Teachers' Use of Theoretical Frames for Instructional Planning: Information Processing Theories

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Abstract

In this article, I examine four information processing theories that may assist teachers with their instructional planning: Gagné's conditions of learning, J.P. Guilford's structure of intellect, Lawrence Kohlberg's stages of moral development, and Howard Gardner's theory of multiple intelligences. Information processing theorists consider that learning occurs as information passes through short-term memory to long-term memory. The first three theorists believe in scaffolded learning, by which students move from low to high, from easy to difficult. Like Guilford, Gardner contends that a variety of mental operations are associated with intelligence.

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The best instructional planning and designs are based on the teacher's knowledge of theoretical frames of learning. Theoretical frames, although not prescriptive, are useful to teachers because they make them more aware of how learning takes place and how students acquire, retain, and recall knowledge. Additionally, teachers can use the learning theories as guidelines to help them in instructional planning, specifically in selecting instructional tools, techniques, and strategies to enable students to successfully complete course objectives.

In this article, I examine four information processing theories: Robert Gagné's conditions of learning, J.P. Guilford's structure of intellect, Lawrence Kohlberg's stages of moral development, and Howard Gardner's multiple intelligences. Information processing theorists consider that learning occurs as information passes through short-term memory to long-term memory. Such theorists believe in scaffolded learning, by which students move from low to high, from easy to difficult.

Conditions of Learning

The teacher should consider conditions of learning as he/she leads efforts for all children to learn. Gagné (1964) considered the objectives of learning when he indicated it was possible to divide objectives into categories that differ in their implications for learning. To do this, teachers must put together a selected set of learning conditions on the one hand and an abstracted set of characteristics of learner tasks on the other. The objective is to distinguish not the tasks themselves (which are infinitely variable), but the inferred behaviors that presumably require different conditions of learning.

Gagné presented eight learning-outcome categories that are a blending of behavioral psychology and cognitive theory; the first four are related to behavioral psychology and the last four to cognitive psychological theory. His categories are hierarchical in the sense that having any one capability usually depends on the previous learning of some other, simpler one. Thus, his two top categories of problem solving and strategy require the pre-learning successively of principles, concepts, associations, chains, identifications, and responses. Gagné's eight categories of conditions of learning follow.

Response Learning

A very basic form of behavior is called response learning, or it is sometimes given other names, such as echoic behavior. The individual learns to respond to a stimulus that is essentially the same as that produced by the response itself. For example, the child learns that fire burns and responds accordingly by withdrawing his hand from the heat.

Identification Learning

In this form of behavior, the individual acquires the capability of making different responses to several different stimuli. Of course, she does this when she identifies letters of the alphabet, colors, numerals, late-model cars, or any of a great variety of specific stimuli.

Chains or Sequences

Long chains of responses can most readily be identified in motor activities of various sorts. But many kinds of short sequences are very important to the individual's performance. One of the most prominent is a chain of two activities, the first of which is an observing response. If a teacher is concerned, for example, with getting a student to put the numeral 18 in the numerator, this activity has two main parts: First, finding the location of the numerator (an observing response); and second writing in that place the numeral 18. In establishing such behavior as part of larger and more complex performances like simplifying fractions or figuring percentages, the teacher has to see that the student has learned such a chain or sequence.

Associations

For many years, psychologists appeared to be considering this category the most basic form of learning, but such is no longer the case. It is now fairly generally agreed, and supported by a good deal of research, that the learning of associations involves more than a stimulus-response (S-R) connection. Instead, an association is perhaps the best considered as a three-step chain, containing in order: first, an observing response that distinguishes the stimulus; second, a coding response that usually is an implicit response that is to be expected as the outcome of the association.

Concepts

A concept is acquired when a set of objects or events differing in physical appearance is identified as a class. The class names for common objects like houses, chairs, and hats are more familiar examples. If one can assume these more basic forms as having been acquired, then the procedure of concept learning is fairly simple. It consists mainly in establishing associations in which the variety of specific stimuli that make up the class to be acquired are represented.

Principles

The next, more complex, form of learning pertains to the acquisition of principles. In their basic form, principles can be considered as a chain of concepts of the form "if A, then B," and the like. Again, it is evident that the important set of conditions necessary for principle learning is previous learning, this time of the concepts that make up the principle. It is assumed either that the learner already knows the concepts liquid, gas, and heating, in acquiring the principle, or that these concepts must first be learned. But when it can truly be assumed that concept learning has previously been completed, the conditions for principle learning become clear. The proposed chain of events is presented by means of particular objects representing the concept making up the chain.

Problem Solving

Problem solving is a kind of learning through which principles are put together in chains to form what may be called higher-order principles. Typically, the higher-order principles are induced from sets of events presented to the learner in instruction. If carried out properly, these become the generalizations that enable the student to think about an ever-broadening set of new problems.

Strategies

Are there forms of behavior that are more complex than principles, or more complex than the higher-order principles acquired in problem solving? Some authors seem to imply that another form of learned organization is evident in the strategies with

which an individual approaches a problem. There can be little doubt as to the existence of such strategies in problem solving. It may be that strategies are mediating principles that do not appear directly in performance of the task given to the individual, but that they may nevertheless affect the speed or excellence of that performance. But it is possible to conceive of strategies as being principles in their fundamental nature, and of being made up of chains of concepts (Gagné, 1985).

Structure of Intellect

For many years, there has been a tendency to think of the intellect as a generalized entity that functions on a generalized level in all situations. In contrast, J.P. Guilford (1967) identified three primary mental abilities broken down into 120 intellectual factors that may be considered necessary to perform well on a particular task. These primary mental abilities are depicted in Figure 1.

In his *structure of intellect* model, Guilford classified and organized the primary mental abilities according to (a) contents of type of information dealt with, (b) the operations to be performed on the formation, and (c) the products resulting from processing of the information. Instructionally, Guilford's second classification is probably most useful from the standpoint of principals sharing with teachers, because operations performed on the information refer directly to the major kinds of intellectual processes. The intellectual processes (operations) follow.

Cognition

Intellectual abilities concerned with the discovery or rediscovery of information; these abilities include comprehension and understanding.

Memory

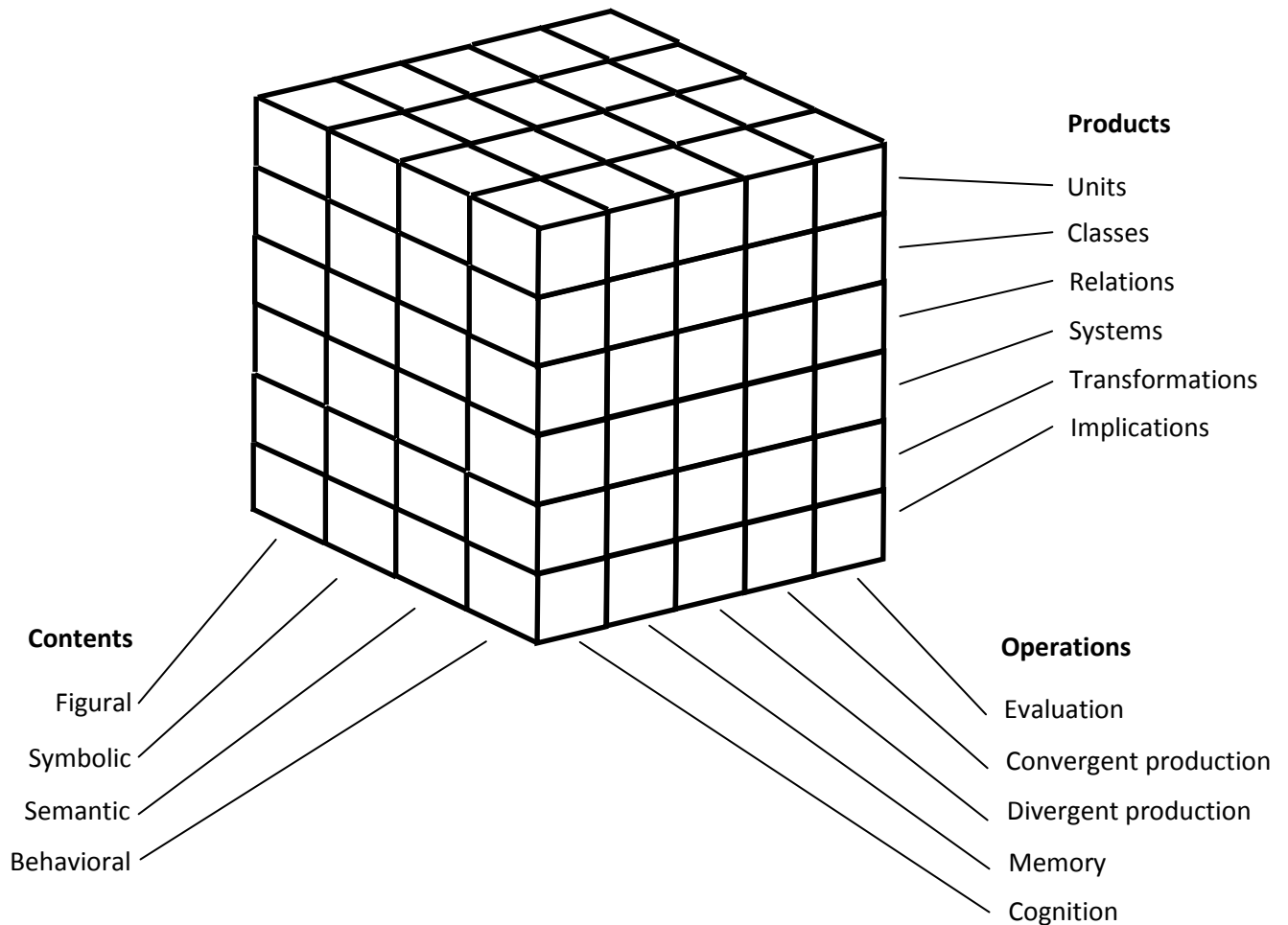Intellectual abilities associated with the retention or storage of information cognized.

Figure 1. Structure of intellect model.

Divergent Thinking

Intellectual abilities related to the generation of new information from known information, with the emphasis on variety and quantity of information. In this case, thinking goes in varying directions, with no real "right" answer being sought.

Convergent Thinking.

Intellectual abilities related to the generation of new information that leads to the right or conventionally accepted answer. In this case, the given or known information usually determines the correct response.

Evaluation

Intellectual abilities related to the intellectual process by which judgments and decisions are made regarding the goodness, correctness, adequacy, or suitability of

information, based on some criterion of consistency or goal satisfaction that resulted from productive thinking.

Guilford's thinking abilities (operations) can be thought of in terms of both their products (units, classes, relations, systems, transformations, and implications) and their content (behavioral, semantic, symbolic, or figural). A major shortcoming in much curriculum planning and instruction is that too much attention is directed toward the products of thinking and not enough to the operations and contents as indicated in the Guilford model. The deficiency needs to be corrected if the precision in planning instructional strategies is to result in predictable behavior changes in students who are exposed to purposeful teaching.

Note in Guilford's model that each of the intellectual processes (operations) is used to deal with processing products in various contents. For instance, students can be taught to comprehend units, classes, relations, systems, transformations, and implications in different content (behavioral, semantic, symbolic, or figural mediums). In the case of comprehending units (segregated items of information that have a single character), the teacher is primarily concerned with information items or facts. The comprehension of units involves the recognition of visual, auditory, and even emotional units. With respect to instruction, this involves recognizing word structure and knowing the meanings of words in a variety of contexts.

The comprehension of classes (sets of items of information that are grouped by common properties) involves classifying groups of objects or ideas according to a prescribed criterion. At this point, the teacher is concerned with the process of concept formation as discussed previously by Gagné (1985). At this point, students are in the most critical phase of instructional activity: If students do not learn how to deal intellectually with units and classes, they will be unable to deal effectively with the remaining products (relations, systems, transformations, and implications) depicted in the Guilford model. This appears to be one of the most important keys to ensuring instructional effectiveness and developing basic understanding in pupils at all levels of instruction.

The comprehension of relations (connections between the units of information based on certain points of contact that are applicable to them) involves helping students to discover relationships that exist among objects, symbols, or conceptual material when arranged according to some pattern.

The comprehension of systems (organized complexities of interrelated or interacting items of information) involves the abilities to structurally arrange objects in a given space; to discover patterns or systems among figural, symbolic, semantic, or behavioral elements; and to cognize or structure a problem preparatory to solving it. The comprehension of systems is more involved than the activity suggested in being able to see simple relationships, for it has to do with the organized total of a given structure. Frequently, this involves several simple relationships, fitted together in a conceptual structure that forms the system under consideration.

The comprehension of transformations (changes in existing, known information or in the actual use of information) involves the ability to form a mental image of patterns that would be possible if objects were rearranged in some way. An example is when a

player creates a mental projection of a chessboard through several moves. Another ability required in the comprehension of transformations is predictive manipulation of available data to suggest a solution to a future problem. If students are to be taught to deal intellectually with transformations, they must be instructed in the processing of data, the detection of trends, and the development of strategies for theoretical formulation of plausible solutions to problems gleaned from the interpretation of selected data and trends.

The comprehension of implications (extrapolations of information, which can take the form of expectancies, predictions, concomitants, or consequences) involves attempts to plan or predict outcomes that might result from present conditions. In order to deal with implications, students must be taught to select the most effective solution to a problem from among a number of alternatives, to validate the process, and to anticipate the likely consequences given a particular situation and a certain arrangement of events (Ornstein & Hunkins, 2012).

Knowledge of Guilford's primary mental abilities is potentially useful in analyzing the kinds of instructional activities practiced and planned. In reflecting on classroom activities, a teacher can determine whether balanced intellectual development is being encouraged. In analyzing curriculum guides and textbooks, a teacher can discover whether balanced intellectual development is an objective, and if it is planned adequately. Of course, this does not imply that intellectual factors should be sought in every teaching unit or daily lesson plan. Nevertheless, awareness of the factors should enable a teacher, formally or informally, to analyze curriculum planning and practice.

The teaching of higher-level thinking skills is a topic that appeals to most teachers. These skills include comprehension of text, scientific processes, and problem solving. Although much has been written about the need for students to perform higher-level thinking operations in all subject areas, the teaching of these operations often fails because the instruction is inadequate.

Stages of Moral Development

Numerous efforts have been made to examine systematically moral behavior as a development process. Kohlberg (1987), a Harvard psychologist, developed a typological scheme describing general structures of moral thought. It is a cognitive-development theory that proceeds through a series of qualitatively distinct stages. In this regard, Kohlberg postulated that the sequence of stages is invariant and that each stage represents a reorganization and displacement of preceding stages. He believed that cognitive conflict is the central condition for reorganization. Kohlberg's stages are not strictly linked to ages and extend into the late twenties. However, according to Kohlberg, many people never reach the highest stages of moral development.

Kohlberg identified three distinct levels of moral thinking. Within each level there are two stages, thus making a total of six stages that may be considered as separate moral philosophies (Kohlberg & Likona, 1986).

Preconventional Level

Although Kohlberg's scheme is not strictly linked to ages, the individual at the preconventional level is typically a preadolescent. To a person at this level, moral value resides in externally imposed cultural rules and labels of good and bad or right and wrong. Thus the individual interprets moral value in terms of physical or hedonistic consequences of action, such as punishment, reward, and exchange of favors; or in terms of the physical power of those who enunciate the rules. The stage 1 individual embraces an *obedience-punishment* orientation; that is, the person has an egocentric deference to superior power and authority, or a trouble-avoiding set. The stage 2 individual has a *naively egotistic orientation*. This individual believes that right action is that which instrumentally satisfies the self's need and occasionally the needs of others. Naïve egalitarianism and orientation to exchange and reciprocity along the lines of "you scratch my back and I'll scratch yours" are representative of such a focus.

Conventional Level

Chronologically, the individual at the conventional level is an adolescent. To a person at this level, moral value resides in good or right roles, in maintaining and conforming to the conventional order and the expectations of others. The stage 3 individual embraces in the good boy-nice girl vein. Thus, the person has an orientation to approval and pleasing and helping others. Conformity to stereotypical images of majority behavior and approval by being "nice" are typical manifestations. The stage 4 individual has an authority and social-order orientation. Orientation to authority, fixed rules, "doing duty," and maintaining the social order for its own sake are representative behaviors.

Postconventional Level

The individual at the postconventional level is of adult age; however, Kohlberg believe that less than 20% of adult society act at the principal level, as it is also called. To a person at this level, moral values and principles are validated and applied apart from authority or conformity to group membership, though these values and principles are seen as shareable. The stage 5 individual embraces a contractual-legalistic orientation. Thus, the person has an awareness of the relativism of personal values and opinions and a corresponding emphasis on procedural rules for reaching consensus. Duty defined in terms of contract, general avoidance, of violation of the will or rights of others, and majority will and welfare are manifestations of such an orientation. The stage 6 individual has a conscience or principle orientation. Orientation to principles of choice involving appeal to logical universality and consistency, and to mutual respect and trust with conscience as a directing agent, are representative of such a focus.

Many contemporary educators view morality as something beyond intelligence. Such a perspective creates a schism between the two. Is not an intelligent person a moral being? Dewey pointed out that if subject matter is treated merely as knowledge acquisition, then is has only limited technical worth, but when subject matter is engaged

in "under conditions where its social significance is realized, it feeds moral interests and develops moral insights" (Dewey, 1916, p. 414)

Some researchers have found an association between moral reasoning and measured intelligence. However, Kohlberg asserted that although a person has to be cognitively mature to reason morally, he or she can be intelligent and never reason morally. He connects moral growth with social development, especially in relation to the amount of opportunity for the role taking (Colby, Kohlberg, & DeVries, 1987).

Kohlberg's findings suggest implications for teaching. The social life of school and classrooms provides numerous opportunities for moral learning, especially if educators deliberately structure programs that facilitate movement from one developmental stage to another. Moral development demands an intimate knowledge of the individual and a program that involves discussion and problem solving (Kohlberg, 1989).

Gilligan (1982) examined the limitations of several theories, especially Kohlberg's stages of moral development, and concluded that developmental theory has not given adequate attention to the concerns and experience of women. Through a review of the literature and from her own research, she derived an alternative sequence for the development of women's moral judgments. She argued for an expanded conception of adulthood that would result from an integration of the "feminine voice" into developmental theory.

In her book, *In a Different Voice*, Gilligan (1982) challenged the notion that moral development is the same for girls and boys. For boys, the higher stages of moral development recognize notions of the rights of individuals; girls tend to view issues in terms of care, responsibility, and relationships. She pinpointed adolescence as a critical time in women's lives. By incorporating gender differences into their work, which Gilligan suggested, teachers can more effectively address adolescent development, prevent psychological suffering, and strengthen women's voices in the world.

Multiple Intelligences

Gardner (1983, 1993, 1999a), like Guildford, contended that a variety of mental operations are associated with intelligence. First, he stated that the theory is an account of human cognition in its fullness. He promoted the intelligences as a new definition of cognitive human nature. He said there are many different types of intelligences, although the society tends to focus on verbal or linguistic factors. He has described human beings as organisms who possess a basic set of seven, eight or a dozen intelligences (Gardner, 1999a).

Gardner (1983) proposed seven relatively independent forms of competence: linguistic, logical-mathematical, spatial, musical, bodily-kinesthetic, interpersonal, and intrapersonal. He later added an eighth intelligence, the naturalist (Gardner, 1999a). Although Robert Sternberg (1985, 1994, 1996) and John White (1998) noted the lack of empirical support for the theory, Gardner's theory has been widely received by educators and provides a useful framework for understanding the basic skill level of all people as well as the unique strengths of individuals. Gardner argues that an individual's

uniqueness and cognitive competence are based on a combination of the multiple intelligences.

Linguistic Intelligence

Linguistic intelligence involves sensitivity to spoken and written language, the ability to learn languages, and the capacity to use language to accomplish certain goals. This intelligence includes the ability to effectively use language to express oneself rhetorically or poetically; and language as a means to remember information. Poets, writers, orators, speakers, lawyers, or persons for whom language is a strong part of their livelihood demonstrate linguistic intelligence.

Logical-Mathematical Intelligence

Logical-mathematical intelligence consists of the capacity to analyze problems logically, carry out mathematical operations, and investigate issues scientifically. In Howard Gardner's words it entails the ability to detect patterns, reason deductively and think logically. This intelligence is most often associated with scientific and mathematical thinking

Spatial Intelligence

Spatial intelligence is the ability to represent the spatial world mentally, as when a sailor or pilot navigates large space or when a painter, a sculptor, or an architect envisions a design.

Bodily-Kinesthetic Intelligence

Bodily-kinesthetic intelligence is the capacity to use one's whole body or parts of the body to solve problems, make something, or perform. It is the ability to use mental abilities to coordinate bodily movements. This intelligence is seen in people who are athletic or who are in the performing arts in dance and theater.

Musical Intelligence

Musical intelligence involves skill in the performance, composition, and appreciation of musical patterns. It encompasses the capacity to recognize and compose musical pitches, tones, and rhythms. According to Howard Gardner, musical intelligence runs in an almost structural parallel to linguistic intelligence.

Interpersonal Intelligence

Interpersonal intelligence is concerned with the capacity to understand the intentions, motivations, and desires of other people. It allows people to work effectively with others. Educators, salespeople, religious and political leaders, and counselors all need a well-developed interpersonal intelligence.

Intrapersonal Intelligence

Intrapersonal intelligence is having an understanding of yourself; knowing who you are, what you can do, what you want, when you need help, how you respond to events, what to avoid, and what to do. In Howard Gardner's view, it involves having an effective working model of ourselves, and to be able to use such information to regulate our lives.

Naturalist Intelligence

Naturalist intelligence designates the human ability to differentiate among living things (plants, animals) as well as to demonstrate sensitivity to the natural world (clouds, rock configurations) as seen in farmers, botanists, chefs, or meteorologists. The type of pattern recognition ability respected in some of the sciences may also relate to naturalist intelligence (Gardner, 1999a).

Since Gardner's original listing of the multiple intelligences in *Frames of Mind* (1983) and the inclusion of naturalist intelligence in *Intelligence Reframed* (1999a), two additional intelligences have been discussed as possible candidates for inclusion: existential intelligence and moral intelligence. Gardner argues that existential intelligence scores well on the criteria. However, empirical evidence is sparse.

As to the inclusion of moral intelligence to the list of multiple intelligences, he asks whether it is possible to delineate the "moral domain." Gardner suggests that it is difficult to come to any consensual definition of moral intelligence. Furthermore, he argues that researchers and writers have not yet captured the essence of the moral domain as an instance of human intelligence; therefore, he has not added it to the list of eight multiple intelligences, but that it is possible to come to an understanding that may take exploration forward in the future.

The Appeal of Multiple Intelligences to Educators

Howard Gardner's theory of multiple intelligences has not been readily accepted within academic psychology. However, it has received strong support from the education community. It has been embraced by a number of educational theorists and applied by teachers and policymakers to the problems of schooling. A number of schools have structured their curricula according to Gardner's theory of multiple intelligences. The theory can also be found in use within pre-school, higher education, and vocational and adult education programs.

According to Howard Gardner, eight kinds of intelligence would allow eight ways to teach, rather than one. And powerful constraints that exist in the mind can be mobilized to introduce a particular concept (or whole system of thinking) in a way that children are most likely to learn it and least likely to distort it. Paradoxically, constraints can be suggestive and ultimately freeing.

Mindy Kornhaber (2001), a researcher and colleague involved in Gardner's Project Zero, has identified a number of reasons why teachers and policymakers in North America have responded positively to Howard Gardner's presentation of multiple intelligences. Among these are:

> ... the theory validates educators' everyday experience: students think and learn in many different ways. It also provides educators with a conceptual framework for organizing and reflecting on curriculum assessment and pedagogical practices. In turn, this reflection has led many educators to develop new approaches that might better meet the needs of the range of learners in their classrooms. (p. 276)

Despite the criticisms of the formulation, it does provide a useful set of questions and "rules of thumb" to help educators think about their practice. The way in which Howard Gardner's theory of multiple intelligences has been translated into policy and practice has varied. Howard Gardner did not, initially, spell out the implications of his theory for educators in any detail. Subsequently, he has looked more closely at what the theory might mean for schooling practice [e.g., in *The Unschooled Mind* (1991), *Intelligence Reframed* (1999a), and *The Disciplined Mind* (1999b)]. From this work, one significant aspect of Gardner's thinking needs to be noted here as it provides an alternative way of thinking, for those educators who wish to look beyond the current, dominant product orientation of skilling, curriculum, and testing. The approach entails a broad vision of education. All eight intelligences are needed to live life well. Teachers, therefore, need to attend to all intelligences, not just the first two (linguistic and logical-mathematical intelligences) that have been their traditional concern.

Conclusion

In this article, I examined four information processing theories that may assist teachers with their instructional planning: Gagné's conditions of learning, J.P. Guilford's structure of intellect, Lawrence Kohlberg's stages of moral development, and Howard Gardner's theory of multiple intelligences. Information processing theorists consider that learning occurs as information passes through short-term memory to long-term memory. The first three theorists believe in scaffolded learning, by which students move from low to high, from easy to difficult. Like Guilford, Gardner contends that a variety of mental operations are associated with intelligence.

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