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Knowledge Mapping: A System for the Design and Construction of Curricula

Linda M. Tipper
Western Michigan University

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KNOWLEDGE MAPPING: 
A SYSTEM FOR THE DESIGN AND CONSTRUCTION OF CURRICULA

by

Linda M. Tipper

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Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
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KNOWLEDGE MAPPING:
A SYSTEM FOR THE DESIGN AND CONSTRUCTION OF CURRICULA

Linda M. Tipper, M.A.
Western Michigan University, 1983

This article presents a concise system for guiding content planners in the selection and analysis of content for any curriculum. The Knowledge Mapping system is compared to other curriculum development systems and is shown to meet some current needs which these systems have not met. An analysis of the Knowledge Map is provided and a demonstration of the impact that Knowledge Mapping can have on curriculum construction is presented. The demonstration illustrates that the use of this system can provide a tool for content planners which leads to a greater consistency between objectives and evaluation materials. The multiple uses of the Knowledge Map system for industrial and formal educational settings are discussed.
ACKNOWLEDGEMENTS

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Linda M. Tipper
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CHAPTER I

INTRODUCTION

The purpose of this article is to present a concise system for the selection and analysis of goals and content for instructional settings. The system is applicable for instructional settings which include elementary, high school, college, or industrial training programs. The system was originally designed by Gilbert (1975) and the author has made slight modifications for a working model. The system was designed as a tool to determine the instructional function of any curriculum. Instructional function indicates what will be fulfilled by any unit of instruction. It is not the goal of this paper to describe or advocate any particular instructional delivery system, although some may be suggested by the system.

This system is called Knowledge Mapping (Gilbert, 1975) and its main function is to determine the "relevant" content of any curriculum or individual training program. In this instance, relevance is defined as the degree to which a skill is valued; that is, the degree a skill will be utilized by the student in the environment, and the lack of which represents a deficiency. This definition implies that the content of any course should transfer to the environments in which the student must ultimately succeed.

There has been much research and discussion of curriculum and instructional design (Bloom, 1956; Gagne, 1964, 1973; Johnson & Chase, 1981; Popham & Baker, 1970a, 1970b; Tyler, 1949) which
highlights the need for a system like Knowledge Mapping to guide content planners in the specification of goals for instruction. Popham and Baker (1970a), in their discussion of content, emphasize the need to have precise statements of goals about the content of any instructional unit so that behaviors enroute to the goals may be evaluated. The system described by Popham & Baker (1970b) for establishing curriculum involves the specification of behavioral and measurable objectives, pre-assessment of learners, selection of learning activities, and evaluation.

In establishing behavioral goals, Popham & Baker (1970b) accentuate the structural properties of the goals, but not where or how these goals are generated. Although some references are made to the deliberations of experts, no specific system is described for the validation or determination of relevance for the goals themselves. Because of this, the system they describe for the specification of goals only allows content planners to later evaluate the acquisition of the goals specified, not the value or relevance of the goals.

The next step Popham & Baker (1970b) advise for the development of content is the pre-assessment of the learners; however, no attempt is made to analyze the goal itself. If learners are pre-assessed on the objective, precise information on the deficiencies is not received unless an analysis is completed on all dimensions of the goal. An analysis by content planners of the pre-requisites for the task itself, of the discriminations necessary, and of the stimulus conditions under which the behavior will occur in the environment would greatly enhance the abilities of the
planners to design materials to pre-assess the learners for deficiencies. Popham & Baker (1970b) may have assumed that this type of analysis would occur, but they give no information for planners to systematically analyze the goal to arrive at the design of pre-assessment materials.

The third step advocated by Popham and Baker (1970b) is the selection of learning activities. The selection of learning activities is critical, but no reference is made to the analysis of the goal itself. With a precise analysis of the goal and the deficiencies of the learners, the selection of learning activities could be greatly enhanced. If the goal was analyzed in terms of the stimulus conditions, behaviors and generalizations necessary for the goal to occur, both in the training environment and the real world, then planners would have a clearer picture of the requirements for the selection of training activities.

With an analysis of the discriminations, generalizations, and stimulus conditions, Popham and Bakers' (1970b) last step, evaluation, could also be enhanced. This analysis would provide the exact dimensions of the goal that are considered necessary for the acquisition of the goal and the basis for evaluation of that acquisition.

The system for content development described by Popham and Baker (1970a, b) does describe the process for the pre-assessment of learners for deficiencies, the selection of appropriate learning activities, and the evaluation of goals. However, it did not
include, and therefore could be greatly enhanced by, the addition of a system that guides content planners in the selection of relevant goals and the analysis of those goals that precedes the steps described by Popham and Baker.

In 1949, Tyler suggested a similar system of content development which included the specification of objectives, assessment of student deficiencies, selection of learning activities, and evaluation. He also suggested that when deciding content, the deliberations of specialists and the problems of contemporary life that the students will encounter be considered. Tyler also gave no specific system for selection or validation of the goals, only suggestions of where to look for them. Neither did he specify a system for the analysis of the task itself that would guide the content planner in the development of the pre-assessment materials for learners nor the selection of appropriate learning activities.

With the advent of taxonomies such as the one developed by Bloom and his associates (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956) which stressed that objectives should be classified so that irrelevant aspects are not taught, the emphasis is once again on to the classification of goals and away from the systems necessary to arrive at the specification of goals. Bloom et al. did make the point that they were not attempting to classify content or subject matter, only the "intended behaviors" of the students, which they defined as the way in which students are to act, think, or feel after instruction. However, Bloom et al. gave no directions for
content planners to arrive at these "intended behaviors." An educator intending to use the taxonomy would need a system that provided methods to arrive at the relevant goals and an analysis of those goals before they could determine the appropriate "intended behaviors."

Gagne (1964) described a system for content development in which he advocated doing a task analysis to determine the "capabilities" implied by any instructional task. He defined capabilities as "exhibiting certain performances which the performer could not exhibit before learning took place" (p. 38). There is no reference in Gagne's materials to a system that would guide the content planner in arriving at the tasks to be analyzed.

Gagne (1973) advocated that the task analysis include an analysis of the stimulus conditions necessary for teaching the tasks that could aid content planners in their analysis of the task. Gagne does not include directions for analyzing the stimulus conditions under which the behavior will have to occur in the natural environment. Content planners should at least be as concerned with the "capabilities" transferring to a larger environment as they are with the stimulus conditions of the training environment.

Gagne's system did emphasize the need for task analysis in any content development model. If content planners started with relevant goals, then analyzed these goals in terms of their value,
the discriminations, and the generalizations necessary for competent performance, they would be able to identify the valued "capabilities" of any training program.

As early as 1901 (Thorndike & Woodworth) the issue of transfer of training has been discussed and investigated (Katona, 1940; Osgood, 1949; Overing & Travers, 1966; Royer, 1979; Thorndike, 1913). Mayer (1975) used the concept of near transfer to refer to the transfer from one school-learned event to another school-learned event. He used far transfer to refer to the situation where information learned in the training situation transfers to a real world situation.

Research on the transfer of training indicates that transfer, both near and far, is facilitated by a similarity in stimulus conditions between the learning situation and the stimulus conditions of the environment where the skill is required (Gagne, 1965; Osgood, 1949; Overing & Travers, 1966; Thorndike & Woodworth, 1901). The implication of this research for curriculum design is that planners must design training to facilitate transfer of relevant skills from previous learning and facilitate transfer of skills to real world situations by analyzing the stimulus conditions of both relevant previously learned skills and the conditions under which the skills will be used in the real world.

The literature on content development seems to indicate that any system for the development of content would need to include a clear specification of goals that are both behavioral and measur-
able. In addition, the task of identifying goals would be augmented by a system that directed content planners in arriving at these relevant goals. The system would also need to direct content planners in the analysis of the goals themselves to determine the relevant prerequisites, discriminations, and generalizations needed for competent performance. Materials could then be developed to pre-assess learners, determine learning activities, and suggest ways of evaluating the acquisition of the specified goals.

The Knowledge Mapping system provides for the validation and selection of goals and the analysis of those goals and then directs a content planner through all of the steps in the process. The validation process includes determining the relevance of the goals by insuring that there is a need for the acquisition of the goals, that they reflect the skills of competent performers, and also allow for later evaluation to determine if the trainees have acquired the goal. The first step in the process of selecting goals when using this system involves not only the specification of the goals, but also the social validation of the goals.

Van Houten (1979) advocated the social validation of goals as part of the process of content development and offered several suggestions on the ways to accomplish validation. He stated,

One way of determining socially validated goals is to assess the performance of individuals who are judged to be highly competent in the area of interest. The norms are obtained from these individuals can then serve as performance goals for less competent individuals. Setting norms in this manner utilizes both commonly employed methods of social validation since it involves first selecting individuals who are universally
judged to be competent at a given behavior and second determining their level of performance. (p. 583)

In addition to validating goals, content planners must specify the goals to be validated, and the question of "what to teach" must be answered. Current theory would direct planners to start by stating objectives, which Vargas (1972) defines as,

statements of what the student should be able to do at the end of a unit of teaching. It describes behavior; moreover, it is observable behavior. It implies learning experiences, it can be communicated to the student, and it indicates a method of measurement. (p. 8)

This definition does not guide the content planner in choosing relevant behaviors, merely the format in which behaviors can be stated as objectives.

Gilbert (1976) advocated as a first step in the production of a Knowledge Map, the specification of accomplishments which are the valued products of learning. Accomplishments not only describe the subject matter, but also what the student will be able to do with the subject matter. He makes a distinction between accomplishments and acquirements. Acquirements are the skills that in and of themselves have no value, but rather comprise the vehicle to arrive at the accomplishments. An example of the difference between accomplishments and acquirements can be seen in long division. Long division problems calculated is an accomplishment. The setting up of the problem, the addition and subtraction involved are all acquirements; because, in and of themselves, they have no "value" as
"goals", rather they are the skills needed to accomplish the goal of long division problems calculated. This distinction directs content planners to choose accomplishments which are the valued products of learning and not to choose goals which are merely acquirements.

The first step in the Knowledge Mapping system is to specify the accomplishments of the trainees. To arrive at these accomplishments, the question content planners should ask is, "what do we want the trainees to be able to do when they are finished with the curriculum." Each accomplishment specifies the chain of behaviors that together comprise a valued end product. The accomplishment should also have a cost-related value that justifies the training expense and a philosophical value. The cost-related value ensures that the acquisition of the accomplishment will either become the prerequisite of some later accomplishment or that the accomplishment will be transferred to the student's professional or work environment. The philosophical value relates to whether the acquisition of the skill will be reinforced in the natural environment or will be seen as a skill that is necessary to be successful. The skill must also remedy a deficiency if it is to be considered a training goal. If the skill has transfer power, a cost-related value, philosophical value, it can be called an accomplishment and become a goal for training.

Once content planners have developed a list of accomplishments, they must then attempt to socially validate them to insure they represent all the accomplishments necessary to become a competent performer. Content planners can then proceed to analyze the
prerequisites, the generalizations, and the discriminations needed to master the skills which make up the accomplishment. After completion of the knowledge map, the planner will have clear statements of the task mastery, the value of the skill (i.e., identified the consequences for acquiring the skill), and the interim objectives of discriminations and generalizations for the accomplishments, and will have met all the requirements of good objectives as Vargas (1972) outlined.

The Knowledge Mapping system does not advocate the abolition of objectives; it is meant to be the analysis that precedes the development of specific task objectives. The Knowledge Map provides the parameters within which the specific objectives can be developed.

Gilbert (1978) and the author advocate that content planners should never lose sight of the fact that any instructional system has as its ultimate goal the success of the trainees in their professional or work environments. All content planners would agree that the clear specification of goals is a necessary first step in curriculum construction and that a system for arriving at those goals would augment any content planner's repertoire. One of the goals of this author is to show the impact that knowledge mapping can have on the selection of goals for any course of instruction.

The second step in the Knowledge Mapping system is specifying for the trainees the consequences of proper and improper performance of the accomplishment. This serves to show the trainees why it is an important accomplishment to acquire. The consequences are stated
in terms of how they will be evaluated, not only in the training situation but also later in their professional and work environments. This section of Knowledge Mapping is labeled Inductive.

When the accomplishments and the consequences of acquiring those accomplishments are specified, the content planner can proceed to the next step: analysis of the prerequisite skills needed to master the skills. The content planner will identify any terminology, concepts, or equipment that the trainee will need, but may not be familiar with, to master this accomplishment. Lindvall (1964) suggested that when planning a curriculum, both consistency and continuity in the goals across curricula should occur. If content planners identify the prerequisites, it would become possible to plan and identify goals for earlier training.

Many authors (Popham & Baker, 1970a, 1970b; Tyler, 1949; White, 1973) have suggested pre-assessment of learners, but a content planner should first be concerned with assessing the accomplishment. A clear specification of prerequisites could make the construction of pre-tests easier and give more specific information on the students' deficiencies. A clear specification of the accomplishment would also allow the content planners to avoid specifying irrelevant prerequisites and only specify those necessary for mastering the accomplishment.

White (1973) suggested that an accurate analysis of prerequisites of a task may play a role in reducing the time required to attain that goal. If all prerequisites were identified and students were tested only on those necessary, specific deficiencies would be
isolated and then trained before the student attempted to master the skills that make up the accomplishments. This method may reduce mistakes early in the training which could reduce the time required to reach mastery.

The specification of prerequisites for an accomplishment could serve as a guide in developing pre-tests, defining deficiencies, and promoting consistency of goals across grades or programs. Proof of the assertion of whether this would affect the rate of attainment awaits empirical investigation.

In the first stage, Application, content planners introduce the student to the consequences of performing the skills. In the second stage, the prerequisite skills are identified that the trainee should possess before training can occur. The third step involves the identification of theory that may mediate the responses. This step is called the theory stage and serves to define the performance theory of the accomplishment. The identification of theory specific to the accomplishment helps to prepare the trainee to generalize the accomplishment to a wide variety of situations.

In the next stage the discriminations and responses required for performance of the accomplishment are defined. This insures that all the skills necessary to the performance of the accomplishment have been acquired. This stage, Skills, includes all of the skills from which objectives can be developed. These skills are the acquirements which together comprise the accomplishment.
In the last stage we require the trainees to demonstrate the mastery of the accomplishment in the context where the skills will ultimately be used. This last stage helps to insure that the accomplishment will in fact transfer from the training situation to the environment where it will ultimately be needed. It causes the content planners to attend to the conditions that will exist in the natural environment and program these conditions into the training situation. Simulations can be an excellent method for the student to demonstrate the ability to transfer all of the skills to a novel situation.

The Knowledge Map is thus a six stage analysis wherein content planners (1) identify valuable accomplishments, (2) motivate, (3) identify prerequisites, (4) identify the concepts of the task, (5) identify discriminations, and (6) extend the skill to a larger context.

The Knowledge Map is based on the operant theories of B. F. Skinner, and can be translated into a useful system for analyzing the Knowledge Map. The Inductive Stage analyzes and states the consequences, both short and long term. The Prerequisite Stage analyzes previous learning history and its antecedents. The Theory Stage specifies the generalizations that mediate the responses. The Skill Stage addresses the stimulus response relationships and discriminations necessary. The Application Stage analyzes the stimulus requirements of transferring the accomplishment to a larger context.
When the Knowledge Mapping system is used, it keeps content planners sensitive both to the stimulus conditions under which learning should occur and the stimulus conditions under which the acquired skill is performed. Knowledge Mapping is a system for establishing curriculum content and analyzing that content. Knowledge Mapping can be seen as a hierarchy in that it classifies the learning task into various stages of analysis.

Johnson and Chase (1981) identified five problems with current hierarchies and taxonomies. The first problem is that current schematas classify tasks on the basis of inferred mental operations. The second problem cited is that schematas focus on internal unobservable behaviors which make them difficult to classify. Knowledge mapping avoids these two problems since the accomplishments are stated behaviorally, and all tasks are classified by environmental stimuli.

The third problem noted is that current systems only focus on the structural and formal properties of the objectives and thereby neglect the conditions under which the skill identified in the objective will be performed. In Knowledge Mapping the analysis not only meets the structural requirements of objectives, but also addresses the stimulus conditions under which the behavior will occur.

Johnson and Chase (1981) also assert that the procedures for using current classification systems are based on the assumption that instructional tasks can be arranged in a taxonomy, or hierar-
chy, from simple to complex behaviors. In Knowledge Mapping relevant accomplishments are identified and then analyzed to determine the discriminations and generalizations necessary that are not based on assumption, but rather on observation of competent performers. This does not imply simple to complex, rather it is an analysis of the task and its components.

The last problem cited by Johnson and Chase regarding current schematas involves errors of omission rather than commission. They are concerned with all of the variables involved with competent performance such as rate and quality. In Knowledge Mapping part of the analysis is insuring that the skills transfer to the larger context of the environment in which they must ultimately occur. In analyzing where the skill must occur, considerations of rate and quality can be tested and specified. Thus Knowledge Mapping can be used to design curricula without the problems associated with other schematas.

Once a Knowledge Map has been completed for a curriculum, the design of evaluation systems can be easily accomplished. Brethower and Rummler (1977) advocate that evaluation of training should occur at four levels: (1) satisfaction; (2) acquisition of the concepts; (3) transfer and use of the skills in the work environment; and (4) positive effect of skill application. Knowledge Mapping allows for evaluation systems to be designed that can easily measure these four levels.
Educators can be given the Knowledge Maps which contain relevant information for the design of instructional tasks. As a result, they will know what the evaluators will be testing independent of the instructional delivery system used to teach the accomplishments. Evaluators can also begin to test for acquisition of all the skills that make up the accomplishment not simply the acquisition of individual skills.

Table 1 summarizes the criteria for good curriculum design as specified in the literature presented, and shows how these criteria represent characteristics of a good Knowledge Map. The additional characteristics of a good Knowledge Map below the dotted line represent those that in most cases precede and direct content planners in arriving at the criteria specified above the dotted line.

Knowledge Mapping can be seen as a tool for the application of operant analysis to the training environment. The Inductive stage addresses the issue of consequences, the Skills stage attempts to define the stimulus-response relationships needed to perform the chain of behaviors, which together, comprise the accomplishment. Knowledge Maps take into account the issues of operant analysis and should be viewed as the analysis which precedes the design of training and instructional materials consistent with the research in operant analysis. Once constructed, Knowledge Maps can serve the same multiple functions both in industry and academia (see Appendix A). Knowledge Mapping meets the needs of content planners for a methodology to accomplish the clear specification of instructional function.
<table>
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<th>THEORY</th>
<th>SKILLS</th>
<th>APPLICATION</th>
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<tr>
<td>Consult subject matter experts</td>
<td>Pre-assessment</td>
<td>Selection of learning activities (Popham &amp; Baker, 1970a, b; Tyler, 1949)</td>
<td>Specification of behavioral &amp; measurable objectives (Popham &amp; Baker, 1970a, b; Tyler, 1949)</td>
<td>Facilitates far transfer by analyzing real world stimuli (Mayer, 1975; Overing &amp; Travers, 1966; Thorndike &amp; Woodworth, 1901)</td>
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<tr>
<td>Social validation by exemplar performers (Van Houten, 1972)</td>
<td>Near transfer of relevant past learning (Thorndike &amp; Woodworth, 1901)</td>
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<tr>
<td>Precise statement of goals</td>
<td>Evaluate</td>
<td></td>
<td>Selection of learning activities (Popham &amp; Baker, 1970a, b; Tyler, 1949)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specify socially validated accomplishments</td>
<td>Specify consequences of proper and improper mastery</td>
<td>Analysis of pre-requisites necessary for mastery (tools, equipment, language)</td>
<td>Design domain theory to create mediators which reflect concept and facilitate generalization</td>
<td>Specify all discriminations necessary</td>
<td>Create simulations to evaluate transfer, and mastery of the accomplishment</td>
</tr>
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</table>

Note: The table reflects criteria for good curriculum design and how this relates to a good knowledge map.
The remainder of this paper will be concerned with the analysis of each stage of application of Knowledge Maps, and a demonstration. The demonstration will attempt to show how the emphasis of training can be affected by the use of the Knowledge Map in the development of course materials. The author will also demonstrate how three courses, courses, all intending to teach the same material, can in fact be teaching completely different aspects of the same information.
CHAPTER II

DESCRIPTION OF SYSTEM

To demonstrate the impact that Knowledge Mapping can have on course development and the evaluation of current curricula, the author selected three university level courses purported to teach the same "subject matter". Once the courses had been selected, the instructional materials (quizzes and objectives) were classified into the Knowledge Mapping categories to determine the emphasis of training in each of the three courses.

The author sent letters to various university professors requesting copies of their instructional materials. The professors contacted currently, or had previously, used the text, *Human Competence* (Gilbert, 1978), to teach a course at the graduate level designed for students entering the industrial psychology field.

Six requests were sent and three responses were received. Of the three responses, only one was chosen for the demonstration because it included quizzes and objectives as part of the instructional materials (Course A). The two responses that were discarded did not contain quizzes and objectives as part of the instructional materials. Since only one response contained the necessary components, the author selected instructional materials from a course designed by the author and her advisor that met the criteria specified (Course B₁).
The third set of instructional materials used for the demonstration were developed by the author with the aid of Knowledge Maps. Before the instructional materials for a graduate level industrial psychology course were designed, the author reviewed the text and identified eight accomplishments and then completed a Knowledge Map for each accomplishment. Once the Knowledge Maps were completed, quizzes and objectives were developed. These instructional materials were included in the demonstration as Course B2.

For each quiz and objective item from each of the three courses, the author determined to which accomplishment the item related. The items were sorted into accomplishments based on their content. A total of 269 items from the three courses were classified into the accomplishments to which they pertained. Except for 38 objectives from Course A, all other quiz and objective items from the courses related to the eight accomplishments originally identified by the author for Course B2. The 38 objectives from Course A pertained to five additional accomplishments. The 231 remaining items comprised the data for the next step in the demonstration.

Once the items had been classified with their accomplishments, the author attempted to classify each item into one of the stages of the Knowledge Map to which it belonged. To determine to which stage the item related, the author attempted to define the characteristics of the items to decide whether their content related to:
a. The consequences of performing the skills correctly, or its value over other skills (Inductive).

b. The underlying logic of the skills (Theory).

c. The specific discriminations of the skills (Skills).

d. The application of the skills that make up the accomplishments (Application).

What follows is an analysis of each of the stages of the Knowledge Map and examples of items from each course and how and why they were classified into the Knowledge Map categories.

**Stage 1: Accomplishments**

The first step in the development of a Knowledge Map is to identify what the trainee will be able to accomplish as a result of the training. If, for example, history is the subject, decisions will have to be made as to what the student will be able to do with the knowledge that is acquired. Some of the possibilities for the course are whether the students will learn to make history, organize historical documents, describe and organize historical data, make predictions, or produce descriptions of history (Gilbert, 1976).

These decisions on the content of training define the emphasis that the instruction will take. To make these decisions on emphasis, the content planner must define the valued accomplishment of learning history. Value must, in part, be determined by evaluating what the trainee will need to do with history in the future environment.
If the history course is designed for college level students who intend to be archivists, the goal of organizing historical documents becomes a valued product of training. If the course is designed for elementary students, the goal of organizing historical documents loses its value since only a few students will be archivists; the same is true for the goals of making history, producing historical documents, or describing and organizing historical data. All of these goals have specific settings, which only a few students will encounter and only after specialized training many years after elementary school. The goal that remains is making predictions; if students are taught to identify the critical variables that account for historical and current events, they will be better able to predict future events. This is a valuable skill since all students will eventually have to vote and make decisions about their future in which the ability to predict the likely outcome of current events will be valuable.

When deciding on the emphasis of training, the best tool that can be used is to identify a competent performer in that particular area and identify the aspects of the performance that exemplify competence. In this way we are not describing what the competent performer knows, but rather what they can do. Knowledge is only of value when it can be joined with the ability to apply it to the environment in which the student must succeed.
When defining the accomplishments of any curriculum, the planner must also consider the transfer power of the accomplishments; that is, the extent to which the trainee will be able to apply the accomplishments to many different situations encountered in future environments. As an example, the accomplishment is long division problems calculated. The student would have to be able to recognize (generalize) when to use long division in instances in the natural environment. In the history example, the ability to make predictions can be applied to many aspects of the environment, from voting decisions to career choices. If the training had only emphasized the variables of specific historical events, the trainee may not have then been able to generalize how general variables that led to an event in the past could be generalized to making a prediction (connection) upon similar events occurring in the present. By considering the transfer power of an accomplishment, content planners would be better able to choose accomplishments that have a wider range of value to the individual anticipating the demands of future environments as well as the training environment.

When considering the content of training, planners must also consider the cost-related value of what is taught. If history is the content for an elementary class, the costs of training all students to "make" history is questionable since the environment will only support so many rebels and politicians. If the students are taught to make predictions, it is a skill that is not only likely to be of value to all students, but also more likely to be supported in the natural environment.
When stating the goals and emphasis of training, the form in which they are specified is important. They should be stated not as process statements or behavior, but rather as accomplishments which are the valued "products" of training. Accomplishments are what the trainee leaves behind when they are finished - the permanent products. When only the behavior is described, the end product may be lost; behavior should only be considered as the costs of arriving at the accomplishment.

For example, if the goal of training is concerned with interviewing skills and the accomplishment is stated as "interview completed", the emphasis is placed on interviewing skills and conducting the interview. But is this the "valued" accomplishment of the interviewer? No, the valued end product for an interviewer is "people hired". The interviewing methods are important and covered by the training; but they are only the skills needed to accomplish the ultimate goal which is to hire employees. They have no value themselves, they are the means to the end product. In the natural environment, the interviewers' performance is determined by measures of whether they hired people and if the people hired performed the job well. Measuring an interviewer's skills at interviewing need not be done unless the above two measures indicate a problem.

One of the accomplishments identified for the courses used in the demonstration of the impact of Knowledge Mapping on course design was "Knowledge Maps completed". This was chosen as an
accomplishment by the author because it met all criteria for selection: (1) transfer power, since the ability to design them can be applied to any level or content in training situations; (2) value to society, since they can save time and money in designed training; (3) cost-related value in that all student were in graduate classes for industrial psychologists and most would be called upon to design training at some point in their careers. In addition to the above criteria, it was ascertained that there was a deficiency by most students at the graduate level in this area. "Knowledge Maps completed" is therefore an accomplishment and not a behavior; it is a valued product (see Appendix B).

The following are examples from Courses A and B1 that were classified under the accomplishment, "Knowledge Maps completed".

**Course A**

a. Objective: What are the cells of the Knowledge Map?

b. Objective: Describe a human learning program, perhaps for a CHD case, that includes each stage of the Knowledge Map appropriately.

c. Objective: What are some of the uses that Gilbert sees for Knowledge Maps?

**Course B1**

a. Evaluation: Prepare a set of recommendations and a justification as to why the university should adopt the Knowledge Mapping system for curriculum design.

b. Evaluation: Imagine that you are teaching a course on the behavior engineering model. Answer the following questions: How much theory would you teach and what would it be?

c. Evaluation: Select one of the following units from this course and develop a Knowledge Map.
These examples are provided to show the reader how the content of the demonstration items were sorted into accomplishments.

In summary the first step in the production of a Knowledge Map is the identification of content which has transfer power, is valued by society, represents a deficiency, has a cost-related value, and is stated as an accomplishment, not behavior.

Stage 2: Inductive

When the accomplishments of training have been specified, the next step in the production of a Knowledge Map is called the Inductive stage. This stage serves two major functions: to familiarize the student to the subject matter, and to demonstrate the consequences of proper and improper performance of the accomplishment. The instructor may design the first part of the inductive by relating the subject matter to areas the students is already familiar with and by emphasizing the value of the accomplishment. The instructor specifies what the student will be able to do as a result of mastering the accomplishment.

The content planner must specify the consequences of proper and improper performance of the accomplishment. If there are no consequences for mastering the accomplishment, the value again must come into question.

The planner must specify the consequences of mastering and not mastering the accomplishment, not only to the individual performer but also to the organization or the larger environment where the
accomplishment will ultimately be performed. By specifying the consequences in this manner, the planner is describing the short- (in training situations) and long-term (mastery or non-mastery in future environments after training) consequences of performance.

In the case of training in industry, the impact of proper and improper performance should include the impact to the individual, other workers, and the organization as a whole. In formal education, the consequences are described in terms of the immediate environment of the classroom, later classes and evaluation, and the environments where the accomplishment will occur.

The Inductive can also analyze the value of mastering the accomplishment over other accomplishments as in the case of a new technology where the value could be compared to earlier technology in the area. In the case of the accomplishment "Knowledge Maps completed", all course items that were categorized in the Inductive category under this accomplishment met the above criteria, in that they were concerned with the merits of using Knowledge Maps over other methods and also the consequences of proper and improper performance (see Appendix B).

In the demonstration courses, no short term consequences were described; but items were classified into the Inductive category if they concerned the impact of the accomplishment on instruction or the merits of using those skills over others. In the case of items relating to the accomplishment, "Knowledge Maps completed", the following are examples of items placed in these categories.
Course A

Objective: What are some of the uses that Gilbert sees for the Knowledge Map?

Course B

Evaluation: Prepare a set of recommendations and a justification as to why the university should adopt the Knowledge Mapping system for curriculum design.

In the Inductive Stage, the content planner specifies the consequences of mastering the accomplishment so that the students know why they should be motivated to master the accomplishment.

Stage 3: Prerequisites

In the third stage of analysis, the prerequisite behaviors necessary for the mastery of the accomplishment are identified. Prerequisites include any tools, equipment, concepts, or technical language that the learner must be familiar with before the accomplishment can be mastered. An example of a prerequisite for long division would be the mastery of addition and subtraction. It may be decided that in our modern world that everyone will be dividing on calculators, so our prerequisites would include mastery of the use of a calculator.

When making decisions pertaining to the prerequisites, planners must determine if it is likely that all of the students will be deficit in the prerequisites or if only some of the students will lack the necessary skills. If all students are likely to be deficit, then the teaching of the prerequisites should be incorporated into the program. In cases where some of the students will have already
mastered the prerequisites, decisions will have to be made about the students who have not acquired the necessary skills. Pre-tests may be developed to test for mastery of the prerequisites. Performance on the test could be used to either move those students who have deficits to a remedial program or develop special programs to be used within the lesson itself. The Knowledge Map used in the demonstration course did not include prerequisites since the only prerequisites were reading and writing, which the author assumed graduate students had already acquired.

Completing an analysis of the prerequisites of any accomplishment can save time and costs in training by pointing out the specific deficits that may hinder the student in acquiring the skills which make up the accomplishment. Pre-test data may also be used as an evaluation of previous training if the prerequisites should have already been mastered. Once the prerequisites have been identified, they can also be used to determine accomplishments for other areas of the curriculum. Pre-testing for the prerequisites also has the advantage of giving specific information on individuals student deficits so that personalized instruction can occur by addressing the specific deficit.

Stage 4: Theory

The fourth step in the production of the Knowledge Map is called the Theory Stage. In this stage we are identifying a repertoire of verbal behavior, which alone will not produce a useful end result, but will serve three educational functions.
The first function will be one of fostering generalizations by mediating the behavior of looking through superficial details to essential properties. The second is that theory increases retention by serving as the verbal prompts for the overt acts of mastery behavior. The third function of theory is to serve to increase reinforcement by shortening the route to mastery and by relating the behaviors in learning more directly to the objectives of the students. (Gilbert, 1962, p. 49)

In summary theory is useful in mediating, maintaining, and extending mastery. The amount of theory to be taught is only the amount needed to produce the generalization required to meet mastery level.

In the Theory Stage content planners are describing a domain theory which includes all the elements of behaviors required and is tailored only to the assigned subject matter and no more. The theory provides the analytic repertoire that underlies the chain of behavior to meet the accomplishment. The content planner must reduce the chain of behavior to its underlying logic.

When identifying the theory of Knowledge Mapping, the author reduced the chain of behaviors for completing a Knowledge Map into:

- Identifying outcomes, not behavior (accomplishments)
- Consequences of proper and improper performance (inductive)
- Needed elements to master accomplishments (prerequisites)
- The underlying mediating logic (theory)
- The specific discriminations in the chain (skills)
- The generalizations needed for mastery (application)
In the Theory Stage, we are establishing a verbal repertoire so that the trainee, when designing a Knowledge Map, will prompt themselves to say, "What's first? ----> Accomplishments ----> which is identifying outcomes". The specific discriminations required are identified in the Skills Stage of the Knowledge Map. When designing theory, content planners should remember that the verbal repertoire identified is not useful in and of itself; it is only used to mediate and help extend the behaviors.

Of the examples given from items classified under "Knowledge Maps Completed", the following items were classified under theory.

Course A

Objective: What are the cells of the Knowledge Map?

Course B

Evaluation: Imagine you are teaching a course on the behavioral engineering model. Answer the following questions: How much theory would you teach? What would it be?

The reason for these classifications is that in both instances the underlying logic (theory) of "Knowledge Maps completed" is being asked for or evaluated.

Stage 5: Skills

The fifth stage of analysis is concerned with skill development and is called the Skill Stage. For many accomplishments, the Skills Stage is identified before the Theory Stage since it aids the planner in determining the amount of theory to teach.
In the Skill Stage the content planner identifies the chain of behaviors required to perform the accomplishment. The chain includes and highlights the specific discriminations required. The planner should be particularly aware of three major areas where deficiencies may exist and can be highlighted to insure mastery. The first area is if the accomplishment requires many difficult discriminations, the planner should insure extra training in those discriminations to insure mastery. The second area concerns response fluency; if the response must occur at a high rate, the instructor must shape the rate of response. The last area is concerned with environmental variables; that is, if the accomplishment must ultimately be performed under highly competitive or stressful situations that can affect performance, the instructor should attempt to introduce these variables into the training.

The content planner in the Skill Stage is not only analyzing the stimulus-response relationship needed for mastery in the training situation, but also those needed for mastery in the trainee's future environments. Once this is accomplished, instructors can then design objectives that stress potential areas of difficulty and test items to evaluate where the specific deficiency exists. In this way specific skills that prevent the trainee from mastering the accomplishment can be readily identified and rectified. When developing the Knowledge Map on Knowledge Mapping all of the discriminations for completing a Knowledge Map were specified (see Appendix B).
In the demonstration, there were no items from Course A or B1 under "Knowledge Maps completed" that represented the Skills stage. In Course B2, there were no evaluation items pertaining to the Skills Stage, but the following is an example of an objective classified into the Skills Stage.

**Course B2**

Objective: When presented with a list of items from a Knowledge Map, be able to label the category to which they belong.

This was classified into the Skill category because it calls for the student to make critical discriminations pertaining to the accomplishments.

In summary, the Skill Stage defines the discriminations and skills needed to master the accomplishment. The skill column can then be used to determine the relevant objectives and training materials required.

**Stage 6: Application**

The last step in the production of a Knowledge Map is called the Application Stage. In the last stage the concern is whether the student will be able to perform the accomplishment at the mastery level in the environments where the accomplishment will ultimately be executed. The content planner must attempt to identify all of the environments where the accomplishment will be performed. The instructor can then develop simulations to evaluate whether or not the student will be able to perform the accomplishment under the
various environmental conditions. For the Knowledge Map on Knowledge Mapping, it was determined that the trainees could best demonstrate their mastery by producing a Knowledge Map (see Appendix B).

Following are examples of items from each of the three courses that were classified in the Application Stage.

**Course A**

Objective: Describe a human learning program, perhaps for a CHD case, that includes each stage of the Knowledge Map appropriately.

**Course B1**

Evaluation: Select one of the following units from this course and develop a Knowledge Map: Computing PIPS; Behavioral Engineering Model; Guidance Techniques.

**Course B2**

Evaluation: Construct a Knowledge Map using Knowledge Mapping as your unit of material.

Each of these items asks the student to engage all the skills required to produce a completed Knowledge Map and, therefore, was classified in the Application Stage.

Content planners should also include in the Application Stage any additional stimulus conditions that may exist in environments outside the training setting. For instance, in the case of new technology, students must be prepared for resistance to the new technology and taught ways to overcome this resistance.
In the Skill Stage, the planner is insuring that the student will master all of the skills required to perform the accomplishment. In the Application Stage, the concern is whether the skills can be applied to produce mastery level performance of the accomplishment.

Once the Knowledge Map has been completed, planners then have an outline and a clear specification of the goals for training. It can be used to discuss curriculum before must time and energy has been invested in the development of instructional materials. It can also be used as a course outline and a tool for the development of evaluation materials. Once developed, the map can also serve as a guide in the development of course objectives, instructional materials, and tests.

Before the development of materials, however, content planners must validate the accomplishments to insure that all relevant material has been included and represents the accomplishments of a competent performer. The validation process should include input from performers in the environment where the accomplishments will ultimately have to occur.

With the clear specification of accomplishments, evaluators can not only evaluate the student's mastery of the material, but also the instructor's ability to design materials for the acquisition of the accomplishments. The Knowledge Map can also be used to evaluate current curriculum to insure that they are teaching relevant and valuable accomplishments not just skills that may or may not be applied to the environments in which students perform.
Knowledge Maps and their continued validation can serve two additional functions. First, they may point out potential candidates for new accomplishments to continually meet the changing needs of the environment. The second function involves training and feedback. With continual social validation, evaluators could track graduates of programs to evaluate the use and effectiveness of the graduates and their accomplishments.
CHAPTER III

METHOD

Each of the quiz and objective items from each of the three courses had been sorted into the accomplishments and categories of the Knowledge Map to which they related. The last stage of the demonstration consisted of determining the emphasis of the training materials and the correspondence between objectives and evaluation items.

The emphasis of training was determined by adding the number of quiz items and objectives from all accomplishments in each course for each category of the Knowledge Map. The number of quiz or objective items was then divided by the total number of quiz or objective items in each category to determine the percent of coverage in each category.

To determine the correspondence between quiz items and objectives, the author designed a chart to show the distribution of quiz and objective items in each category for each of the eight accomplishments for each course.
CHAPTER IV

RESULTS

A total of 269 items from the three courses were classified into both the accomplishment and the Knowledge Map category to which they pertained. Except for 38 objective items from Course A, all other quiz and objective items for the three courses related to eight major accomplishments. Each of the eight accomplishments concerned techniques for diagnosing and solving performance problems in industrial settings.

The 38 objectives from Course A pertained to five additional accomplishments. These items and accomplishments were not included in the data for three reasons. The first is that they could not be compared to the items in Courses B₁ and B₂. Secondly, all of the objectives concerned the Inductive or Theory areas of the Knowledge Map and did not have evaluation items pertaining to them, which made their value dubious. In addition, the items seem to concern material that went beyond the scope of the material presented in the text and seemed appropriate for other courses.

Table 2 depicts the emphasis of training by reporting the percentages of objectives and quiz items concerning each of the Knowledge Map categories for each course. All percentages under 5% have been deleted to emphasize the amount of coverage and emphasis placed on the various categories. (For a detailed reporting on the coverage of each accomplishment for each course, see Appendix C.)
### TABLE 2

PERCENT OF OBJECTIVES AND QUIZ ITEMS IN EACH KNOWLEDGE MAP CATEGORY FROM EACH COURSE

<table>
<thead>
<tr>
<th>COURSE</th>
<th>Inductive</th>
<th>Theory</th>
<th>Skill</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>O = 106</td>
<td>58.0%</td>
<td>35.0%</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Q = 18</td>
<td>39.0%</td>
<td>56.0%</td>
<td>X</td>
</tr>
<tr>
<td>B&lt;sub&gt;1&lt;/sub&gt;</td>
<td>O = 13</td>
<td>23.0%</td>
<td>15.0%</td>
<td>30.0%</td>
</tr>
<tr>
<td></td>
<td>Q = 23</td>
<td>26.0%</td>
<td>8.0%</td>
<td>17.0%</td>
</tr>
<tr>
<td>B&lt;sub&gt;2&lt;/sub&gt;</td>
<td>O = 45</td>
<td>X</td>
<td>X</td>
<td>58.0%</td>
</tr>
<tr>
<td></td>
<td>Q = 32</td>
<td>X</td>
<td>X</td>
<td>38.0%</td>
</tr>
</tbody>
</table>

O = Objectives  
Q = Quiz/Evaluation Items
The pattern in the summary data is repeated in the reporting of the data for each course. The pattern indicates that in Course A the emphasis was placed on the importance of the accomplishments (Inductive) and the theory of them. In Course B₁ there appears to be a distribution of the items across accomplishments. In Course B₂ the emphasis is almost solely on the skill and application of the accomplishments.

Figure 1 is a graphic representation of the distribution of quiz and objectives items into each of the Knowledge Map categories for each course. For examples of various objectives classified from each course, see Appendix D. Again it can be seen that in Course A there is almost exclusive emphasis placed on the theory and inductive aspects of the accomplishments. Course B₁ shows a distribution and Course B₂ indicates specific emphasis on the skill and application areas.

Figure 2 illustrates not only the emphasis of training, but also depicts the relationship between objectives and quiz items for each of the accomplishments. In Course A, when quiz items are paired with objectives, for the most part they correspond to the objectives. Many of the areas covered by objectives do not have quiz items to evaluate the acquisition of the objective. Again we can also see the emphasis being placed on the inductive and theory aspects of the accomplishment. In Course B₁ there seems to be little relationship between the stated objectives and the quiz items themselves. There is a distribution across the Knowledge Map.
Figure 1. The percentage of quiz and objective items in each of the Knowledge Mapping categories for each course.
PERCENT OF COVERAGE

KNOWLEDGE MAPPING CATEGORIES

OBJECTIVES EVALUATION ITEMS

A

B1

B2
Figure 2. The relationship between objectives and evaluation items for each accomplishment in each category of the Knowledge Map for each course.
<table>
<thead>
<tr>
<th>ACCOMPLISHMENTS</th>
<th>A</th>
<th>B1</th>
<th>B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERFORMANCE AUDIT</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>KNOWLEDGE MAPPING</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>TRAINING TACTICS</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>PERFORMANCE AIDS</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>PERFORMANCE MATRIX</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>PERFORMANCE TABLES</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>BEM</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>JOB MODELS</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
</tbody>
</table>

▼ OBJECTIVES   ▼ EVALUATION ITEMS
categories of items, but there seems to be no systematic relationship for each accomplishment. Course B2 depicts an almost one-to-one relationship between the objectives and the quiz items for each accomplishment. The emphasis is clearly on the application and skills necessary to perform each accomplishment. There is also a consistency in the design of materials for each accomplishment in that they almost all show an emphasis on skills and application of each accomplishment.
CHAPTER V

DISCUSSION

From the demonstration, several points can be made about the impact of Knowledge Maps on the design of instructional materials. In Course A the objective and quiz items emphasized the importance of the accomplishments and their theory almost exclusively. In only one instance is application of the accomplishment evaluated and only in five instances are there objectives to emphasize the skills and application of the accomplishments. Since there is a greater correspondence between objectives and evaluation in the inductive and theory areas, it can be assumed that the designer intended the students to only be able to state the importance and theory behind the accomplishments, but not be able to perform the accomplishment itself.

In Course B1 there is no clear correspondence between objective and evaluation items in any given area or any accomplishment. For each of the accomplishments, an evaluator would have to determine the emphasis in training before they could design an evaluation of that accomplishment. It can be seen from the demonstration that Course B1 was designed without attention to the correspondence between objectives and evaluation nor a clear goal with respect to the accomplishments.
Course B₂, which was designed with the aid of a Knowledge Map, shows an almost one-to-one correspondence between quiz and objective items across accomplishments. It is clear from the data that the emphasis of training was on the skills and application of the accomplishments. In none of the accomplishments is the theory emphasized or tested. As a result of the emphasis being on the execution of the accomplishments, evaluators could assume that they could directly test for the performance of the accomplishment rather than the theory or importance of it.

The question becomes one of whether there is more value in training the students to describe the value of the accomplishments or whether the value is in the ability to perform the accomplishment. Since the courses were designed for graduate students in the industrial psychology curricula, the answer of what is valued lies in the demands of their future environments. Most industrial students will need to perform the accomplishments not simply know why they are important. It would appear that in this respect, Course B₂ was most successful.

The final test for training is whether the students in fact apply the training in their future environments. If from the training in Course A the students are convinced of the importance of applying the accomplishment to their work environment and they attempt to do so, Course A has been successful to a certain degree. It is very likely that some of the students will generalize the theory and be able to correctly perform the accomplishments; but
since they have not received specific training and practice and have not been evaluated, trainers will not have predictors as to how effective their application will be in this future work environment. The likelihood is that the student will demonstrate the accomplishment; if performed incorrectly the student will probably be punished and therefore the likelihood that they will choose that accomplishment in the future is diminished.

When the results of the demonstration is viewed in terms of the potential for far transfer (Mayer, 1975), Course B₂ has the greatest potential for far transfer since application has been evaluated. Course B₁ emphasized the consequences and theory, but made no attempt to evaluate the skills and application of the accomplishments. In Course B₂, an attempt was made to design the training stimuli to be as similar as possible to the stimuli the trainees would encounter in their work and professional environments.

Overing and Travers (1966) support this with their research which suggests that transfer is facilitated by training to discriminate relevant and irrelevant features of the situation (Skills Stage) and by relating the stimuli and responses to a practical situation (Application Stage). In support of the emphasis placed on skills and application in Course B₂ and how this relates to transfer, DiVesta and Thompson (1970), in their review of the transfer literature, stated,

In all cases two practical points about transfer are certain: The first is that learning from in-school situations does not transfer to real life situations unless the two are functionally equivalent, that is
unless the pupil perceives where, when, and how the learning is to be applied. Secondly, transfer is not necessarily automatic. To assure beneficial amounts of transfer to desired situations the teacher must point out or otherwise instigate the necessary applications (p. 269).

In Course $B_2$, the designer has chosen to emphasize the area where the instructors can have the most control by emphasizing the performance of the accomplishment. The ultimate evaluation is still whether the student can correctly perform the accomplishments in their work environments; but if the emphasis was placed on the performance of the accomplishments, evaluators can be more certain that if performed, it will be performed correctly and hence reinforced. This will, in part, insure that the content of the course was valuable.

Course $B_2$ did not have quiz and objective items pertaining to the inductive and theory of the accomplishments; this, however, does not imply that these areas should be ignored in training. In this particular course, much of the text dealt with the inductive and theory aspects of the material and, therefore, was not stressed in the other instructional materials. The author recognizes that although Course $B_2$ did not evaluate the acquisition of the Inductive skills, this should have been done to insure the students had acquired the information. To insure and increase the likelihood that the students will perform the accomplishment in their work environment, designers should insure not only that the students can perform the accomplishment, but also to recognize why it is the best
alternative. Quiz and objectives items should also include the theory and inductive aspects of the material. Given that Course B2 did not test for theory and inductive, it still demonstrates a greater consistency between test and objective items and a greater emphasis on the actual execution of the accomplishments. Although Course B2 did not directly evaluate the students' acquisition of theory, this was tested through the evaluation of skills and application.

Due to the nature of the material, no attempt was made to formally validate the accomplishments for their relevance. Some content validity is present in the selection of accomplishments since Gilbert (1978) wrote the text from which the accomplishments were derived. Gilbert and his associates have been training and implementing the systems that the accomplishments represent for many years in industry. The accomplishments are also taught through workshops given by Kepner Tregoe, a leading supplier of industrial seminars. For these reasons the author assumed the accomplishments to be relevant to the needs of industrial psychology graduates. The author also did not attempt to evaluate the effectiveness of the three courses in terms of the mastery of the accomplishments since it was determined that that went beyond the scope of this paper. If formal validation had occurred, the process would have included validating whether the accomplishments reflected the accomplishments of competent performers in the field of industrial psychology in a larger context (content validity).
When using the Knowledge Maps, trainers can expand the validation process to include tracking graduates to ascertain whether they are using the accomplishments in their work environments and, if they are applying them, whether they are having the desired effect on their environments. This form of validation provides the designer with feedback that can be used to evaluate the success of training and provide information on deficits in the training accomplishments.

Expanding the validation process to include whether the performance of the accomplishments has the desired effect can create a direct dialogue between educators and the industrial world which is the ultimate receiving system for the accomplishments. This dialogue, if successful, could begin to bridge the gap between the real needs of the work environment and what formal education can do to meet those needs. The use of the validation in this manner helps to provide a framework that allows for a Total Performance System (Brethower, 1972) which can then use information gained from the feedback to improve the system.

In education much attention has been given to the tactics of training, but there appears to be a gap in the development of policy for the training environment. Policy refers to the goals of training and tactics refer to the delivery systems used to arrive at these goals. Knowledge Mapping provides a system whereby the goals of training can be clearly specified so that there can be a consistency between those goals and the delivery systems and materials.
used to arrive at those goals. Knowledge Maps are used as the planning tool that allows for the precise communication of the requirements of the training that insures the development of relevant instructional materials and systems. Knowledge Maps can also be used to evaluate the effectiveness of the instructors. Since it presents the goals of training precisely, students can be evaluated to determine if they have met the goals of training. By evaluating the students' abilities to perform the accomplishments, evaluators can determine the effectiveness of the instructor and their delivery systems without having to directly observe their teaching methods. Knowledge Maps should precede any development of instructional materials since they can save time and money by providing a framework for the discussion of the best types of instructional material. The maps can be used for the design of workshop materials, self-instructional modules, or evaluating the worth of current instructional materials.

Further research is needed in the area of the effectiveness of Knowledge Maps with particular areas of content and whether they aid in the transfer of training to other environments. Further research could also begin on the use of Knowledge Maps and whether they effect the selection of delivery systems and the evaluation of those delivery systems by providing a clear framework for evaluating the accomplishments.
It is the conclusion of this author that the use of Knowledge Mapping in the design of content could take education and training a step closer to teaching students to better meet the demands of the environments where they will ultimately have to be successful. Knowledge Mapping is not new; it should rather be viewed as being consistent with the operant principles of B. F. Skinner and the current literature pertaining to content development. The Knowledge Map provides the framework for analyzing the consequences, stimuli, and responses required in an unit of instruction. The analysis done in each of the stages represents what is known about facilitating the transfer of accomplishments and conditioning skills. As more information is gained on how people learn and transfer skills, the specific type of analysis of the stages may change; but the framework of the Knowledge Map will remain the same. The Knowledge Map insures that content planners remain aware of what controls and facilitates behavior. The Knowledge Map has led to the development of a tool for content planners to aid in the development of policy for training that precedes the development of instructional materials. This author asserts that if the Knowledge Mapping system is implemented, it can lead to a more cohesive, measurable, consistent, and specific design of content for any instructional unit and can be considered as the first step in the design of any unit of instruction.
REFERENCES


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Thornndike, E. L., & Woodworth, R. S. The influence of improvement in one mental function upon the efficiency of other functions. Psychological Review, 1901, 8, 247-261.


APPENDIX A

Industrial and Educational Uses of Knowledge Maps

Industrial

1. Personnel Departments
   a. Match knowledge and skills of applicants to the requirements of the job for selection.
   b. Match, place, promote employees depending upon their degree of mastery.
   c. Identify specific deficiencies for training.

Training Departments/Educational Uses

1. Serve as a basis for developing evaluation measures for:
   a. trainee
   b. instructor
   c. content
   d. effectiveness of training
   e. instructional materials

2. Provide a guide for the development and selection of:
   a. text books
   b. supplemental instructional materials
   c. objectives
   d. tests
   e. job aids
**APPENDIX B**

**Completed Knowledge Map for Knowledge Mapping**

<table>
<thead>
<tr>
<th>Accomplishment</th>
<th>Inductive</th>
<th>Prerequisites</th>
<th>Theory</th>
<th>Skill</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Map Completed</td>
<td>a. Cost-effective training</td>
<td>Reading, writing</td>
<td>Accomplishments-identifying outcomes not behavior</td>
<td>Discriminations: a. accomplishment vs. behavior</td>
<td>Produce Knowledge Map on a given content area</td>
</tr>
<tr>
<td></td>
<td>b. Basis for communicating instructional functions</td>
<td></td>
<td>Inductive-consequences of proper and performance</td>
<td>b. consequences</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Gives basis for development of evaluation measures for training, instructors, curricula</td>
<td></td>
<td>Prequisites-needed to master the accomplishments</td>
<td>c. prerequisites vs. skill</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Clear outline for development of instructional materials</td>
<td></td>
<td>Theory-the underlying, mediating logic</td>
<td>d. mediators vs. skill</td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. Evaluation criteria for training situation</td>
<td></td>
<td>Skill-specific discriminations specific in the chain</td>
<td>e. discrimination rules</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Application-generalizations needed for mastery</td>
<td>f. generalizations vs. transfer</td>
<td></td>
</tr>
</tbody>
</table>
## APPENDIX C

<table>
<thead>
<tr>
<th>ACCOMPLISHMENT</th>
<th>INDUCTIVE</th>
<th>THEORY</th>
<th>SKILL</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B₁</td>
<td>B₂</td>
<td>A</td>
</tr>
<tr>
<td>Performance Audit</td>
<td>O</td>
<td>50%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Knowledge Map</td>
<td>O</td>
<td>46%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Training Tactics</td>
<td>O</td>
<td>71%</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Performance Aids</td>
<td>O</td>
<td>42%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Performance Matrix</td>
<td>O</td>
<td>17%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Performance Tables</td>
<td>O</td>
<td>58%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>BEM</td>
<td>O</td>
<td>73%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Job Models</td>
<td>O</td>
<td>67%</td>
<td>30%</td>
<td>6%</td>
</tr>
</tbody>
</table>
APPENDIX D

SAMPLES OF OBJECTIVES AND EVALUATION ITEMS FROM EACH COURSE

<table>
<thead>
<tr>
<th>COURSE</th>
<th>INDUCTIVE</th>
<th>THEORY</th>
<th>SKILL</th>
<th>APPLICATION</th>
</tr>
</thead>
</table>
| A      | Why do a performance audit? (0)  
        Why do stakes matter? (0)  
        What is the purpose of the behavior engineering model? (0) | What are the six levels of vantage? (0)  
        What is ACORN? What does it stand for? (0)  
        What are vantage levels? (0) | Give examples of what some of the missing decision might be for E3 and P1. (0) | Be able to calculate the pip of a car salesman (0). |
| B1     | Be able to explain why our goal should always be exemplary performance rather than average performance. (0) | Be able to define each of the terms in the following equation: \[ W = \frac{A}{B} \] (0) | Given some sample objectives, apply ACORN Test and revise them as necessary. (0)  
        Given some familiar jobs, identify a mission for each. (0) | Select a college course that you have taken, or are now in, and attempt to identify the accomplishments (E).  
        Given several problems to troubleshoot, you will identify all of the causes and list possible solutions. (0) |
| B2     | Write an essay summarizing Gilbert's and Skinner's position on values. (E) | When presented a terminal response, be able to list potential mediators. (0)  
        Be able to discriminate when to use the 3 types of P.A.'s. (0) | Construct a Knowledge Map using Knowledge Mapping as your unit of material. (E)  
        When presented with performance data be able to set a standard. (0) |


