DOCUMENT RESUME

ED 051 374 VT 012 457

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TITLE	A Capability Classification System.
INSTITUTION	Massachusetts Research Coordinating Unit for Vocational Education, Boston.
PUB DATE	17 Dec 70
NOTE	25p.
EDRS PRICE	EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS	Behavioral Objectives, *Classification, Educational Research, Educational Researchers, Feedback, *Methodology, *Program Evaluation, Program Improvement, Research Coordinating Units, *Research Tools, Systems Approach, *Vocational Education

ABSTRACT

A developmental product for the Massachusetts and New York Evaluation Service Center for Occupational Education, the classification system is designed to treat behavioral objectives from which cognitive, psychomotor, and affective capabilities can be inferred. The system provides an analytical tool to render the products of the Evaluation Service Center more useful for the purpose of program modification in a manner consistent with the philosophical principle on which the Center was established. The Capability Classification System allows institutions to deal with specific elements of programs and provides feedback on the specific capabilities these programs are designed to develop. (Author/JS)

A CAPABILITY CLASSIFICATION SYSTEM

by

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December 17, 1970

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A CAPABILITY CLASSIFICATION SYSTEM

Introduction

The purpose of this paper is to present a classification system for behavioral objectives or, more specifically, for capabilities which educational programs are designed to produce. These distinctions will be made explicit soon.

The Capability Classification System is a developmental product for the Massachusetts and New York Evaluation Service Center for Occupational Education which is located in Amherst, Massachusetts. The Evaluation Service Center is a major, two year experimental project of Massachusetts and New York designed to test the feasibility of maintaining a continuous feedback of program evaluation data to local educational agencies offering occupational education in such a way that program standards are not assumed to be constant among schools. Twenty schools in both states are involved with the project in which each institution evolves its own program objectives and receives measurement information on student performance in respect to stated criteria. When similar objectives are entertained by several institutions, normative data will be available. The evaluation process supported by the Evaluation Service Center is considered a major alternative to a standardized testing approach for program evaluation, which assumes the existence of specific standards against which all programs can be compared.*

* Conroy, Jr., William G., Cohen, Louis A., Massachusetts and New York Evaluation Service Center for Occupational Education, A Planning Document, The University of the State of New York, The State Education Department, Bureau of Occupational Education Research, Albany, New York, May 1970.

Important Definitions

Given a definition of capabilities as things persons can and/or will do, all education, including occupational education, is in the business of capability production. The capabilities an educational process seeks to establish in its product, i.e. students, are ultimately derived from values that society considers important. Frequently, the values are not rationally articulated, but few would argue that American society places a high value on occupational competency. This paper is not concerned with examining this assumption, but merely seeks to acknowledge its existence.

Often capabilities are invisible, i.e. they cannot be directly observed. In these cases, capabilities are inferred from things people do, i.e. behavior. All behavior is essentially motor, i.e. muscular movement. Behavioral objectives are usually described as explicit statements of expected student behavior an educational program seeks to attain or, simply, what the students can do at the end of an educational program that he couldn't do before it began. The intervening educational program is usually praised or blamed as the causal variable.

To conceive of behavioral objectives as the desired outcome of instruction is quite misleading. The essential goal of instruction is capability production and the legitimate role of behavioral objectives is to provide a measure from which capabilities can be inferred.

This paper stipulates three distinct types of capabilities:

(1) Cognitive Capabilities - the ability to do things that are mostly intellectual or mental in nature. In general, cognitive capabilities involve acquiring and applying knowledge or information.

(2) Psychomotor Capabilities - the ability to do things that are mostly muscular in nature, but which ensue from cognitive capabilities. In general, psychomotor capabilities involve manipulating objects with various parts of the body.

(3) Affective Capabilities - the ability to do things that are mostly emotional in nature. In general, affective capabilities involve acquiring a positive or negative feeling toward a particular object.

Psychomotor capabilities can be observed directly, while cognitive and affective capabilities must be inferred from behavior. Therefore, a behavioral objective describes a psychomotor capability, but cognitive and affective capabilities must be inferred from behavioral objectives. Although all behavior described in behavioral objectives is essentially psychomotor, i.e. muscular movements ensuing from mental activity, behavioral objectives can be classified as either cognitive, affective, or psychomotor. When the muscular movement is fundamentally a means of communicating a mental or emotional capability, the objective is cognitive or affective. When the muscular movement described by the behavioral objective is, in fact, the capability sought by the instructional program, the behavioral objective is psychomotor.

Capability Classification System

The purpose of this paper is to describe a Capability Classification System both among and within capabilities which is uncomplicated enough to be useful by the practitioner, but sufficiently developed to be meaningful for comparison and analysis. The classification system is designed to treat behavioral objectives from which capabilities can be inferred, and the distinction and relationship between capabilities and behavioral objectives is considered important. The system is adopted from the work of Benjamin S. Bloom, David R. Krathwohl and others.

Cognitive Capabilities*

Cognitive capabilities are the most difficult to classify because of their range and invisibility. Two major categories of cognitive capabilities are offered: (1) Knowledge Acquisition; (2) Knowledge Application.

> Knowledge Acquisition - Knowledge acquired is knowledge stored or filed such that is can be recalled at the discretion of the individual. The cognitive capability is the ability to maintain and recall knowledge. Since stored knowledge cannot be observed it must be inferred from recalling or remembering behavior. Further, if knowledge cannot be recalled it is not possible to measure its existence. Therefore, knowledge is defined as that information which can be recalled, while the cognitive capability remains the maintenance and recall

* Modified from: Bloom, Benjamin S., A Taxonomy of Educational Objectives: Handbook I: Cognitive Domain, David McKay Company, Inc., New York, 1956

of knowledge. Behavioral objectives from which knowledge can be inferred describe the process of knowledge recall. Two kinds of knowledge are defined:

C1.1 Knowledge of Specifics: This includes facts and specific information. For example, names, dates, places, events, technical and trade terminology, etc. The capability might be knowledge, that is to have on file and be able to recall the parts of an automobile carburetor. A behavioral objective would describe a recall process from which the capability would be inferred. The recall process might be to name, to identify, to list, to select, or to point to all the parts of an automobile carburetor.

C1.2 Knowledge of Ways and Means of Dealing with Specifics: Knowledge within this category is more abstract than knowledge of specific facts. Knowledge within this category would include classification systems, criteria by which specific facts and information are tested, methods of inquiry for obtaining knowledge or information, and principles and theories by which information is organized on the very highest level. This category does not include capabilities to apply or use ways and means of dealing with specific knowledge, but is limited to knowledge of ways and means of dealing with specific knowledge, i.e. to have on file and be able to recall ways and means of dealing with specific knowledge. Behavioral objectives would describe the recall process

from which the knowledge capability could be inferred. Examples of behavioral objectives in this category would be:

(1) The student will name the botanical and zoological classification system in descending order.

(2) The student will list steps in detecting the amount of antifreeze in an automobile radiator.

(3) The student will list the steps by which social scientists develop knowledge.

(4) The student will name the principles of chemistry which are relevant to the life process.

(5) The student will identify a specific and complex description of the theory of evolution.

Knowledge Application (Problem-Solving)- Knowledge is applied or used to solve problems or reach goals. Cognitive capabilities in this category refer to the ability to use or apply knowledge in problem-solving or goal attainment in a purposeful way. Since one cannot directly observe this capability, one must infer its existence from a behavior. Behavioral objectives in this category, therefore, specify the kinds of behavior from which this inference can be made. Although the behavior is psychomotor, i.e. muscular, its function is to describe a cognitive capability, i.e. the ability to apply knowledge to solve problems or attain goals.

Two distinct kinds of knowledge application are stipulated: Knowledge Application Without Manipulation and Knowledge Application With Manipulation.

C2.1 Knowledge Application Without Manipulation - Knowledge Application Without Manipulation describes an ability to use or apply knowledge in a straightforward way to new situations. What is intended in this category is a cybernetic process, i.e. when presented with a problem or goal, the problem-solving response is to sort through one's existing knowledge on file, recognize the correct knowledge to apply, call up and apply the knowledge and thereby solve the problem or reach the goal. The knowledge stored is relatively unaltered when applied. This capability could involve the application of little or much information. The chief characteristic of this category is knowledge application without alteration. Knowledge application in this category usually involves a sequential, checklist process, i.e. if this condition exists then that solution applies, with that solution already existing as stored knowledge.

Examples of objectives in this category might be: for a computer programmer to apply a known routine to solve a particular data processing problem; for an accountant to apply learned depreciation methods or cost analysis formulas to analyze an institution's fiscal position; or for a researcher to apply a stored statistical formula to test a hypothesis. In all these cases a specific problem is presented, the student recognizes the existence of the problem, sorts through his memory bank for the proper solution, and applies the knowledge to solve the problem.

C2.11 Non-Memory Knowledge Application Without Manipulation

A special case of Knowledge Application Without Manipulation occurs when a problem is solved or a goal attained with the straightforward application of knowledge which is not stored in memory, but is located and called from non-memory storage. The problem-solving process is something like the following:

1. The problem is recognized.
2. A search of existing knowledge is made.
3. Existing knowledge does not offer solution.
4. Knowledge is found and called up from non-memory storage.
5. Knowledge is applied to solve problem.

An example of an objective might be a student who perceives a mathematical problem, and calls up and applies a formula from a mathematics manual to solve the problem. The chief characteristic of the cognitive capability is the straightforward application of knowledge, exactly like C2.1. The difference is that the knowledge is not stored in memory, so that the cognitive capability involves being able to find and apply knowledge to solve a problem or attain a goal.

2.2 Knowledge Application With Manipulation - Perhaps the best way to specify this cognitive category is to outline the problem-solving process which typifies this cognitive capability.

1. The problem is recognized.

2. A search of existing problem-solving knowledge is made.
3. Existing knowledge does not offer solution.
4. Existing knowledge is manipulated.
5. Manipulated knowledge is applied to solve the problem.

Two methods of knowledge manipulation are stipulated:

> Analysis - Analysis involves breaking stored knowledge into its constituent parts such that detection of the relationships between the parts can be recognized. This could involve analyzing elements within existing knowledge, analyzing relationships among existing knowledge, and analyzing the organizing principles of existing knowledge.
>
> Synthesis - Synthesis involves assembling isolated and specific pieces of knowledge to form a new whole. This is a combining process, which could involve considerable creativity. Synthesis of existing knowledge results in new knowledge, new plans or new understandings of relationships between elements.

Behavioral objectives from which the capability of Knowledge Application With Manipulation is inferred describes something of a hypothesis testing behavior in which existing knowledge is analyzed and synthesized such that new knowledge is produced to solve a problem or attain a goal. A very different modus operandi is involved in Knowledge Application With Manipulation than with Knowledge Application Without Manipulation. In Knowledge Application Without Manipulation, the capability involves only search and application, while with Application With Manipulation the capability involves search, manipulation and application. Behavioral objectives that only describe search and

application are not properly classified in this category. Knowledge must be manipulated before applied to be properly classified in this category. A well known example of this capability is: Given certain mathematical principles, a student will demonstrate that the following statement, in which a and b are rational numbers, is true:

$$(a+b)^2 = a^2+b^2$$

If the student had previously stored the step by step information of solving the problem, this objective, of course, infers the cognitive capability of Knowledge Application Without Manipulation. If, on the other hand, the student had to manipulate existing knowledge to arrive at the solution, the objective is properly classified in the category of Knowledge Application With Manipulation, that is, it infers the capability of Knowledge Application With Manipulation, a process quite distinct from Knowledge Application Without Manipulation.

Psychomotor Capabilities

No attempt is made to distinguish among the relative complexity of psychomotor capabilities in the Capability Classification System. Psychomotor capabilities are either simple or complex and the simplicity or complexity of the psychomotor capability is obvious from the description of the capability. For example, hammering a nail into a wall is a relatively simple psychomotor act, while swimming the English Channel on one's back and juggling a mermaid, a monkey, and a martini is complex.

* Gagne, R. W. The Conditions of Learning. New York: Holt, Rinehart & Winston 1965

Psychomotor behaviors or capabilities are essentially special cases of knowledge application, with the application involving largely muscular movement. It is therefore possible to differentiate among psychomotor capabilities by the related cognitive competency required to perform the psychomotor behavior. Specifically, psychomotor capabilities are a function of either Knowledge Application With Manipulation or Knowledge Application Without Manipulation.

The same psychomotor behavior could be the function of different cognitive behaviors, and this distinction might be important. For example, the psychomotor remedy to an automotive trouble-shooting experience could be exactly the same for two groups of students, while the related cognitive behavior could be quite different. One group's cognitive behavior might be classified as C2.1, i.e. Knowledge Application Without Manipulation, while the second group might arrive at the same psychomotor conclusion, as it were, from an analysis of first principles, or C2.2, i.e. Knowledge Application With Manipulation. After knowledge has been manipulated and a solution found and stored, the next time the same problem is encountered it is likely that the related cognitive behavior would be C2.1.

Psychomotor capabilities sought by instructional programs can be distinguished by the related cognitive behavior and this differentiation might describe important aspects of both the student and the training program that would otherwise go unnoticed. To classify a psychomotor capability with its related cognitive competency sought by an instructional program is indeed uncomplicated. Simply stipulate "P" for psychomotor

and follow the P with either C2.1 (Knowledge Application Without Manipulation) or C2.2 (Knowledge Application With Manipulation). For example, P-C2.2 would describe a psychomotor capability sought by an instructional program with a related Knowledge Application With Manipulation cognitive capability.

In addition to differentiation between the cognitive competencies related to psychomotor capabilities, it is useful to provide a coding process by which the amount of strength, dexterity and coordination required to perform the psychomotor behavior can be specified. The following coding system is offered:

1. Specify P for psychomotor.
2. Next to P stipulate the level of related cognitive competency.
3. Next to the related cognitive competency specify information about the required dexterity, strength and coordination required.

Dexterity - Strength - Coordination Classification Code

D - Dexerity of anatomy part(s) required in performing psychomotor behavior
S - Strength of anatomy part(s) required in performing psychomotor behavior
C - Coordination of two or more anatomy parts in performing psychomotor behavior

0 - Not applicable
1 - Little
2 - Average
3 - Great

1st position - fingers
2nd position - arms
3rd position - torso
4th position - legs

To classify a psychomotor objective that required a related cognitive competency of Knowledge Application Without Manipulation, great

finger and torso dexterity, great finger and arm strength, and average coordination one could enter the following:

P-C2.1, D3, 0, 3, 0 S3, 3, 0, 0 C2.

This might be a trouble-shooting objective in automotive repair.

Affective Capabilities

Affective capabilities are defined as positive or negative feelings toward an object, person, or idea. Positive or negative feelings can be described as a point on a continuum, from extremely positive to extremely negative. The purpose of the classification system is to differentiate parts of the continuum such that common understandings can be obtained in communicating the amount of positive or negative affect toward an object, person, or idea. An affective capability could be conceived as a value, with the classification system describing the extent of adoption.

Affective capabilities are invisible and must be inferred from behavior. Behavioral objectives describe specific behaviors from which affective capabilities can be inferred. Cognitive and psychomotor capabilities are inferred from what a person is capable of doing or can do, while affective capabilities are inferred from behavioral objectives that describe what a person will do.

Affective Classification System:*

A1.0 Receiving Capability - A receiving capability describes perception of an object, person, or idea, and is a precondition to the

*Modified from Krathwohl, David R., Taxonomy of Educational Objectives, Handbook II: Affective Domain, David McKay Company, Inc., New York, 1964

adoption of a positive or negative feeling toward a particular object, person or idea. A receiving capability is defined very much like a knowledge capability. The emphasis is not the ability to recall but that the individual wills to be conscious of an object, person, or idea. Behavioral objectives from which a receiving capability can be inferred would describe a person willing to perceive an object, person, or idea. A receiving capability would be defined as a willingness to be aware of or receive an object, idea, or person. If the affective object were shop safety, a typical behavioral objective from which a receiving capability could be inferred might be that the person had willed to obtain knowledge of shop safety.

Receiving capabilities are defined as including some positive or negative feeling component such that perception is willed. (See affective Continuum, page 17).

Responding Capability (beginning to commit) - At this band in the continuum the attention to an object, person, or idea is willed. The behavior from which this capability can be inferred describes a person doing something about an object, person, or idea beyond merely being aware of it. Two distinct categories are stipulated within this subdivision, an Acquiescence Capability and a Willingness Capability.

A2.1 Acquiescence Capability - Compliance or obedience behaviors to an object, person, or idea are those which infer this affective

capability, i.e. a person's behavior is a function of something other than a commitment. Educators at all levels should have little difficulty in recognizing behavior which infers this capability by conceiving of it as "psyching out" behavior. An example of a behavioral objective might be that an individual complies with shop safety rules. The feeling component of this part of the continuum is such that compliance is not psychologically uncomfortable, i.e. it is at least positive or negative enough not to cause dissonance with conformity.

A2.2 Willingness Capability - Willingness, which implies voluntary behavior, is the fundamental characteristic of this part on the affective continuum. The affective capability is described as the existence of enough feeling that a person wills, without outside interference, to behave in a way consistent with a positive or negative feeling toward an object, idea, or person. He is much more committed than when he is only willing to perceive the object, person, or idea, and somewhat more committed than when he involuntarily complies. A behavioral objective from which this capability can be inferred might describe a student seeking knowledge about safety procedures in a shop setting.

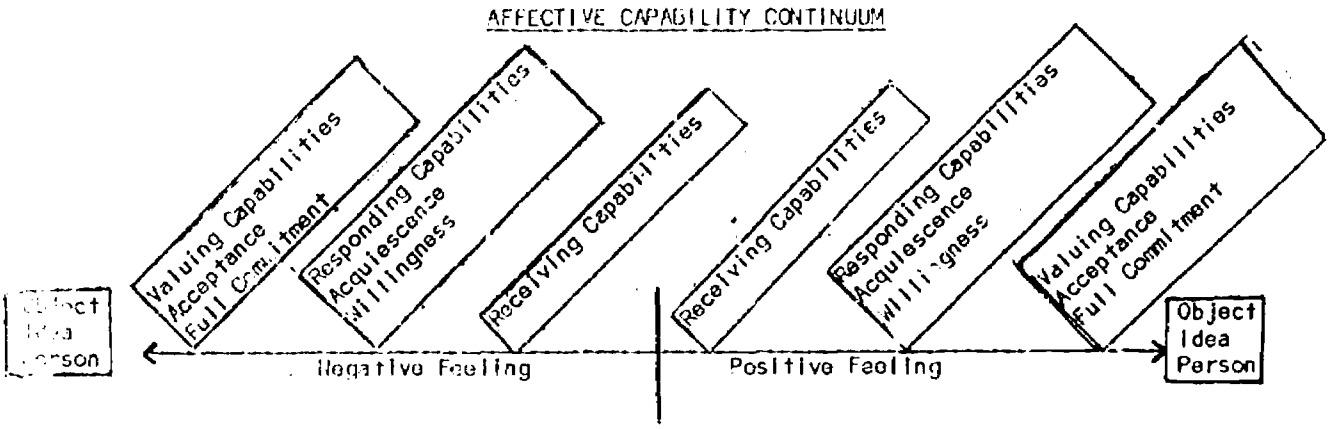
Valuing Capability (Full Commitment) - At these ends of the affective continuum the affective capability involves consistent commitment to a positive or negative feeling toward an object, person, or idea. Two categories are stipulated: Acceptance and Full Commitment.

A3.1 Acceptance Capability - The affective capability at these bands of the continuum results from the internalization of sufficient positive or negative feeling toward an object, idea, or person that an individual wills to be publically identified with his feeling. A second distinguishing feature of this capability is consistency of feeling, reflected in behavior. Behavioral objectives from which this capability could be inferred might be a willingness to play a leadership role to improve shop safety.

A3.2 Full Commitment Capability - The affective capability at these outside ends of the affective continuum can be described as complete emotional commitment to a positive or negative feeling toward an object, person, or idea. The affective capability at these ends of the continuum is such that the individual wills to convince and/or convert others to his "cause". A behavioral objective from which the affective capability might be inferred could be that an individual wills to convince all participants of the necessity of establishing and maintaining shop safety rules and regulations.

A4.0 Values Organization Capability - Up to this point we have been describing an affective capability continuum which provides for the internalization of a single value toward an object, person, or idea. Values Organization Capability does not fit anywhere on the continuum, but is a separate phenomenon; the organization of a value system. This capability describes a person willing

to interrelate a complex of values into a value system. This is an extremely complex psychological process, and the purpose of this category is not to distinguish among various strategies of value system organization, but, simply to provice a classification category for this distinct affective capability. An objective from which this capability might be inferred would be that a saw mill foreman, for example, wills to reconcile an extremely strong feeling (A3.1) toward shop safety with an equally weighted feeling toward productivity.



Relationship Between Affective and Other Capabilities

No provisions are made in the Capability Classification System for relating affective capabilities with specific cognitive or psychomotor capabilities sought by instructional programs, although such a development would be straightforward. The reason is that it is anticipated

affective capabilities will span cognitive and psychomotor capabilities both within and among educational programs. For example, it seems that educational institutions are typically more concerned with fostering positive feelings toward relatively global concepts such as self as a competent worker and work as a desirable activity, rather than with the particular affective components of a specific cognitive or psychomotor capability.

A Summary of the Capability Classification System

The following is offered not only as a summary, but a statement of the simplicity of the Capability Classification System offered in this paper.

I Cognitive Capabilities are to be classified as follows:

- C1.1 Knowledge of Specifics
- C1.2 Knowledge of Ways and Means of Dealing with Specifics
- C2.1 Knowledge Application Without Manipulation
  - C2.11 Non-Memory Knowledge Application Without Manipulation
- C2.2 Knowledge Application With Manipulation

II Psychomotor Capabilities are to be classified as follows:

Specify P for psychomotor
Next to P stipulate the level of related cognitive competency
Next to the related cognitive competency specify the amount of dexterity, strength and coordination required in performing

III Affective Capabilities are to be classified as follows:

- A1.0 Receiving Capability
- A2.1 Acquiescence Capability
- A2.2 Willingness Capability
- A3.1 Acceptance Capability
- A3.2 Full Commitment Capability
- A4.0 Values Organization Capability

The Usefulness of the Capability Classification System

To probe the potential usefulness of the Capability Classification System it is necessary to make several assumptions:

1. Capabilities which occupational programs of participating schools are seeking to attain are described by behavioral objectives.

2. In addition to being classified by capabilities, behavioral objectives are classified by: type of institution; grade or semester level; specific curriculum, program, division and unit within an occupational curriculum; a discipline area, if applicable; and the sequential level within a program at which the objective is offered.

Given a computerized retrieval system, participating institutions can obtain, in a mechanical flash, the following information:

1. A list of specific knowledge capabilities sought by any occupational program, at any unit, division, program or curriculum level for any institution at any grade level. For example, one could determine the knowledge capability differences, if any, between secondary and postsecondary institutions which are assumed as prerequisite to automobile ignition repair performance skills. All cognitive capabilities among programs can, of course, be compared and analyzed.

2. A list of common cognitive capabilities within disciplines and across occupational programs can be obtained. For example, one could analyze the knowledge capabilities in physics across all programs within a particular institution.
3. Similar information for psychomotor capabilities could be obtained such that comparisons could be made on any dimension stipulated above. For example, an institution could compare levels at which specific psychomotor capabilities are sought within programs and among institutions.
4. Information would be available to examine differences among institutions or levels within institutions of related cognitive competencies to specific and similar psychomotor capabilities. Such information is very useful in analyzing the type of technician and tradesman developed by programs. Different problem-solving cognitive capabilities related to similar psychomotor capabilities among institutions would describe major differences between programs that might otherwise remain undetected.
5. A comparison of occupational programs by physical strength, muscular dexterity, or by body coordination would be possible. (This may be a convenient time to merely acknowledge the vocational guidance potential of the system. As the system is developed, this use of the data is anticipated.)
6. Comparisons among values, i.e. positive or negative feelings toward objects, persons, or ideas sought by various institutions could be obtained.

It should be pointed out that all institutions participating in the Massachusetts and New York Evaluation Service Center will remain anonymous, as it were, and only be identified by type. Specific rules and regulations for data release are yet to be determined by the State Directors of Massachusetts and New York.

Obviously, when test data is obtained for behavioral objectives, the analysis potential increases considerably. Participating institutions will not only be able to compare their programs with others in terms of capabilities sought, but analyze the degree to which their program is meeting its objectives and how it compares with others seeking similar capabilities. The variety of ways in which the data can be accessed provides an enormous source of information fundamental to program modification, establishing an empirical basis for change in occupational education.

Conclusion

The fundamental purpose of the Capability Classification System is to provide an analytical tool to render the product of the Evaluation Service Center more useful for the purpose of program modification in a manner consistent with the philosophical principle on which the Center was established. Without such a classification system, the program modification potential offered by the Center would be extremely gross. The Capability Classification System allows institutions to deal with specific elements of programs and provides feedback on the specific capabilities these elements are designed to develop. If it were not

possible to differentiate behavioral objectives by capabilities across occupational programs and institutions, program modification would continue to occur in the absence of educationally important information.

The Capability Classification System is designed to be useful to and usable by both the practitioner and the educational researcher. Indeed, this is a difficult gap to bridge. The success of the system will be directly related to its ability to meet the needs of both audiences, such that communication can occur. Both groups must reach out and adopt this or a related system if the Evaluation Service Center and similar evaluation projects are to reach their full potential and become important change agents in education.

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