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ABSTRACT

Weaknesses in the structure, levels, and sequence of Bloom's taxonomy of cognitive domains emphasize the need for both a new model of how individual learners process information and a new taxonomy of the different levels of memory, thinking, and learning. Both the model and the taxonomy should be consistent with current research findings. The Stahl Perceptual Information Processing and Operations Model (SPINPrOM) details a 21-component process explaining how individuals think and learn. The SPINPrOM process begins with environmental information and moves through stages that include perceptual register, transient storage, an "executor" to assign meaning and choose responses, working memory, long-term memory, utilization of retrieved information, and feedback. SPINPrOM is related to the proposed Domain of Cognition taxonomy, which identifies eight levels of cognitive behaviors involved in thinking and learning. The eight levels comprise preparation and observation, reception, transformation and information acquisition, retention, "transfersion" (applying old information to new situations), incorporation, organization, and generation. Ten principles useful for teachers can be derived from the new model and taxonomy, involving learning times, similarities between cognitive and affective information, and learners' use of rules or guidelines when thinking. (Author/RW)

THE DOMAIN OF COGNITION: AN ALTERNATIVE TO BLOOM'S COGNITIVE DOMAIN WITHIN THE FRAMEWORK OF AN INFORMATION PROCESSING MODEL

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Bloom's Taxonomy (Bloom et al., 1956) has dominated instructional design and evaluation for a quarter of a century. Programs at all levels of education use this Taxonomy as the major framework to plan, develop, implement, monitor, and evaluate teacher and student process and product instructional variables. The popularity of this hierarchical model is evidenced by the entry of nearly 1,000 articles on the Taxonomy of Educational Objectives in Education Index between 1966-1978 (Clements, 1979). Furthermore, some teacher educators have even taught the Bloom System as a learning theory in its own right, giving the Taxonomy a status it was never intended to have.

Interestingly, the Bloom taxonomic system has been and is being used even though it is not consistent with any presently accepted theory, model, or approach to human memory, thinking, or learning (Stahl, 1979). Clements (1979) pointed out that three of the four major principles upon which the system was based were never supported by its developers. These initial problems have become but one area where weaknesses in the structure, levels, and sequence of the Taxonomy have been reported (Kropp and Stoker, 1966; Miller, Snowman and O'Hara, 1979; Smith, 1968, 1970; Poole, 1971, 1972; Seddcn, 1978).

The intent of this paper is not to provide a review of the literature relative to Bloom's Taxonomy. Instead, the reader will be introduced to an entirely new taxonomy, the Domain of Cognition, which was developed from the research literature on human learning. To support this hierarchical system, a model of how humans process information will be presented as a synthesis framework to pull together the memory and learning research as well as to provide a flow model representation of how thinking, memory and learning occur interactively within instructional settings.

TAXONOMY DEFINED

Prior to the examination of the Domain of Cognition taxonomic system to be presented here, it seems appropriate that some consideration be given to the nature and attributes inherent in any taxonomy. Among the definitions of taxonomy found in the literature one finds the following:

> 1. ... the classification of data according to their natural relationships or the principles governing such classification.[1]
>
> 2. ... a system of classification of data according to their natural relationships.[2]
>
> 3. ... a system of classification and the concepts underlying it.[3]
>
> 4. The primary meaning of taxonomy ... is systematic classification...[4]
>
> 5. ... classification, esp. (sic) in relation to its general laws or principles; the classification or putting things in proper order.[5]

Although not stated in the definitions above, an important distinction needs to be made between the term "classification" and the term "taxonomy."

> Classification is the ordering of phenomena into groups (or sets) on the basis of their relationships, that is, of association by contiguity, similarity, or both.
>
> Taxonomy is the theoretical study of classification, including its basis, principles, procedures, and rules.[6]

The distinction can be further highlighted by paraphrasing Gregg[7] in stating that the subjects of classification are the phenomena and the subjects of taxonomy are classifications.

Theoretical science is concerned with ordering, and taxonomy is a branch of science that is exclusively and explicitly devoted to the ordering of complex phenomena.[8] Krathwohl, Bloom and Masia refer to the ordering process in terms of "a . . . set of principles."

> A true taxonomy is a set of classification which are ordered and arranged on the basis of a single or on the basis of a consistent set of principles. . . . The taxonomy must also be consistent with sound theoretical views in the field.[9]

With the above information in mind, salient attributes of a taxonomy as a model, including basic assumptions underlying taxonomic systems, can be discussed. Some of the principal features of taxonomic systems are:

1. Classes or aggregations of phenomena, not individual specimens, are the basic units of taxonomy and are the things to be classified.

2. Observations of properties and characteristics are essential, but not definitive in taxonomic studies.

3. Classes at all levels of a taxonomy are not in principle defined by their membership, but by their relationships. Characteristics in common are viewed as evidence of the theoretically derived relationships, which are primary.

4. The construction of formal classifications of particular groups is an essential part and a useful outcome of taxonomic effort. However, it is not the total or even the controlling purpose. Rather, the aim of taxonomy is to understand the groupings and the relationships of phenomena in conceptual terms in order to make generalizations and extend knowledge of the field being studied.

5. Members of a taxonomic class, or order are both similar to each other and dissimilar to members of other classes . . . The taxonomist's criteria for sorting specimens into ordered groupings are, in essence, (a) minuteness of resemblance and (b) multiplicity of similarities.

6. Taxonomic groupings should contribute to understanding of and insight into the phenomena so ordered.

7. The taxonomic process should result in sorting so that the categories can be identified with, and distinguished from, one another.[10]

These attributes and assumptions underlie all taxonomic systems and all taxonomic development. The primary purposes/functions of taxonomic systems are:

1. To construct classes about which generalizations can be made.

2. To organize, order and control phenomena.

3. To result in a gestalt (that is, the developed taxonomy is greater than the sum of its individual classes).

4. To clarify and better understand the phenomena in question.

The definitions, attributes/assumptions and purposes of taxonomic systems should provide a substantial basis for the development of theory within education. A taxonomic system helps to devel p clarity along with control of the phenomena in question. In turn, greater clarity and control should lead to more effective educational development.

A LEARNING HIERARCHY DEFINED

A hierarchy is "a systematic framework with a sequence of classes (or sets) at different levels in which each class (except the lowest) includes two or more subordinate classes."[11]

Robert Gagne refers to learning outcomes, each of which leads to a different class of human performance, and each requires a different set of instructional conditions for effective learning. The key to the design of conditions for this effective kind of learning is the learning hierarchy.[12]

> The learning hierarchy is an arrangement of intellectual skill objectives into a pattern which shows the prerequisite relationships among them. Beginning with a particular objective (often a lesson objective), the learning hierarchy shows which intellectual skills are prerequisite; having identified this second set of skills, the prerequisites of each of these is in turn indicated, and this process continues until one has displayed in a bottom "row" the most elementary intellectual skills with which one needs to be concerned.[13]

In addition to the prerequisite skills hypothesis of learning hierarchies, a second major hypothesis may be referred to as the "positive-transfer hypothesis." The positive transfer hypothesis holds that prerequisite skills mediate transfer for the superordinate skills to which they are related. This hypothesis assumes that if one skill is prerequisite to another, mastery of the prerequisite skill will facilitate the learning of the other skill.[16]

A TAXONOMY AS A MODEL: STRENGTHS AND WEAKNESSES

A taxonomic system or model can be used to identify and describe different types or levels of processes (learning, thinking) and learning outcomes (behaviors). Some types of thinking and learning are different from other types of thinking and learning. Likewise, behavior can be observed in various forms and can be of various types. The crucial relationship between a given behavior (i.e., outcome; objective) and the required type or level of thinking or learning can be visualized more clearly through a classification system (taxonomy).

The categories of a taxonomy serve the purpose of contextual referencing. That is, any single category or subcategory is located within the context of other categories or sub-levels. These categories provide a basis for placing any given behavior within a group of behaviors. Contextual referencing also enables one to understand and see relationships between and among all of the categories and behaviors within the taxonomy.

If a learning/thinking taxonomy represents a convenient way of describing how learning/thinking takes place, instruction can be planned, implemented and then evaluated based upon that taxonomy. Though a taxonomy may identify internal processes (i.e., thinking, learning), observable behaviors must be used to make inferences about these internal processes.

The constructs of learning and thinking cannot be measured or observed directly. A taxonomy of learning/thinking can be used to classify and order those constructs inferred from and based upon valid research studies on human thinking, memory, and learning. If a taxonomy is used to classify internal processes, and appropriate, corresponding external indicators of those processes, the user has a frame of reference that can be used to describe (in inference) these abstract, internal activities.

Weaknesses of any taxonomic system revolve around philosophical arguments and/or empirical questions which focus on the criteria of content, logic and validity.

The criterion of content centers around whether the categories and sub-categories within a given taxonomy are complete. Does the taxonomy contain all distinguishable categories, and does each category contain all distinguishable sub-categories? In terms of this criterion, the weakness is incompleteness. Any taxonomy which does not identify and describe in complete form that which it is classifying is providing an incomplete scheme of the construct in question.

No taxonomist can ever be completely assured that his/her taxonomy is totally complete. The basic reason for this is that a taxonomy that identifies different types or levels of processes and/or learning outcomes cannot do so directly. The identification and subsequent classification of the various classes takes place via inferences concerning the construct in question. It is through observation of behavior that the taxonomist may infer that such and such has taken place (internally). In this way taxonomizing involves a process that indirectly identifies and describes that process in question.

The criterion of logic is more complex than that of content. The question of focus is "why?" Why this particular way of classification as versus another? For example, a common way of classifying is from simple to complex. The first class or category is the simplest, followed by another which is more complex, etc. A common feature using this way of classifying is that each subsequent category subsumes (incorporates) all previous (simpler) categories. When looking at a taxonomic system which incorporates the simple-to-complex means of classifying, one gets the impression that this is the only means by which a taxonomic system can be used.

However, the question can be asked: "Why can't a different means be used (for whatever is being classified) in the taxonomic system in question?" For example, though a simple-to-complex scheme may be shown, could not another scheme be utilized which grants the user an alternative perspective? Other means may be: part to whole, detail to general, unfamiliar to familiar, concrete to abstract, dependent to independent, order by usefulness, order by function, etc.

The point is that the means utilized in various taxonomic systems are oftentimes arbitrarily established. Though serving useful functions and granting the user a perspective of certain value, it may not give a total picture. The weakness then, in terms of the criteria of logic, is that of simplicity. The critic often argues on the one hand, for a varied perspective, one that may view the construct from the point of view of multiplicity; and argue, on the other hand, for parsimony, i.e., a more simplistic model.

The criterion of validity refers to determining whether the taxonomy accurately represents the construct in question. In one sense, this criterion incorporates the other two criteria, content and logic, because accuracy would not be present if content and/or logic were deficient in any way.

The criterion of validity meets its most rigorous scrutiny via mathematico-statistical analysis and hypothesis testing. Factor analysis, hierarchical syndrome analysis (McQuitty, 1960), simplex analysis (Kropp and Stoker, 1966), complex model analysis (Madaus, Woods, Nuttall, 1973), path analysis, commonality analysis and multiple regression analysis (Miller, Snowman, O'Hara, 1979), cluster analysis and radex theory (Geisinger, 1973) are some of the approaches used in the validation of taxonomic systems in education.

It is interesting that the literature regarding validation of taxonomies emphasizes the statistical procedures to be employed void of any concern on the research methods, design, and procedures employed to investigate the research questions and to obtain the data. In making cases for statistical analytic procedures, researchers should be cautioned not to allow the tail (statistics) to wag the dog (design, method, etc.). The insistence on absolutes in explorations of theoretical constructs and their validity ought to be re-evaluated in terms of the functional and interrelated, complementary value of research questions, methods, design, procedures, statistics to one another and as single components of any research paradym or algorithm.

Introduction to the Models

The Bloom-Krathwohl taxonomic domains were important contributions to all areas of education in that they provided a much needed framework to consider learning outcomes. However, today, the results of research on thinking, memory, and learning suggest that an entirely new frame of reference is needed for identifying the accurately classifying learning outcome behaviors.

Instructional design in the 1980's must be tied to a taxonomic model which is directly compatible with the results of learning research conducted on human subjects. The new Taxonomy would be more useful if accompanied by a model of how individuals process information which has the strong support of extensive research findings. The models should have the additional attributes of being content-free and unrelated to the structure of any discipline. They should also be compatible with such divergent learning theories as those proposed by the "Behavioral," "Developmental," "Cognitive," "Perceptual," and "Gesalt" schools of psychological thought.

Besides the obvious benefits related to measurement of learning, the new information processing-taxonomy model would have advantages for teacher educators. They would allow teacher educators to help pre-service and in-service teachers make sense out of the various learning theories presented in the literature. This is especially true for teachers who have been introduced to different models of learning which appear to be inconsistent with one another and which are incongruent with the Bloom taxonomic system they are to use to plan and evaluate instruction. They would also help teachers develop instructional strategies likely to attain the different levels of learning they have established as their end goals.

What is needed in the field of instructional design is:

a) a model or explanation of how information is accepted, treated, processed, and acted upon within the individual learner. Such a model must be consistent with the research findings on human subjects and would distinguish among thinking, memory, and learning as separate yet interrelated aspects of human behavior;

b) a model (taxonomy) explaining the different types or levels of memory, thinking, and learning which is consistent with the information processing model cited above and which stands upon its own merits with sufficient research support for it;

c) a way of helping pre-service and in-service teachers separate pre- and post-learning behaviors within classroom situations;

d) a way of looking at memory, thinking, and learning which "makes sense" to teacher educators and teachers and is compatible with an extensive body of literature related to human learnings; and

e) a way of converting the internal operations of thinking, memory, and learning into observable process (i.e., in-class) and produce (i.e., outcome) behaviors (Stahl, 1980).

A system incorporating the points above would be worthwhile and practical from the perspective of the teacher educator and the pre-service and in-service teacher.

The Stahl Perceptual Information Processing and Operations Model (SPInPrOM)

The basic components and flow of the SPInPrOM model are provided in Figure 1. The features and characteristics of the operations of the model are explained below. The SPInPrOM model contains some components featured in existing information processing models. The explanation suggests a workable sequence of how this information processsing model operates to determine what and how thinking and learning take place.

The order of the presentation below is based upon convenience and ease of understanding. As appropriate, additional items will be identified for comprehensiveness, completeness and readability. The intent of this description is to explain the ways an individual goes about thinking which may result in learning.

1. Environmental Information. The Environmental Information component serve to identify the external source of information to be confronted and handled by a person's processing system. This component is defined to include all the information and stimuli which are available within the life space of the individual. Environmental factors vary in their power, direction, intensity, and strength. Some of these factors may influence or dominate the person's thinking and behavior. The individual ultimately decides what in the environment will be attended to, internalized, and processed.

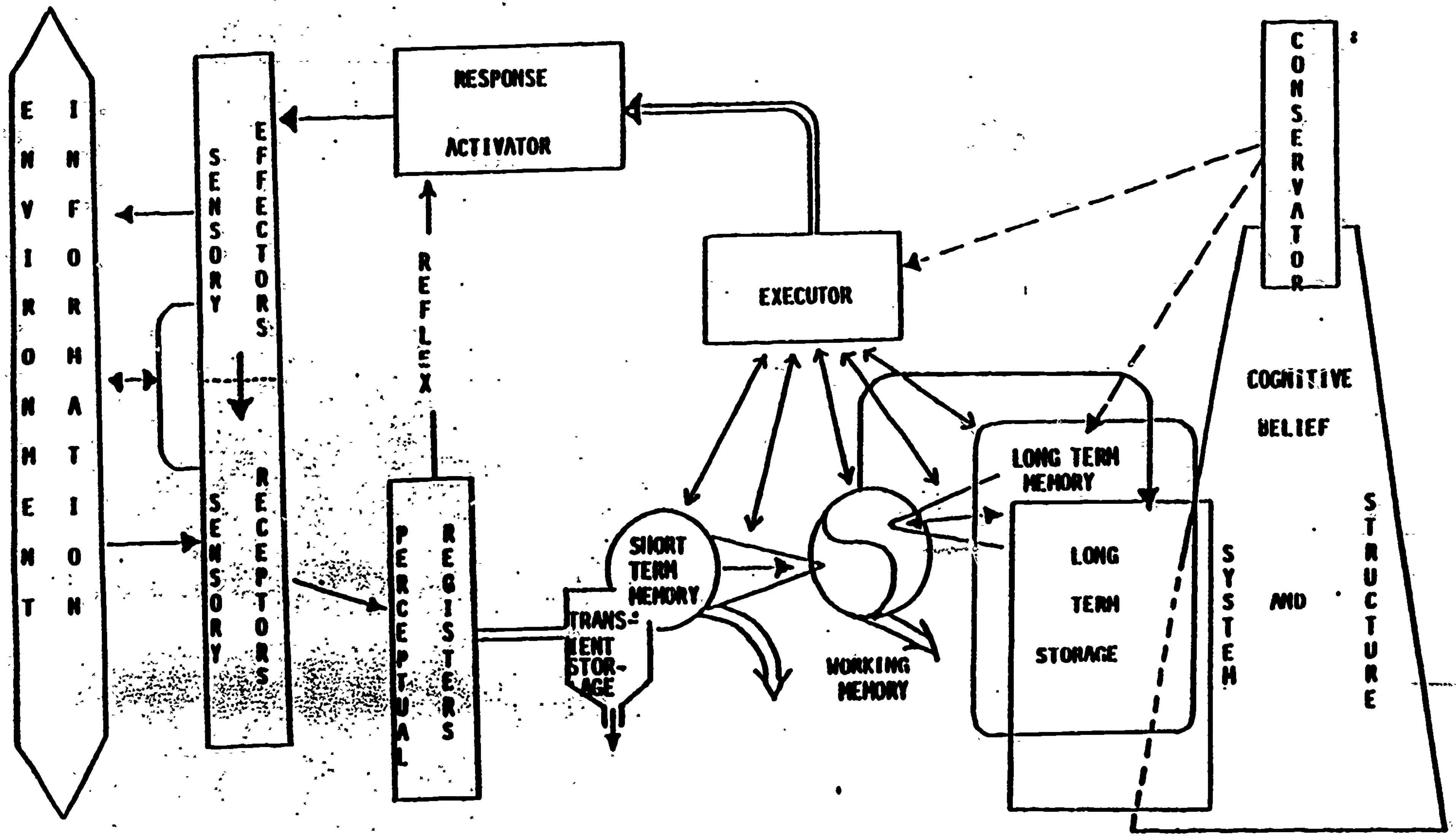


FIGURE 1: A diagram of the components, operations, and flow of activity within the Stahl Perceptual Information Processing and Operations Model--SPInPrOM. (Copyright, Robert J. Stahl, 1979)

2. Preparation or Perceptual Set. Although this aspect of information processing is not identified by any single component of the model, Preparation plays an important role in the early stages of the entire processing operation. Sometimes referred to as "expectancy set," this mind set guides a number of ways a learner attends to, receives, processes, and understands available and recently received information (Estes, 1972; Frase, 1977; Gagne and Rothkopf, 1975). The person's mind set may persist during an entire learning activity.

   "Readiness" or preparation for information plays a critical role in learning (Bloom, 1968; Ausubel, 1960; Neisser, 1976). In most situations the learner's personal motivations, learnings, and needs produce a powerful perceptual set (Gagne, 1976). These motivations prepare learners to expect certain environmental events and to view such events in ways consistent with their own motives and needs. At the same time, certain types of information (e.g., pre- and adjunct questions, advanced organizers) often alert learners to attend to, receive, process, and assign special meaning to about-to-be-presented information (Ausubel, 1960; Rothkopf and Bisbicos, 1967). This information suggests a "feed forward" feature of one's mind or perceptual set which acts in ways seemingly parallel to motivation-produced mind set.

3. Sensory Receptors - Effectors. Information in the environment is picked up by the individual's Sensory Receptors. These receptors include the physical physiological elements of the sensory system, including the organs and nerve networks of sight, sound, taste, smell, touch and interior physiological activities such as muscle pain, fatigue, and aches. Sensory Receptors pick up information from the environment and convert it into nerve impulses. Sensory Effectors, on the other hand, operate to act upon the environment via internal behavior response commands. For instance, while picking up and decoding sounds into auditory nerve impulses within the inner ear provides an example of Sensory Reception, the activity of directing the ear to deliberately 'listen for' certain sounds is an example of a Sensory Effector at work.

While often identified with "selective attention" or selective reception, this component of the model indicates where information from the environment is actually taken into (and by) the processing system. To be available for later processing, information must first be received.

4. Perceptual Register. The Perceptual Register picks up and momentarily records the kinds of information associated with an entire "perceptual system" rather than that merely picked up by each individual sense organ as separate items (Gibson, 1966). Several "perceptual systems" exist and function within the body, and the information they pick up is recorded in the Perceptual Register.

   The learner is capable of preserving the information (e.g., image) in this Register for milliseconds after the external information is no longer available to the Sensory Receptors. While the capacity of the Perceptual Register apparently is quite large, information is held for only milliseconds.

   Information not registered is no longer available for further processing into the system. The information registered may not survive the encoding operations which translate sensory information into the "languages" the storage, memory, and processing systems require. Hence, parts of the Sensory Registered information will not reach the Transient Storage or Short Term Memory (Haber, 1970).

   Certain types of sensory information which reach the Perceptual Register are automatically converted to messages which direct a behavior response. Sensual data which require an immediate response (e.g., a hand on a hot stove) are registered as such (i.e., reflex action required). A message is then immediately sent to the Response Activator to behave in appropriate "reflex" ways (i.e., pull the hand away).

5. Transient Storage. Information passing through this transporter mechanism must receive immediate

attention or its specifics are quickly lost. In this component, information is presented and then rapidly—"pushed out" within a few seconds. Information "pushed out" is lost to the memory and all later processing systems. However, information which is attended to may be preserved and remembered for longer periods of time. Unfortunately, the Transient Storage is often equated with Short Term Memory rather than being seen as the data conveyer operation that it is.

6. Surviving Transient Storage. Information flowing through the Transient Storage will remain for a short period of time (i.e., a matter of seconds) and is then discharged (Baddeley, 1972). The processing system operates to instantly decide what is to be done with this information. These decisions determine what will be retained verbatum, whether the 'gist' of the message is enough to remember, and/or what other actions may be called for to deal with the information. If the information is deemed meaningful in some way, the result is a "memory trace" of this information within Short Term Memory. Unless motivated to do otherwise, the tendency of the system is to allow the specific information passing through to be lost to the memory system, while a memory trace of the general gist of the details survives and is kept alive in Short Term Memory (Berelson and Steiner, 1964).

7. Short Term Memory. Short Term Memory includes "that which can be remembered about" recently received information. In contrast to the Transient Storage which serves an extremely short "data flow" function, Short Term Memory serves a "recollection-remembrance" function. This memory operation tends to retain general features of recently received information while often allowing the details to be lost. At the same time, attention to detail aids this mechanism to remember (i.e., keep in mind) specific details as well).

The functional capacity of Short Term Memory, though relatively small--perhaps a range of 7+ items of recently received data, can be greatly expanded by organizing information into units or "chunks" of information (Miller, 1956). Without interference, one can transfer Short Term Memory information into Working Memory where it can be rehearsed and practiced. Extended periods of time spent on categorizing and "chunking" suggest Working Memory and not Short Term Memory operations. However, interference disrupts the "chunking activities" and the transference of data into Working Memory (Underwood, 1964; Peterson and Peterson, 1959). Without attention and appropriate rehearsal, information in Short Term Memory will begin to fade out after seconds, with up to 90% loss after only 18 seconds (Broadbent, 1963, 1971; Peterson and Peterson, 1959).

Information reaching this far into the system has already begun a transformation or translation into information which has meaning for the learner. This transformation may result in alterations, incompleteness, inaccuracies, and/or distortions in the originally presented information so that it is more (or is made) compatible with what the system already knows and/or expects. Unless feedback is received otherwise, the system will accept these transformations as being equivalent to the information originally presented in the environment.

8. Executor. Before moving on to the Working Memory component, it is appropriate to introduce the Executor. The Executor is the administrator of the entire information processing system. To do its administrative tasks, the Executor operates to:

   a) assign meaning to recently encouraged and received information. This includes influencing the Sensory Receptors, Perceptual Register, and the encoding of data to the Transient Storage. In effect, it assesses, reduces, modifies, and to some degree censors information entering the system (Prokasy and Hall (1963) in Ellis et. al., 1979).

   b) assign meaning to (making sense of) information in Short Term Memory and Working Memory. This includes deciding what this information means in terms the learner can understand (i.e., in terms that make sense to the learner) (Flavell, 1977; Martin, 1971; Postman, 1968).

c) <u>decide what</u> information <u>will be retained</u> within the <u>system</u> as well as <u>how</u> it is to be used, transformed, retained, and stored. Such decisions involve recently received information as well as that information stored in and retrieved and used from Long Term Storage (Greeno in Gregg, 1974).

d) <u>direct the functioning</u> of other components of the <u>memory system</u> (i.e., Short Term, Working, and Long-Term Memories) and their interactions (Krech et. al., 1974).

e) <u>decide how much influence</u> the learner's Cognitive-Belief System will have on directing the meanings given to new and recently received information. It also identifies the alternative responses open to the learner (Allport and Postman, 1945; Salomon, 1979; Tulving, 1962).

f) <u>decide how the learner will respond</u> within the environment and situation. The Executor notifies the Response Activator which behavior has been decided upon. This message transmits the type and kind of response needed in the given situation (Ellis et. al., 1979).

g) <u>direct the internal thinking operations</u> within the system responsible for conscious thought, processing, and related activities and functions (Cofer, 1973; Berelson and Steiner, 1964).

In review, the Executor directs the inner functionings of the memory-storage-response system which ultimately controls what is learned, how it is stored, and how one will respond. As a general rule, the Executor is greatly influenced by previous experiences as they are established in the learner's own Cognitive-Belief System. Hence, there is the overwhelming tendency to perceive and transform new information to fit the individual's existing "world view." Decisions as to what information is relevant to the learner are made by the Executor as influenced by the Cognitive-Belief System.

The Executor decides what information will be transferred into Working Memory (Crowder, 1976). It also determines how this information will be transformed and handled within this particular memory component. In completing this and many of its other functions, the Executor seems to operate outside the conscious control of the individual (Shevrin and Dickman, 1980).

9. Staying Alive in Memory. The life span of recently received information within the processing system up to this point has been measured in terms of seconds. Information which is to be "learned must be retained for much longer periods of time. For this reason, the learner must take steps to keep information in the system for much longer periods of time. The longer information is kept "alive" within the memory system, the more likely it will be stored for later retrieval. The learner can keep information alive by "rehearsing" it in various ways with past Long Term Memories and other new information.

   There is no doubt that this rehearsal operation takes place and works (Rock, 1958; Tulving, 1974). The primary purpose of "rehearsal" or practice is to enable the learner to understand the meaning, message, intent, value, and/or uses of information in relationship to other information already or just being processed. Extensive rehearsal takes place within Working Memory which allows interaction between Short Term and Long Term Memories. During this operation, the information as transformed is being personalized and further internalized into information which makes personal sense to the learner. (Wittrock, 1979; Salomon, 1979).

10. Working Memory. Working Memory provides the arena where newly received information actively interacts with information obtained via Long Term Memory (Wittrock, 1979; Shifflin and Geisler, 1973). This interaction tends to "field test" the new data to determine how it will or might fit into the Long Term Storage-Memory system. The more the information seems consistent with long term memories, the more likely it will be found meaningful and hence be filed for rapid retrieval in Long Term Storage. The mental application of recently received information as well as the application of retrieved-from-Long Term Storage information upon recently received problems takes place within Working Memory.

    Information reaching Working Memory includes that recently received information which has been kept alive for further processing. At this time, information tends to be further transformed into the types of data which has meaning for the learner in light of previous understandings and experiences (Greeno, 1973; Lindsay and Norman, 1972; Gagne, 1976). If the information needs to be retained in Long Term Storage as originally given, then this rehearsal is referred to as "memorizing." However, the most common tendency of Working Memory operations is to transform the new information into "impressions" or "generalizations" which the system equates with the originally given information (Wittrock, 1979; Neisser, 1976).

11. Consolidation and Storage. At the close of an "attention span period," the information, meanings, and impressions included within Working Memory will either be "unloaded" into Long Term Storage or dropped out of the system as if erased. The learner does not consciously control what will be stored nor how it will be retained. The learner can work to improve the likelihood of its storage and later retrieval. The operations below influence the what, how, and extent of information which moves from Working Memory into Long Term Storage:

    a) the more meaning the system has attached to some information;

    b) the more it has been appropriately transformed and rehearsed;

    c) the more it fits in (although, in some cases, contrasts) with Long Term Memories; and

    d) the greater the quality of the consolidation which takes place immediately prior to the close of the "attention span."

An "attention span" is the period of time information in Working Memory is held before it is sent into Long Term Storage or is "unloaded" from the system. The "attention span" varies across learners and across situations for the same learner (Posner, 1969). These spans appear to be unconsciously regulated. The close of these spans frequently results in information being encoded and stored in Long Term Storage for later retrieval or it is 'dropped' from the system as if never encountered.[3] The more important it is for the newly received information to be retained for later thinking, the more necessary it is for consolidation to occur before the attention span ends. Under certain conditions, individuals are capable of carrying information over from one span period to the next. This ability gives the appearance that the Working Memory component has "elastic qualities," i.e., it acts as though it has 'stretched' its capacities to accommodate information processing across attention span periods.

Unless motivations and perceptions function otherwise, the results of the encoding-to-storage operation tend to support previous generalizations and impressions (or schemata) that the learner already possesses while tending to store specific details where they are more difficult to retrieve (Conrad, 1964; Duell, 1976; Sachs, 1967). In most situations where new information has been encountered by the learner, consolidation of the contents in Working Memory is necessary to help ensure its transfer into Long Term Storage (Bauman and Glass, 1969; Tishner and Power, 1978).

12. Long Term Storage. Long Term Storage should not be equated with Long Term Memory. The information contained in Long Term Storage is extensive, detailed, and somewhat permanent (Loftus and Loftus, 1980). While there is a theoretically limitless amount of such storage space, it seems that once information is stored in Long Term Storage, there is a great deal that appears to get "lost." A transfer-to-storage operation encodes the data from Working Memory and files it as is appropriate. Such encoding and filing is beyond the conscious control of the learner (Shevrin and Dickman, 1980).

13. Retrieval and Learning. Information which can be recovered from Long Term Storage and used reveals what has been 'learned.' By definition this recovery is required since it suggests the information is available over time for use in thinking and behaving. The more stable this thinking and behaving is across time periods, the better the indication of how well the information was originally learned. This retrieval operation produces information as required by the learner for a given situation. Higher forms of thinking-learning require later retrieval, but they are not restricted to just how much one can recall. These higher forms are characterized by how well the learner can use retrieved information to guide thinking and behavior without having to take time to "think about" the information before using it. Thinking and behaving guided by the learner's Cognitive-Beliefs are indications of higher level thinking and behavior.[4]

14. Long Term Memory. Long Term Memory includes that which the learner "remembers about what is stored." This memory component also directs "how" stored information is remembered. This memory component and not Long Term Storage directs the retrieval operations of searching, locating, recovering, organizing and constructing information stored in Long Term Storage.

The retrieval of data from Long Term Storage via Long Term Memory may be accurate in many details. Frequently, material seems to be fabricated (invented) by the information processing system at the time the memory reports its findings. Thus, missing information is often filled in to present a reasonably complete and consistent "memory" (Berelson and Steiner, 1964; Loftus and Loftus, 1980). "Forgetting" (or the failure to retrieve accurate, complete, and/or detailed information from Long Term Storage) is a failure of the Long Term Memory-retrieval operation rather than a failure of the storage system.

15. <u>Utilizing Retrieved Information</u>. Since information and how it may be used to guide thinking as retrieved via Long Term Memory is "learned information," the memory system <u>depends upon</u> its learnings to make sense of and think through newly received information. This learned information is constantly being used in Working Memory to assist the learner 'comprehend" and 'personalize' new information. As a general rule, the memory system uses learned information to make the new information compatible with that remembered and retrieved via Long Term Memory. Seen in this way, "relevancy" assigned to new information depends upon the associations which can be made between new and previously stored information.

16. <u>The Cognitive-Belief System</u>. The Cognitive-Belief System is generated out of Long Term Storage-Memory. It is an organized framework which functions to separate, departmentalize, structure, and develop hierarchial arrangements of the major ideas, guidelines, beliefs, and generalizations the learner understands from and forms about the universe in which s/he lives. These 'cognitive-beliefs' focus on the learner as a person (i.e., the Self) as well as the relationships s/he has with the world outside Self.

The Cognitive-Belief System contains the learner's world view, values, beliefs, and attitudes as well as those ideas and generalizations which are used to make sense out of personal experiences. As a general rule, the Cognitive-Belief System through the Conservator operates to influence the entire system to "see" and "understand" things in ways consistent with the existing world view and the perceived Self.

17. Conservator. The Cognitive-Belief System exercises its conforming tendency via the Conservator. This Conservator exerts a strong influence on the Executor and Long Term Memory operations to retrieve and/or process information in ways consistent with the learner's previous perceptions and existing world view. While the Conservator does not control the Executor or Long Term Memory, prior reinforcements and repeated similar experiences allow these components to be easily influenced by the Conservator. In essence, the Executor is quite "gullible" to the influence exerted by the Conservator. This explains why individuals almost always perceive new experiences and revives past memories to conform to their present world view. It also explains why, on some occasions the learner may resist this conservative, conforming world view and adapt new perceptions, ideas, and beliefs about Self and the world.

18. Influence on Behavior Not only do previous learnings and the Cognitive-Belief System influence thinking within Working Memory, they also provide the Executor with data about alternative or needed behavioral responses and/or performances. This information informs the Executor which then uses the information to reach a decision. Should the situation and content call for a habitual pattern of response or routine behaviors (or "automatized reactions" (Furst, 1979)), the Executor allows existing Cognitive-Beliefs and Long Term Memories to operate with a relatively open, automatic hand in directing the response. Learned information may also be used to influence what is attended to, selected, and/or rejected within the early stages of the processing operations.

19. Response Activator. The Response Activator functions as the entire nervous system in responding in the given situation. This component receives orders from the Executor as to what the response will be and then directs the various physiological systems: (e.g., muscles) to carry out the order. The Perceptual Register can also send directives to this Activator component initiating what is called a "reflex action."

20. Sensory Effectors. Sensory Effectors are the sense organs, muscles, and other physiological components which carry out the response transmitted from the Executor by way of the Response Activator.

THE DOMAIN OF COGNITION

1.00 **PREPARATION**

"OBSERVATION" (Sensory input of data)

2.00 **RECEPTION**

- 2.10 Literation
- 2.20 Recognition
- 2.30 Recollection

3.00 **TRANSFORMATION**

- 3.10 Personalization
- 3.20 Adaptation

"INFORMATION ACQUISITION" (Encoding and storage of information into Long Term Storage)

4.00 **RETENTION**

- 4.10 Recognition
- 4.20 Recollection

5.00 **TRANSFERSION**

- 5.10 Replication
- 5.20 Variation

6.00 **INCORPORATION**

7.00 **ORGANIZATION**

8.00 **GENERATION**

Figure 2:

An outline of the major levels and sublevels of the Domain of Cognition.

21. Feedback-Feedforward. A behavior or thought generated by the learner is supported or rejected in whole or in part as a result of the information which is received into the processing system about that thought or behavior. If a particular guideline is used and produces positive results to the learner, the guideline is likely to be used again in similar situations. Negative results provide feedback as to what did not work, as well as feedforward about what probably won't work or should be avoided in the future. Information provided by the environment in regard to the learner's behavior must be received by the Sensory Receptors and the processing of this newly received information begins its journey through the system (Wittrock, 1979; McKeachie, 1976).

A Note on the "Ecological Validity" of the SPInPrOM Model

These phases, components, and operations possess "ecological validity" in that they provide a practical and realistic overview of how individuals process information within their natural environments (Neisser, 1976). Findings from empirical research studies using human subjects and conducted in the natural environments of the learner support the model. Of equal importance is the fact that teacher educators and teacher trainees have reported the SPInPrOM model explains how students as well as themselves are likely to think, behave, and learn within and outside classroom settings.

THE DOMAIN OF COGNITION

As shown by the SPInPrOM model, information presented to be learned undergoes a great deal of processing on its way through the system. In some cases, what happens to this information is not what the teacher would like have happen. Now that these processing events are familiar, it seems appropriate to introduce a sequence which has more direct application for considering outcome-of-instruction behaviors. This sequence takes the form of a taxonomic system entitled the Domain of Cognition.

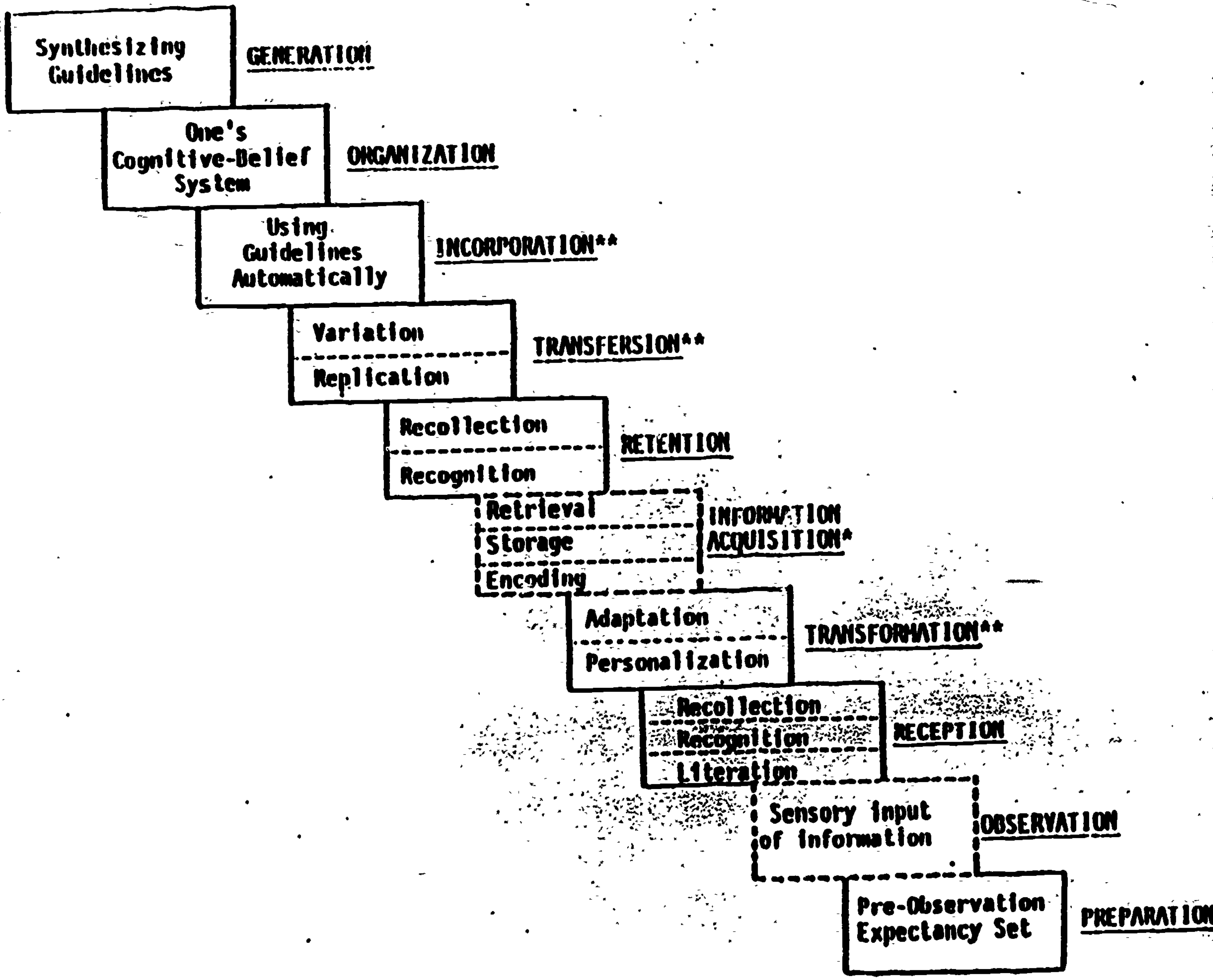
The Domain of Cognition includes eight levels of cognitive and cognitive-affect thinking and learning-related behaviors (see Figure 2). This Domain also includes two 'pseudo levels' which point out where two crucial learning-related activities take place within this explanation of the thinking-learning continuum. Within this sytem, thinking is defined as "any mental activity" while learning is defined as "acquiring a new thought or behavior which will be retained, maintained at a reasonably stable level, and demonstrated in similar situations across time." Thinking may result in learning as well as incorporate previous learnings, but it is not to be equated with learning. The Domain of Cognition includes pre-learning thinking levels and post-learning levels which operate within and may result from classroom instruction. One advantage of this taxonomy is that it helps teachers to view the entire range of thinking-learning activities likely to occur during and as an outcome of instruction.

The levels of the Domain of Cognition described below identify the sequence of processing information for thinking and learning from an instructional viewpoint. This taxonomy is not a modification of the Bloom-Krathwohl systems. It is an entirely new system and should be seen as such. And although the Domain of Cognition is related to the SPInPrOM model, the reader is advised not to look for an exact one-to-one correlation between components of these separate models.

Progressing Up the Levels of the Domain of Cognition

The eight levels and two "pseudo" levels of the Domain of Cognition are presented below in sequence from the lowest to highest levels. These levels are described in linear order for convenience and readability (See Figure 2).

> Level 1:00 PREPARATION. The Preparation level indicates that the learner's existing "perceptual set" or "mind set" toward the class, course, content, etc., affects what information will be received by the learner. The learner's motivations, needs, attitudes, and expectations operate to influence what and how information in the environment will be attended to, noticed, and taken in. This level represents the pre-Observation readiness of the learner immediately prior to the presentation of an experience or information.
>
> First Placebo Level: OBSERVATION. This placebo level is included to indicate where the actual intake of external information occurs within this sequence of thinking-learning. This level is added for completeness. Information not taken in or "observed" via the senses is not available to the learner for later processing, thinking, or learning.



The levels and sublevels of the Domain of Cognition illustrated in hierarchial form.

Level 2:00 RECEPTION. The Receptor level describes the ways learners may report and/record the information they have received. Learners are capable of thinking about recently received information in three specific ways. First, they may report what they are taking in at the present moment. This Literation sub-level involves the learner's identification of the information immediately before him or her. The second sub-level, Recognition, involves the ability to identify whether information currently available to the learner is similar to or different from information presented earlier in the same lesson. The highest sub-level, Recollection, requires the ability to completely recall from Short Term or Working Memory the information which is needed for a particular response.

Reception level thinking involves operations of Short Term and Working memories since it deals with information recently received in the given class period. Learner responses on this level have not as yet reached Long Term Storage, so the teacher is not to infer the response has been learned. Reception level thinking is not equivalent to long term retention of the information received by the learner.

Level 3:00 TRANSFORMATION. Transformation level thinking is where the learner translates just-received information in ways that make personal sense to him/her. To increase the chances of being stored into Long Term Storage, information just received must be given meaning that "makes sense" of this information in terms the learner will understand. During this phase of thinking, learners translate recently received information into a form and version which gives it meaning as well as has meaning for them. In transforming this information, learners may alter or change its message, content, intent, accuracy, or details in order to make sense of it. The activity of assigning meaning to this recent information is associated with the "Personalization" sub-level of Transformation.

The second sub-level is called "Adaptation." Adaptation is where learners practice using or "rehearse" newly received information and the meanings which have been assigned to it. This rehearsal may include using the information as guidelines (or rules) to direct uniprocess and megaprocess thinking.[5] Researsal actually serves to help the learner field test the various uses which may be put to the new information. It allows the learner to comprehend the information in regard to its possible and appropriate uses. Adaptation level rehearsal, especially when accompanied by external constructive and corrective feedback, increases the likelihood that information received in a given class period will be encoded more completely. and correctly into Long Term Storage.

Second Placebo Level: INFORMATION ACQUISITION. This second placebo step in the sequence operates beyond the conscious control of the learner. Added for completeness, this step identifies where the acquisition, encoding, and storage of recently transformed information from Working Memory into Long Term Storage following the close of an "attention span" occurs.

Level 4:00 RETENTION. Retention is that level where the learner demonstrates the ability to successfully search, locate, and recover information stored in Long Term Storage via Long Term Memory.[6] This ability to recover information when and as necessary from Long Term Storage provides evidence that learning on a minimal level has occurred. (Note: As pointed out in the SPInPrOM model, information received by the learner in a given class period and recalled and used from Short Term and/or Working Memories is not evidence of successful learning. Learning is dependent upon retrieval from Long Term Storage--a phenomenon not possible to measure during the class period during which the information is first received.)

"Recognition" is the lower of the two sub-levels of Retention. Recognition behavior requires the learner to retrieve sufficient information to verify or indicate whether a particular set of data has been experienced previously (e.g., multiple choice or matching test items). On the other hand, "Recollection" requires the learner to recover information to complete or fill in gaps of missing data (e.g., completion or fill-in-the-blanks tests).

Level 5:00 TRANSFERSION: Transfersion represents the learner's ability to go beyond mere retrieval of information via Long Term Memory. It requires the demonstration of the use of the information in relevant situations. During this phase, the learner must make regular and appropriate use of guidelines or rules which have been retrieved from Long Term Storage. This ability is indicative of higher levels of learning and thinking since both require the reasonably stable use of retrieved guidelines or rules as the basis or guide for behavior. (Note: Learners use these guidelines as the basis for various uniprocesses and megaprocesses and to deal with problems similar to those studied previously.[7] It is not the uniprocess, the type

The Levels of the Domain of Cognition: Short Descriptors

1.0 PREPARATION (Function: Readying to receive and/or capable of accepting information)
Students make ready to receive, attend to, or accept information
Students are ready to receive, attend to, or accept information
Students use cues which alert them to pay attention to upcoming experiences
Students possess the cognitive structure to facilitate information about to be received

"OBSERVATION" (Function: Taking in and becoming aware of information and stimuli)
Students take in information and stimuli as sensory input of data
Students receive stimuli through their senses from external environment and sources
Students become consciously aware of the products of their own behavior and thinking

2.0 RECEPTION (Function: Noticing and remembering information that has just been presented)
Students take in and notice information that is presented before them at the time it is present
Students remember information enough to recognize it when presented later in some class period.
Students recall information that was presented earlier in same class period/lesson.
Students reveal their knowledge of information presented during the same class period

3.0 TRANSFORMATION (Function: Giving meaning to information that has just been received)
Students make sense of newly received information in ways they understand it
Students translate recently taken in information into personally meaningful information
Students process recently received information to understand how to use it
Students use newly received information to identify and verify its uses
Students give meaning to the uses that have just been put to recently received information

"INFORMATION ACQUISITION" (Function: Placing information and meanings into Long Term Storage)
Students automatically and unconsciously code recently received information and store it into Long Term Storage
Students demonstrate tendency to store meanings given to data over the actual data itself
Students demonstrate tendency to disregard and not store information which is not meaningful to them
Students are able to retrieve when needed information stored in Long Term Storage

4.0 RETENTION (Function: Identifying information retrieved from Long Term Storage)
Students remember information enough to recognize it when it is presented to them later
Students recall and provide information they need to deal with a question, problem, etc.
Students recall answers to who, what, when, where, and some how and why questions
Students can remember guidelines they can use as a basis for all higher level thinking and learning

5.0 TRANSFERSION (Function: Using recalled information (guidelines) to deal with new situations)
Students make use of recalled guidelines to deal with situations and problems familiar to them
Students make use of recalled guidelines in situations new to them
Students use recalled guidelines with one or more processes or procedures to deal with various situations and problems
Students practice using recalled guidelines to master their correct use

6.0 INCORPORATION (Function: Using information (guidelines) which has been internalized)
Students understand guidelines so well that it becomes an automatic and unconscious basis for their thinking
Students use guidelines to deal with situations without consciously being aware of what information they are using
Students use internalized guidelines to form new combinations and arrangements of guidelines to deal with situations or problems.

7.0 ORGANIZATION (Function: Interrelating and prioritizing all previously understood information)
Students form and make use of their cognitive-belief system
Students automatically and unconsciously arrange, interrelate, and prioritize information and meanings they understand and have internalized
Students use their cognitive-belief system to influence what information is received and what meanings it is given

8.0 GENERATION (Function: Synthesizing previous information to form new ideas and understandings)
Students form new ideas and understandings by integrating old guidelines to thinking
Students create new understandings and products by synthesizing (e.g., Hegel) previous understandings and information

Short descriptions of the levels of the Domain of Cognition.

UNIPROCESS NAME	MAJOR ACTIVITY OF THE UNIPROCESS	FUNCTION OF THE UNIPROCESS[1]	COMPLEMENTARY ACTIVITIES
1. Association	Associating	joining or tying two or more items together with the emphasis on the conjunctive aspects rather than on the whole	Affiliating, Connecting, Interrelating, Relating, Tying
2. Classification	Classifying	forming groups and/or putting items into categories	Categorizing, Grouping, Ordering, Sorting, Systematizing
3. Combination	Combining	putting separate items or information into some single whole	Blending, Chaining, Compiling, Integrating
4. Comparison	Comparing	identifying what and/or how items are similiar to and/or different from one another	Contrasting, Equating, Likening
5. Condensation	Condensing	producing a shortened version of some longer form of information	Abbreviating, Abridging, Consolidating, Simplifying, Summarizing
6. Conversion	Converting	changing the external or internal features, size, etc. of an item or information for the purpose of making it different	Altering, Changing, Deviating, Modifying, Revising
7. Description	Describing	reporting the features, number, etc. of the external aspects of information or an item	Announcing, Narrating, Reporting
8. Designation	Designating	assigning a label, name, or exactness to an item	Naming, Defining, Labeling, Specifying
9. Discrimination	Discriminating	treating items or information differently from one another	Differentiating, Discerning, Distinguishing
10. Extension	Extending	providing information which would likely fill a void in the information which is available or being considered	Appending, Concluding, Conjecturing, Estimating, Projecting, Completing
11. Extraction	Extracting	taking apart or a way from a larger whole to focus on its parts and their relation to each other and/or to the whole	Abstracting, Analyzing, Assuming, Deriving
12. Interpretation	Interpreting	making sense of information in terms of the meaning it has	Conceptualizing, Opining, Perceiving, Personalizing
13. Organization	Organizing	putting separate items together in some interrelated order or sequence with the stress on the interrelationships as well as the order and system	Adjusting, Arranging, Assembling, Composing, Sequencing, Structuring, Systematizing
14. Proposition	Proposing	suggesting or providing a probable way of dealing with a situation or problem	Hypothesizing, Planning, Recommending, Theorizing
15. Reconciliation	Reconciliating	putting apparent opposition items or information together so that they form a compatable or consistent whole	Accommodating, Arbitrating, Balancing, Compromising, Conforming, Equalizing
16. Selection	Selecting	making a preferred, imperative, or needed choice	Choosing, Deciding, Determining, Judging, Picking
17. Separation	Separating	taking apart information and/or a whole to identify its distinct individual parts with the focus on the spliting of the parts from eachother	Breaking, Disconnecting, Disuniting, Dividing, Segregating, Severing
18. Translation	Translating	putting information into a different form or version than it was originally given without deliberately changing its message, meaning, or intent	Coding, Decoding, Defining, Paraphrasing, Restating, Simulating, Substituting, Symbolizing, Transforming
19. Utilization	Utilizing	demonstrating how information or an item could be, is being, or has been put to use	Applying, Employing, Fitting, Transferring, Using
20. Valuation	Valuating	assigning value, a rating, or priority to an item or information	Appraising, Appreciating, Assessing, Evaluating, Judging, Prioritizing, Ranking, Rating
21. Verification	Verifying	specifying how information has been or is to be accepted as valid, true, reliable, or accurate	Authenticating, Confirming, Proving, Substantiating, Supporting, Validating

[1] Functions listed are illustrative and are not to be treated or considered as inclusive.

Note: The numbers are nominal and do not represent order of priority or importance.

FIGURE 3: The Twenty-one Uniprocesses

Major Categories in the Domain of Cognition Taxonomy
(Stahl, 1979)

DESCRIPTIONS OF THE MAJOR CATEGORIES IN THE DOMAIN OF COGNITION

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1. <u>PREPARATION</u> Preparation refers to the mental readiness of the individual immediately before and at the time new information is presented. This level stresses the need for students to have the background and mental set to be ready for new information. The student outcome is the cognitive background and attitude to take in outside experiences and input.

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2. <u>RECEPTION</u> Reception refers to the reciting of information immediately in front of the individual (i.e., like reading aloud) or recalling information that has recently been presented within the same lesson. This learning outcome is for students to recall a wide range of information in much the same form it was presented. The student is required to recognize or recall the appropriate information from short term or working memory. Reception represents information the student can retrieve from memory within a few hours after encountering this information.

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3. <u>TRANSFORMATION</u> Transformation refers to the ways students may alter or change the original information as they try to give it meaning. This understanding may be demonstrated by changing the wording of the information (paraphrasing), by personalizing it (changing it in a way that makes sense to the individual), or by practicing this new information to understand its uses (applying the information in particular situations). This level of student learning outcomes represents the lowest level of comprehension, with the practice step requiring the application of rules, methods, laws, etc., during the lesson where these are first encountered and used.

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4. <u>RETENTION</u> Retention refers to the recalling from memory of previously learned information and transformations approximately 24 hours after this information was first thought about. This student learning outcome includes the recall of a wide range of information from specific facts to results of applications they made during previous lessons. The student is required to recognize or recall appropriate information using Long Term Memory. Retention represents the lowest level of learned outcomes possible in the Domain of Cognition.

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5. <u>TRANSFERSION</u> Transfersion is the ability to use information retrieved by Long Term Memory in specific situations similar to and/or different from those where the information was first practiced. This level is where students consciously remember the rules, laws, principles that are to be applied, and then use these in appropriate situations.

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6. <u>INCORPORATION</u> Incorporation is the ability to use information in appropriate situations such that its use is automatic and habitual without the student's conscious recall and application of the information. On this level, students demonstrate the ability to apply rules, principles, laws, etc., that they have learned to use without consciously remembering these rules, laws, etc., they are using. This level represents a high level of internalizing information and its various applications and usually occurs only after numerous practices at the Transfersion level.

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7. <u>ORGANIZATION</u> Organization represents that level whereby students express how they have arranged, organized and/or prioritized their learnings as part of their cognitive-belief system. Student learning outcomes on this level express their personal ratings, rankings, or preferences for information already acquired or they may explain or assess situations or new experiences in terms of their cognitive-beliefs. Student beliefs, attitudes, ideals, stereotypic or prejudicial perspectives, and the like, are most often reflections of this level.

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8. <u>GENERATION</u> Generation is the ability to produce new sets of rules, principles, guidelines, methods, etc., which represent unique combinations or synthesis of two or more sets of rules, principles, etc., which the student has mastered on the Incorporation level. This new set of rules, etc., is to be appropriate to a situation or to explain a phenomenon and should represent a less complex way of describing or solving the situation.

Examples of General Instructional Objectives and Behavioral Terms for the Domain of Cognition Taxonomy

ILLUSTRATIVE GENERAL INSTRUCTIONAL OBJECTIVES	ILLUSTRATIVE BEHAVIORAL TERMS FOR STATING SPECIFIC LEARNING OUTCOMES
(None appropriate)	Report or indicate a readiness to begin or engage in an activity.
Understands information and facts Recognizes details and data Knows verbal information Understands steps of a method Knows a formula or principle Recognizes laws or theories	Report a definition, description, explanation, fact, table, listing, name, or other details of information, or match, select, or indicate any of the above in reference to information as it was given during the just completed lesson.
Understands laws or theories Comprehends information Understands facts Knows the meaning of	Report a paraphrasing, translation, rewriting, restating, explanation, or other personal version of information presented during the just completed lesson.
Applies principles to a situation Utilizes steps of a method Solves problems Constructs examples of a graph	Classifies, combines, compares, condenses, converts, describes, distinguishes, estimates, evaluates, abstracts, interprets, organizes, proposes, selects, solves, translates, rates, verifies, gives examples using information presented during the just completed lesson.
Understands information and facts Recognizes details and data Knows verbal information Knows laws, principles or rules Understands steps of a method	Report a fact, description, or any other information which indicates retrieval of information from previous lessons: Write down, orally express, match, select or indicate associations, classes, comparisons, descriptions, definitions, distinctions, estimates, evaluations, solutions, etc., and/or the rules used to complete these or an explanation how these rules could be used.
Understands laws or theories Applies information Utilizes steps of a method Solves problems Applies principles or laws Understands how information is used	Classifies, combines, compares, condenses, converts, describes, distinguishes, estimates, evaluates, abstracts, interprets, organizes, proposes, selects, solves, rates, ranks, confirms, or gives new examples using information recalled from previous lessons to obtain and/or explain these results.
(Same as above)	(Same as above, except behaviors have become habitual ones for the student in similar situations)
Demonstrates consistent and predictable beliefs Provides consistent and defensible rationale Demonstrates commitment to a particular perspective Appreciates how a technique works Values a particular point of view or product	Initiates, performs, volunteers, modifies, supports, defends, ranks, rates, selects, completes (or engages in other behaviors which reflect a pervasive, consistent, and predictable set of beliefs, values, perceptions, or viewpoints).
Formulates a new set of rules or principles Develops a new explanation Formulates a new way of solving a problem	Creates, composes, devises, generates, constructs, develops, explains, synthesizes, or combines a new set of rules, principles, guidelines, methods, etc. (once mastery of each original rule, principle, etc., has been demonstrated on the Incorporation level).

of guidelines used, nor the problems encountered which signify higher level learning or thinking. The criterion is that the guidelines used as the basis of the thinking or behavior must come via Long Term Memory).

Learners can demonstrate Transfersion level learning in one of two ways. When learners use guidelines on a reasonably stable level in various situations much like those where the guidelines were originally practiced, this behavior represents "Replication" sub-level learning. When these same guidelines are being applied to situations dissimilar to those where the guidelines were first learned, "Variation" learning is evidenced.

Level 6:00 INCORPORATION. After a set of guidelines or rules is understood so well that its use becomes automatic, the learner is considered to have reached the incorporation level for guiding thinking and behavior. Sometimes this level is evidenced by the learner's ability to use a guideline or rule without being able to recall the details of which guideline was used. At some point, the learner understands a set of guidelines and its related cues so well that it no longer becomes necessary or efficient to consciously recall the guidelines automatically as appropriate cues are presented.

The Incorporation level signifies that the learner has internalized a set of guidelines so well that its meaning has been abstracted and can be used without the learner having to consciously think about the guidelines. The learner uses guidelines understood on this level to guide various uniprocesses and megaprocesses in problem-solving situations. In essence, Incorporation level implies the learner has achieved habitual almost unconscious use of a single or a given set of guidelines, rules, or principles.

Level 7:00 ORGANIZATION. The Organization level represents the arrangement of an interrelations among the vast number of guidelines and rules which have been internalized by the learner. The exact nature of how this Organization is established, occurs, or is structured is not known. Its influences on the learner suggest this Organization framework is departmentalized and hierarchial in that different types of guidelines and rules seem to have more influence (i.e., possess a higher priority) than do others. This framework is often referred to as one's Cognitive Belief System.

—Level 8:00 GENERATION. The Generation level does not necessarily signify the mentally highest level of thinking but seems to represent a very sophisticated mental operation not utilized by most persons. Generation represents the synthesizing of several guidelines understood as abstractions and not previously interrelated. The mere use of several combinations of guidelines (no matter how complex) does not signify Generation. This phase represents more than the transfer of guidelines to a new situation or context. Generation requires the genuine production of a new set of guidelines, a new idea or a new explanation which is internally consistent and adequate while representing the synthesis (e.g., Hegel's dialectic or "Janus thinking") of two or more previously separate perspectives or sets of guidelines.

One of the more unique features of the Domain of Cognition is its avoidance of the use of specific processes (e.g., Application, Analysis, and Synthesis) as the basis for determining "higher" and "lower" levels of thinking and learning. The findings in cognitive psychology reveal that higher level thinking and behavior is related to the degree to which one has internalized and uses rules to guide thinking. It is not the process itself which determines the "highness" or "lowness" of the level of thinking. Rather, it is the level one has acquired and internalized the rules to guide the various processes which determine the appropriate level of one's thinking (Segal and Stacy, 1975).

Consistent with this research literature, the Domain of Cognition describes a sequence of degrees or levels which information and rule may be internalized and used by the learner. Figure 3 illustrates 21 separate mental operations or ways which individuals may use rules in thinking and responding. Each mental operation or uniprocess represents a distinct way the learner can make use of rules or guidelines which have been acquired. So-called "complex processes" or megaprocesses are defined as 'complexes' or combinations of uniprocesses which are used to respond to a single situation or problem.

Therefore, it is possible for learners to use the same uniprocess on any one of several different levels of thinking and learning (i.e., Transformation, Transfersion, Incorporation, Organization and Generation). Teachers must learn to focus their attention on helping learners increase the degree to which they internalize rules which can become the basis for higher levels of thinking. They must also abandon their belief that it is the process itself rather than the degree of the internalization which determines "higher" level thinking and behavior. Finally, teachers may consider the act of "processing" information as "rehearsal time" when the learners are practicing putting the rules and guidelines to use, thus increasing the likelihood these rules will be acquired and further internalized.

The above represents a brief description of some of the major features of the Domain of Cognition. The eight levels include both pre-learning and post-acquisition learned behaviors. Preservice and inservice teachers at Arizona State University are currently using the taxonomic system as a basis for identifying and writing specific behavioral/instructional objectives. They are also developing test items to measure the various outcome behaviors associated with these different levels. With these uses and attributes, the Domain of Cognition represents an important new addition to the field of teacher education and is a viable alternative to the taxonomic models presently being used.

Some Principles of Learning and Thinking

In reflecting upon the SPInPrOM and the Domain of Cognition models described above, the following list presents useful principles for instructional designers and teachers to consider in planning for and assessing the outcomes of instruction:

a) the individual learner is confronted with so many specific details in the environment that it is a wonder that as much detail as does is eventually stored in and retrieved from Long Term Storage (Deese and Hulse, 1967).

b) the processing system has a general tendency to deal with and produce generalizations and impressions of what information was received rather than retain the specific details of this information (Crowder, 1976; Kolers, 1974; Sachs, 1967).

c) a learned behavior is impossible to confirm at the time new information is first encountered, even though one's performance might suggest otherwise. The classroom teacher should follow the general rule of waiting 24 hours until the next class period begins to measure what was retained and can at least be re-trieved and used via Long Term Memory. This 24-hour period has precedence in learning-memory research (Postman and Rau, 1957); Deese and Hulse, 1967). Learned behavior cannot be demonstrated during the class period information was first received.[8]

d) there is no inherent difference between information useful for guiding cognitive (e.g., geometric theorems) and information useful for guiding affective (e.g., reasons for making moral decisions) thinking and learning (Meehan, 1969; Messick, 1979). It is the society, culture, institutions, etc., which attach special meaning to such information and give the appearance that affective, values, moral, and/or normative oriented information do possess inherent qualitative features. The learner actually deals with cognitive guidelines (e.g., how to read a map) the same way as affective guidelines (e.g., do unto others as you would have them do unto you) within the information processing system.

e) the learner continually uses and is influenced by information and understandings from his/her own Cognitive-Belief System and Long Term Memory which in turn operate to assist the learner transform, select, make sense of, and assign meaning to new experiences and data (Samuels, 1974). By and large, the entire information processing system tends to translate new information and experiences to make them conform to and compatible with one's existing Cognitive-Belief System and Long Term Memories.

f) the individual uses rules as the basis for guiding his/her thinking and behavior. The critical role rules (or guidelines) play in psychological processing must be understood by teachers (Segal and Stacy, 1975). Rules or guidelines do provide the basic explanations, reasons, and basis for behavior (i.e., one behaves because of the operation of certain guidelines at the time of his/her behavior) (Katona, 1940; Postman, 1954, Segal and Stacy, 1975; Zeiler, 1963).

g) the use of a rule or guideline by a student does not necessarily mean s/he can identify (at least beforehand) what the rule is (Erickson and Jones, 1978; Wason and Evans, 1975). At the same time, recalling or stating a rule does not necessarily mean one understands it nor can use it (Erickson and Jones, 1978); Van Duyne, 1974). Furthermore, the learning of information as information is different from learning information as guidelines and using it (Gagne and Briggs, 1974).

h) the individual tends to learn how to use guidelines in certain situations when (and seemingly only when) certain specific cues associated with those guidelines are present. The more these cues and situations appear during initial rehearsals and the more the individual is reinforced to use the guidelines with these and only these cues, the less likely the individual will be able to transfer these guidelines to new situations at later times (Berelson and Steiner, 1964; Knight, 1963; Luchins, 1942). Transfer of learning implies the transfer of guidelines originally associated with one type of situation to other situations where their use is appropriate but not necessarily evidence to the individual.

i) the consistent and sometimes contradictory research findings related to the effects of external cues, stimuli, and reinforcers suggest very strongly that the effects of these external variables are learner determined and not externally determined (McKeachie, 1976; Wittrock, 1979).

j) the individual learner operates frequently on two different "levels" of thinking and processing of information. As the learner retrieves and uses information via Long Term Memory to work with recently received information, thinking using retrieved-from-storage information represents higher level thinking while mental activities working with recently received information represent lower level thinking.

The SPInPrOM model and the Domain of Cognition are supported by extensive findings related to human learning research and possess ecological validity from the perspective of inservice and preservice teachers. These two systems are compatible with a wide variety of apparently divergent schools of psychological thinking. Both also represent feasible models to differentiate among the internal aspects of memory, thinking and learning. Both models also lend themselves to explaining external behaviors as they are occurring and as they may be identified as outcomes of instruction. Finally, these models are "teachable" within the framework of teacher education programs, and they are "learnable" in that inservice and preservice teachers are able to understand and use them, especially SPInPrOM, within a very short period of time.

FOOTNOTES

[1]Horace B. English and Ava Champney English, eds., A Comprehensive Dictionary of Psychological and Psychoanalytic Terms (New York: David McKay, Co., 1958).

[2]Benjamin B. Wolman, ed. Dictionary of Behavioral Science (New York: Van Nostrand Reinhold Co., 1973).

[3]Carter V, Good, ed. Dictionary of Education (3rd ed., New York: McGraw Hill, 1963).

[4]Lee C. Deighton, ed., The Encyclopedia of Education (New York: Crowell-Collier Educational Corporation, 1971).

[5]Oxford English Dictionary (Oxford: The Clarendon Press, 1933).

[6]George Gaylord Simpson, Principles of Animal Taxonomy (New York: Columbia University Press, 1961), pp. 25-26.

[7]John R. Gregg, The Language of Taxonomy (New York: Columbia University Press, 1954), p. vii.

[8]Daniel E. Griffiths, ed., Developing Taxonomies of Organizational Behavior in Educational Administration (Chicago: Rand McNally and Company, 1969), p.22.

[9]David R. Krathwohl, Benjamin S. Bloom, and Bertram B. Masia, Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook II: Affective Domain (New York: David McKay Co., Inc., 1964), pp. 8-9.

[10]Griffiths, op.cit., pp. 23-24, 176-177.

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