>
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<td>The general background of the student target population for learning that unit should be described.</td>
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<td>12. The specific competencies required as prerequisites for students to learn that unit should be described.</td>
<td>SA</td>
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<td>13. Instructions should be stated clearly.</td>
<td>SA</td>
<td>A</td>
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<td>D</td>
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<tr>
<td>Objectives And Instructional Goals</td>
<td>SA</td>
<td>A</td>
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<tr>
<td>15. Specific objectives of the unit should be displayed to the student.</td>
<td>SA</td>
<td>A</td>
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<td>16. Objectives-statements should be clear without multiple meanings or ambiguity.</td>
<td>SA</td>
<td>A</td>
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<td>17. Objectives should be stated in terms of expected student behavior.</td>
<td>SA</td>
<td>A</td>
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<td>18. Objectives should include what instructional problems are expected to be solved, what behaviors are to be modified, or what attitudes are to be changed.</td>
<td>SA</td>
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<tr>
<td>19. Unit objectives should match the school objectives as well as curriculum objectives.</td>
<td>SA</td>
<td>A</td>
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<tr>
<td>Pretest And Review Areas</td>
<td>SA</td>
<td>A</td>
<td>MA</td>
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<tr>
<td>20. A courseware unit should have a pretest for diagnostic purposes at the beginning of that unit.</td>
<td>SA</td>
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<td>21. The pretest questions should cover the prerequisite knowledge necessary for learning the new material.</td>
<td>SA</td>
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<td>22. In light of the pretest results, prerequisite areas for review purposes should be recommended and branched to, in the same courseware unit.</td>
<td>SA</td>
<td>A</td>
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<tr>
<td>Previous Experience</td>
<td>SA</td>
<td>A</td>
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<tr>
<td>23. In general, the previous experience level of the typical target population should be considered.</td>
<td>SA</td>
<td>A</td>
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<tr>
<td>24. Specifically, the material to be taught should be related to the width and depth of what the learner already knows.</td>
<td>SA</td>
<td>A</td>
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<tr>
<td>25. Prerequisite concepts, ideas, principles, etc. should be reviewed.</td>
<td>SA</td>
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</table>
### Text-Clarity, Format, Accuracy, And Validity of Content

<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Moderate</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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<tr>
<td>26</td>
<td>Students progress from one objective to the next should depend upon the</td>
<td>SA</td>
<td>MA</td>
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<td></td>
<td>mastery of the first objective.</td>
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<td>27</td>
<td>Known situations should be used to explain unknown ones using inductive</td>
<td>SA</td>
<td>MA</td>
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<td></td>
<td>reasoning.</td>
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#### Structuring And Sequence Of Presentation

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<tr>
<th>Number</th>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Moderate</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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<tr>
<td>38</td>
<td>Definitions, variety of examples, counter-examples, and explanations should</td>
<td>SA</td>
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<td></td>
<td>be used and presented whenever necessary.</td>
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<td>39</td>
<td>The instruction should be sequenced by logical ordering.</td>
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<td>40</td>
<td>The instruction should be organized so that the learner acquires basic</td>
<td>SA</td>
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<td>skills before attempting more advanced skills.</td>
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<td>41</td>
<td>Student's progress from simple concepts to cognitive clusters must go</td>
<td>SA</td>
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<td>smoothly.</td>
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<td>42</td>
<td>Examples and explanations should be related to the same topic and</td>
<td>SA</td>
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<td>relevant to the point of instruction.</td>
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<td>43</td>
<td>Concepts should be explained and organized first, then combined into</td>
<td>SA</td>
<td>MA</td>
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<td>SD</td>
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<td>principles, generalizations, and constructs.</td>
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<td>44</td>
<td>Practice and applications using concepts, principles, and knowledge</td>
<td>SA</td>
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<td>should be considered.</td>
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<td>45</td>
<td>Variety of questioning formats such as multiple choice, matching, true or</td>
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<td>MA</td>
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<td>SD</td>
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<td>false, completion, or yes or no should be utilized.</td>
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<td>46</td>
<td>To reinforce learning, restatement of important concepts should be</td>
<td>SA</td>
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<td>provided.</td>
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<td>47</td>
<td>Summaries, reviews, or outlines should be provided to help the student</td>
<td>SA</td>
<td>MA</td>
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<td>SD</td>
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<td></td>
<td>organize the key ideas of the unit.</td>
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#### Level Of Easiness And Difficulty

<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Moderate</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>The vocabulary, sentence construction, and readability of the instruction</td>
<td>SA</td>
<td>MA</td>
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<td>SD</td>
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<td></td>
<td>text should be consistent with the expected ability of the target</td>
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<td>population.</td>
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<tr>
<td>49</td>
<td>Examples, counter-examples, explanations, and graphic illustrations should</td>
<td>SA</td>
<td>MA</td>
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<td>suit the target-student level.</td>
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<td>50</td>
<td>The time required for relevant cognitive activities should be judged on</td>
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<td>the basis of the target population range.</td>
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<td>51</td>
<td>In logical processes, size of steps should suit the ability of the</td>
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<td>SD</td>
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#### Motivators

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Appendix C (Continued)

-3-

57. Various responses of student's input should be considered. ..............
58. Whenever necessary, opportunity for practice should be provided. .........

Student's Creativity

59. Courseware instruction should involve the student in a continuous active
manner rather than in a passive one. ........................................
60. Control of the input variables should be by the student. ......................
61. The student should be allowed to take as many input decisions as possible.
62. The student should be provided with opportunities to answer open-ended
questions and clues to decide upon his or her responses. ......................
63. A wide range of possible responses should be anticipated by the courseware
writer. ..............................................................................
64. Some areas of further exploration should be suggested in courseware
instruction. ...........................................................................
65. Alternative paths through the instructional material should be presented to
accommodate a range of individual differences. ..............................

Interaction And Feedback Of Responses

66. Instructional courseware should require the student to participate and inter-
act in most input activities. ......................................................
67. There should be relevant feedback to student responses. .......................
68. Feedback should be given immediately after the student's responses. ......
69. If the Student gives a wrong response at the first trial, he or she should be
given the chance to try at least two more times. ............................
70. If the student fails to give the correct response, a hint, cue, or a reference
should be provided. .................................................................
71. If the student's response in the last allowable trial is incorrect, a remedial
answer should be displayed. ......................................................
72. Flexibility in expecting and accepting the learner's different responses,
especially synonyms, numerals, and words, should be considered. ...........

Learning Rate And Student's Self-Control

73. The student should have the option to start at a point appropriate to his or
her previous experience. ............................................................
74. The student should have control over the rate of displaying material to enable
himself or herself to acquire the information at his or her pace. ............
75. The student should have control over the time allowed for solving problems or
other learning activities in order to accelerate or slow the rate as necessary.
76. The courseware unit should have a provision for pre-review on instructions
initiated by the learner. .............................................................
77. The courseware unit should have key-functions for student options such as:
HINT, HELP, REVIEW, REFERENCE, RESTART, etc. ..............
78. If the material appears difficult to be retained or mastered, student should
be encouraged in the text to overlearn. ......................................
79. Courseware should be designed so that the student controls the program, not
the program controls the student. .............................................
80. The student should have the option to exit from an activity and enter a new
one, if so desired. .................................................................

Evaluation Of Student Feedback

81. Praise words or expressions such as GOOD, GREAT, or TERRIFIC should follow the
correct response. .................................................................
82. A quantitative feedback of the student's performance in cumulative percentage-
score should follow each correct response. ..................................
83. A cumulative record for each student should be devised for teacher follow-up
which shows the student's performance and progress. ......................

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Appendix C (Continued)

Posttest

84. A posttest should be included to determine the learner's achievement of the stated objectives. ................................................................. SA A MA MD D SD 84.

85. The posttest questions should cover the basic concepts, skills, or knowledge of the courseware unit. ...................................................... SA A MA MD D SD 85.

86. The learner's percentage achievement in the posttest should be provided. ................................................................. SA A MA MD D SD 86.

87. If a wrong key is pressed accidentally (e.g., division by zero), the program should not crash. ................................................................. SA A MA MD D SD 87.

88. Pressing "Control C" (the escape key) should not cause the program to stop. ................................................................. SA A MA MD D SD 88.

89. Pressing the "Reset-Key" should not cause the system to halt. ................................................................. SA A MA MD D SD 89.

90. Leading and trailing blanks in the student's responses should not cause the system to treat them as incorrect responses. ................................................................. SA A MA MD D SD 90.

91. Alternate responses should not cause courseware disruptions (e.g., five instead of 5). ................................................................. SA A MA MD D SD 91.

92. Mixing of upper and lower case characters in student's responses should not cause problems. ................................................................. SA A MA MD D SD 92.

93. The student should be able to use the backspace, delete, or rubout keys in order to correct responses prior to pressing the "RETURN" key. ................................................................. SA A MA MD D SD 93.

111. TESTING AND EVALUATION PHASE

Developmental Testing

94. The courseware unit should be tested on several students of the average target population, then the problems that those students encountered should be identified through posttest results and face-to-face talking with the students. ................................................................. SA A MA MD D SD 94.

95. Revision with suitable amendments should be introduced, and retesting should be done each time on new students of the average target population. ................................................................. SA A MA MD D SD 95.

96. Amendments-retesting cycle should be repeated two or three times (as necessary) so that the mean-value of the cumulative-percentage scores of the last students in the posttest is about 75%. ................................................................. SA A MA MD D SD 96.

97. The revised version should be tried out at least twice: once on some bright students and the second time on some slow students of the same target population, and revised each time as necessary. ................................................................. SA A MA MD D SD 97.

98. The revised version of the last step should be tried out on a cross-section of the representative student target population until it is concluded that the final version realizes the unit objectives. ................................................................. SA A MA MD D SD 98.

Implementation Testing

99. The revised version from the "Developmental Testing" should be tested under real classroom conditions with a full range of the target population. ................................................................. SA A MA MD D SD 99.

100. A thorough analysis of what was intended should be done, and any amendment to strengthen the resulting courseware should be introduced. ................................................................. SA A MA MD D SD 100.

101. Periodic review on the package should continue so that the teacher as a courseware-writer knows the effectiveness of the courseware package. ................................................................. SA A MA MD D SD 101.

NB. The following judgment-item is very important, since it determines the validity of the criteria:

102. As an authority in this area, I recommend that an item of these criteria should be considered to be a valid item if the percentage of respondents who are in favor of that item is: (please circle one) 80% 65% 70% 75% 80% or more

NOTE: If you would like to have a copy of the results of this study, please include your name and address here.

Are there other criteria that you think should be added to those that have been listed above. If so, please include them on a separate piece of paper.

Thank you for your cooperation.
APPENDIX D

The Five Corresponding Statistics Of The 101 Criterion Items Prior To Applying The

Five Screening Conditions
### APPENDIX D

**The Five Corresponding Statistics Of The 101 Criterion Items Prior To Applying The Five Screening Conditions**

<table>
<thead>
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<th>Item No</th>
<th>Percentage (Frequency)</th>
<th>Percentage (Wtd. Scale)</th>
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The Five Corresponding Statistics Of The 101 Criterion Items Prior To Applying The Five Screening Conditions

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APPENDIX D (Continued)

The Five Corresponding Statistics Of The 101 Criterion Items Prior To Applying The Five Screening Conditions

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APPENDIX E

Statements Of The 82 Valid Criterion Items

That Form The Valid Criteria - Instrument

In The Final Form
APPENDIX E

Statements Of The Eighty Two Valid Criterion Items
That Form The Valid "Criteria Instrument"
In The Final Form

I. ANALYSIS AND DESIGN PHASE

Setting The Objectives:

1. Determine the unit of instruction to be taught.

2. Identify the primary objectives for learners in behavioral terms, for example, according to the six levels of Bloom's Taxonomy Cognitive Domain: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.

3. Analyze the Instructional Objectives into more narrow performance objectives.

Unit Breakdown And Instruct

4. Breakdown the unit into topics (or modules).

5. Identify the type of learning of each module (whether it is discrete information, concepts, principles, skills, attitudes,...or any combination).

6. Determine the instructional-learning strategy to be adopted (tutorial, drill and practice, simulation, problem solving, etc.) in the courseware development.

7. Examine closely each objective to determine the steps that learners must follow to realize that objective.

8. In the process of instructional task analysis, ask repeatedly a question such as the following: "What does the student need to know in order to realize each objective?"

II. COURSEWARE PRODUCTION PHASE

The Unit Title, Target Population, And Prerequisites:

9. The unit title, when displayed, should precede the courseware instructional unit.

10. The learner should be briefed on what is to be learned.
APPENDIX E (Continued)

Statements Of The Eighty Two Valid Criterion Items That Form The Valid "Criteria Instrument" In The Final Form

11. The specific competencies required as prerequisites for students to learn that unit should be described.

12. Instructions should be stated clearly.

Objectives And Instructional Goals:

13. Specific objectives of the unit should be displayed to the student.

14. Objectives-statements should be clear without multiple meanings or ambiguity.

15. Objectives should be stated in terms of expected student behavior.

Pretest And Review Areas:

16. The pretest questions should cover the prerequisite knowledge necessary for learning new material.

Previous Experience:

17. In general, the previous experience level of the typical target population should be considered.

18. Specifically, the material to be taught should be related to the width and depth of what the learner already knows.

19. Prerequisite concepts, ideas, principles, etc. should be reviewed.

20. Known situations should be used to explain unknown ones using inductive reasoning.

Text-Clarity, Format, Accuracy, And Validity Of Content:

21. Instructions should be clear and meaningful.

22. Lables or headings should precede the different parts of the unit to identify them.

23. Content material should be accurate and error-free.
APPENDIX E (Continued)

Statements Of The Eighty Two Valid Criterion Items
That Form The Valid "Criteria Instrument"
In The Final Form

24. Content terminology should be consistent with those terms generally encountered by the student.

25. Content material should not be outdated.

26. Historical concepts in content material should be true and reliable.

27. Scientific concepts in content material should be accurate and clear.

28. Content material should not be improperly or invalidly used.

Structuring And Sequence Of Presentation:

29. Definitions, variety of examples, counter-examples and explanations should be used and presented whenever necessary.

30. The instruction should be sequenced by logical ordering.

31. The instruction should be organized so that the learner acquires basic skills before attempting more advanced skills.

32. Student's progress from simple concepts to cognitive clusters must go smoothly.

33. Examples and explanations should be related to the same topic and relevant to the point of instruction.

34. Concepts should be explained and organized first, then combined into principles, generalizations, and constructs.

35. Practice and applications using concepts, principles, and knowledge should be considered.

36. Variety of questioning formats such as multiple choice, matching, true or false, completion, or yes or no should be utilized.

37. To reinforce learning, restatement of important concepts should be provided.
APPENDIX E (Continued)

Statements Of The Eighty Two Valid Criterion Items That Form The Valid "Criteria Instrument" In The Final Form

38. Summaries, reviews or outlines should be provided to help the student organize the key ideas of the unit.

Level of easiness and difficulty:

39. The vocabulary, sentence construction, and readability of the instruction text should be consistent with the expected ability of the target population.

40. Examples, counter-examples, explanations, and graphic illustrations should suit the target student level.

41. The time required for relevant cognitive activities should be judged on the basis of the target population range.

42. Multiple levels of instruction should be integrated to consider individual differences in target population so that abnormal students can branch to difficult concepts to meet their educational needs.

Motivators:

43. Content material should include selective instructional activities.

44. Student's self evaluation should be integrated in the courseware unit.

45. The courseware language should be presented in a warm, friendly, and conversational manner.

46. Student interaction should take a major part of the courseware, in terms of answering questions, solving problems, etc.

47. Various responses of student's input should be considered.

48. Whenever necessary, opportunity for practice should be provided.

Student's Creativity:

49. Courseware instruction should involve the student in a continuous active manner rather than a passive one.
APPENDIX E (Continued)

Statements Of The Eighty Two Valid Criterion Items
That Form The Valid "Criteria Instrument"
In The Final Form

50. The student should be provided with opportunities
to answer open-ended questions and clues to decide
upon his or her responses.

51. A wide range of possible responses should be anti­
cipated by the courseware writer.

52. Some areas of further exploration should be
suggested in courseware instruction.

53. Alternative paths through the instructional material
should be presented to accommodate a range of indi­
vidual differences.

Interaction And Feedback Of Responses:

54. Instructional courseware should require the
student to participate and interact in most input
activities.

55. There should be relevant feedback to student
responses.

56. Feedback should be given immediately after the
student's responses.

57. If the student fails to give the correct response,
a hint, a cue, or a reference should be provided.

58. If the student's response in the last allowable
trial is incorrect, a remedial answer should be
displayed.

59. Flexibility in expecting and accepting the learner's
different responses, especially synonyms, numerals,
and words, should be considered.

Learning Rate And Student Self Control:

60. The student should have the option to start at a
point appropriate to his or her previous experience.

61. The student should have control over the rate of
displaying material to enable himself or herself
to acquire the information at his or her pace.
APPENDIX E (Continued)

Statements Of The Eighty Two Valid Criterion Items
That Form The Valid "Criteria Instrument"
In The Final Form

62. The student should have control over the time
allowed for solving problems or other learning
activities in order to accelerate or slow the rate
as necessary.

63. The courseware unit should have a provision for pre-
review on instructions initiated by the learner.

64. The courseware unit should have key functions for
student options such as: HINT, HELP, REVIEW,
REFERENCE, RESTART, etc.

65. Courseware should be designed so that the student
controls the program, not the program controls the
student.

Evaluation Of Student Feedback

66. A cumulative record for each student should be
devised for teacher follow-up which shows the
student's performance and progress.

Posttest

67. A posttest should be included to determine the lea-
rner's achievement of the stated objectives.

68. The posttest questions should cover the basic con-
cepts, skills, or knowledge of the courseware unit.

69. The learner's percentage achievement in the post-
test should be provided.

Bullet-Proofing:

70. If a wrong key is pressed accidently (e.g. division
by zero), the program should not crash.

71. Pressing "Control C" (the escape key) should not
cause the program to stop.

72. Pressing the "Reset-Key" should not cause the system
to halt.
APPENDIX E (Continued)

Statements Of The Eighty Two Valid Criterion Items
That Form The Valid "Criteria Instrument"
In The Final Form

73. Leading and trailing blanks in the student's responses should not cause the system to treat them as incorrect responses.

74. Alternate responses should not cause courseware disruptions (e.g. five instead of 5).

75. Mixing of upper and lower case characters in the student's responses should not cause problems.

76. The student should be able to use the backspace, delete, or rubout keys in order to correct responses prior to pressing the "RETURN" key.

III. TESTING AND EVALUATION

Developmental Testing:

77. The courseware unit should be tested on several students of the average target population, then the problems that those students encountered should be identified through posttest results and face-to-face talking with the students.

78. Revision with suitable amendments should be introduced, and retesting should be done each time on new students of the average target population.

79. The revised version of the last step should be tried out on a cross-section of the representative student target population until it is concluded that the final version realizes the unit objectives.

Implementation Testing:

80. The revised version from the Developmental Testing should be tested under classroom conditions with a full range of the target population.

81. A thorough analysis of what was intended should be done, and any amendment to strengthen the resulting courseware should be introduced.

82. Periodic review on the package should continue so that the teacher as a courseware writer knows the effectiveness of the courseware package.
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