DOCUMENT RESUME

ED 342 779 TM 017 134

AUTHOR Voss, James F.; Schauble, Leona
TITLE Is Interest Educationally Interesting? An Interest-Related Model of Learning.
SPONS AGENCY Andrew W. Mellon Foundation, New York, N.Y.; Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE 91
NOTE 35p.
PUB TYPE Viewpoints (Opinion/Position Papers, Essays, etc.) (120) -- Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Beliefs; Educational Research; Elementary Secondary Education; Feedback; Higher Education; Interest Research; *Interests; Knowledge Level; *Learning Processes; Learning Theories; Models; *Motivation; *Objectives; Student Interests; *Values

ABSTRACT

Interest is examined in relation to its role in the learning process. A broadly based model of learning is presented, and implications of the model for the educational context are considered. In the framework presented, learning involves the perception, interpretation, and storage of information about the environment under particular motivational conditions that are generated by goals and interests. Acquired knowledge and beliefs are then used to accomplish goals and fulfill interests. Knowledge and beliefs influence the perception and interpretation of new information, which may include feedback indicating whether goals are being achieved. Information from the environment may lead to revisions of goals and interests, which provide motivational conditions for additional perception, interpretation, and learning. Interest is described as following and deriving from values, and in turn, generating the goals that motivate and direct processing. What is learned and what goals and interests a person develops are fundamentally an issue of value. A 42-item list of references and one flowchart illustrating a general model of learning are included. (SLD)

Is Interest Educationally Interesting?

An Interest-Related Model of Learning[1]

James F. Voss and Leona Schauble

University of Pittsburgh

The title of this chapter poses a question, one that most people would probably answer in the affirmative. Yet, despite the presumed facilitating effect of interest, research since Dewey's (1913) treatise on the topic has been concerned largely with the difficult problem of how interest is related to other concepts such as emotion (cf. Izard, 1977; Piaget, 1981), while the question of how interest is related to learning has received only infrequent study (e.g., Renninger, 1989).

The position taken in the present chapter is that interest indeed has the potential to be educationally interesting, but to show why this is the case, one cannot simply consider interest per se. Instead, interest must be examined in relation to its role in the learning process. Similarly, we believe that to develop an understanding of the learning process, learning must be viewed in the context of the individual's overall mental functioning. Therefore, the initial section of this chapter presents a broadly based model of learning, including consideration of the role of interest. In the subsequent section we consider the implications of the model for the educational context.

The Nature of Learning

The Fragmentation of Mental Functioning in Psychology

General theories of psychology have typically had one of three foci, motivation, perception, or learning. Moreover, a theory having one of these foci typically has been thought to be weak with regard to the other two. Motivational theories have viewed an individual's behavior in relation to needs and motives that produce goal-directed action. Learning therefore is considered to be a function of motivation, but usually little is said about the mechanisms by which learning takes place. Perceptual approaches, such as Gestalt theory (e.g., Koffka, 1935), have emphasized that how one perceives, interprets, and mentally organizes the environment is critical to what one does. In this case learning tends to be viewed as the acquisition of perceptual relations. These, in turn, are stored in memory and utilized in subsequent perceptual experiences. However, as with motivational approaches, perceptual theories usually have had little to say about the mechanisms of learning.

Learning theory, derived in large part from the writings of Aristotle, the British empiricists, and the Soviet reflexology tradition of Sechenov (1863/1965) and Pavlov (1927), has generally held that learning consists of the acquisition of associations. While Hullian theory (e.g., Hull, 1943) attempted to relate learning to motivation, the study of how motivation influences human learning has, until recently, consisted largely of isolated studies investigating how particular motivational variables influence learning. However, in recent years, some research (e.g., Dweck, 1986) has addressed how motivational activities, such as goal-setting, influence student performance. With respect to perception, learning theory has had to address the idea that the organism, as an active processor of information, could select and elaborate upon the stimulus input, thus demonstrating that how input was perceived was directly related to what was learned (cf. Voss, 1979).

In recent decades, psychology has been dominated by the cognitive movement, an approach having its origins more in relation to perception than to motivation or learning, as shown, for example, by the central role played by representation in cognitive theory, that is, how the individual represents or builds models of the environment. With respect to the study of learning, while cognitive psychology has made substantial theoretical contributions, a theory of learning has not been one of them. There has been considerable research on skill acquisition (e.g., Anderson, 1982), and a number of the concepts that have been employed in this work, such as spreading activation, are associative and come from classical learning theory. Similarly, general modeling approaches such as connectionism and neural nets have associative roots. However, a cognitive theory of learning involving such topics as knowledge acquisition has not been forthcoming. Cognitive research has nevertheless demonstrated how particular factors affect the learning process, especially showing the importance of prior knowledge in the acquisition of new knowledge (e.g., Spilich, Vesonder, Chiesi, & Voss, 1979). Indeed, much of the current research on subject matter learning conducted within the cognitive framework is concerned with how the knowledge and skills a student brings into the learning situation influence learning or how such knowledge becomes restructured in the process of learning. This perspective implies that learning is basically a process of transfer, in the sense that to understand how learning takes place it is necessary to determine how prior knowledge and skills facilitate or perhaps retard learning (cf. Voss, 1978).

The general theoretical traditions in psychology have thus tended toward fragmentation of the perceptual, motivational, and learning components of mental functioning. We assume, however, that to understand the learning process we must take motivation and perceptual factors into account, for we regard them as not only germane to the learning process, but as part of that process. The human functions holistically, and the delineation of concepts such as learning, motivation, and perception is somewhat arbitrary, albeit necessary for the purpose of analysis. But in performing the conceptual dissection, it is important not to lose sight of the coordinated nature of mental functioning.

A Functionalist Framework of Learning

Staying within the general functionalist tradition (e.g., Carr, 1925; Dewey, 1896), we assume that individuals are in continual interaction with their environment, and that within this context, the primary purpose of learning, broadly conceived, is to facilitate the organism's adaptation to the environment, including not only physical and biological factors but also social-cultural components. Moreover, during the course of development, the individual is assumed to become increasingly equipped with value-related and intellectually-related mental structures. Value-based "equipment" develops as the individual acquires the norms and principles of the sociocultural milieu in which he or she is raised, the individual differentially applying such norms to his or her own situation. Beliefs are also established, and such values and beliefs are assumed to play a major role in the establishment of goals. These goals may include moral goals, such as maintaining integrity, career goals, and social goals. Particular values and the related goals also include affect. As the person learns more about the environment, interests are developed and goals may be established that are aimed at satisfying the interests. Correspondingly, interests may be established in satisfying one's goals. These interests and goals are thus based upon the respective values and beliefs, as well as affect.

The individual's goals and interests thus produce motivation, that is, a person is directed toward a particular activity which is aimed at accomplishing goals and/or exploring an interest (cf. Bolles, 1975). Motivation thus has two functions, one qualitative and the other quantitative. Qualitatively, motivation directs the individual toward selecting activities that will accomplish goals and/or satisfy interests. Quantitatively, motivation serves an energizing function, providing the effort and persistence needed to accomplish a goal or pursue an interest (Atkinson & Wickens, 1971). An interest in baseball may establish the goal of going to a game, and, if the Cubs lose, one may go to games repeatedly, until the Cubs finally win.

But if the individual had only values, beliefs, goals, and interests, and the motivation engendered by them, the likelihood of survival or success in dealing with the environment would be minimal. The individual needs intellectual "equipment." The individual builds models of the environment (Johnson-Laird, 1983), including event contingencies, and scripts (Schar'' & Abelson, 1977), which are sequential, and categorical relationships, schema, and mental maps are also constructed. Models may be hierarchical (Spilich, Vesonder, Chiesi, & Voss, 1979), procedural (Ryle, 1949), or may consist of topic-centered information. For example, a person may have an "abortion" model containing knowledge about the political, moral, physical, interpersonal, affective, and possibly experiential components of abortion, as well as a representation of one's own beliefs about abortion and affect related to it.

An important function of models is that they not only provide for an understanding of the environment, they also serve as a resource to consult in satisfying goals and interests. The use of intellectual "equipment" as a resource occurs in a number of ways. The resources enable the individual to interpret incoming information, and they help to provide the means by which goals and interests can be satisfied, constituting a major component of the problem solving process. Furthermore, when a given goal cannot be satisfied, perhaps because of an environmental constraint, the individual may be able to adapt by using some other means derived from models. This view is essentially taken from Selz (deGroot, 1983; Selz, 1922), who maintained that cognitive and motivational factors exist within a given subsystem, and that the failure of one subsystem to yield a problem solution leads to a search for another subsystem likely to lead to the goal. The motivational and cognitive components are thus closely integrated.

While mental models serve as a resource in problem solving, they also are modified and developed in the process of solving a problem. Individuals engaged in problem solving also learn about ways of solving the problem, and those means are stored for future use. Indeed, the building of mental representations can, in its own right, become a goal or interest. Individuals may want to learn for the sake of learning, although typically learning is related to a more particular goal or interest.

A basic assumption about mental functioning within the adaptive framework is that when they process input information, people interpret and provide meaning to it. Furthermore, the meaning is generated by what the individuals know and feel about the events; that is, interpretations are based not only upon the individual's knowledge, but upon beliefs and values, goals and interests. Since the interpretations or representations are the product of the processing, it is interpretations that are acquired, that is, an integration of environmental stimuli and the meaning provided.

How one's knowledge influences interpretation is reasonably straightforward. Having relatively little knowledge about a situation severely constrains how it can be interpreted. For example, in a recent study of novices' models of electric circuits (Schauble, Glaser, Raghavan, & Reiner, in press b), undergraduates were confronted with eight small metal boxes, each containing a hidden piece of electrical equipment. Subjects knew that the boxes contained batteries, resistors, plain wire, and in one case, nothing at all, but they did not know what was in each box. The task was to try to figure out what was in each box by plugging them, singly or in combinations, into a simple circuit containing a lightbulb. In this study, subjects approached the task in four qualitatively different kinds of ways, each characterized by a different kind of knowledge or belief about the kinds of entities involved in the task and their interrelationships. For example, the simplest model specified that there were only two classes of components within the boxes, those that "worked" (that is, lit the bulb when plugged into the circuit), and those that did not "work." Students holding this model had no way to distinguish among the five boxes that did not contain batteries (and that thus did not "work" when plugged alone into the circuit). They typically made decisions about what was inside these boxes by guessing, shaking them, or hefting them in their hands. In contrast, the most knowledgable students understood that all the resistors, the plain wire, the empty box, and even the lightbulb itself had the property of resistance. Therefore, they understood that the only way to identify them was to plug them into test circuits in combination with one or more boxes previously identified as containing batteries. Furthermore, they knew that although these components had different names, they could all be distinguished on the basis of changes in the brightness of the bulb. Clearly, for these subjects, "understanding" involved not only accessing relevant knowledge about electrical circuits and components, but also appropriately applying this knowledge to the task at hand. Although this task posed a well-formed problem with a correct solution, we do not intend to imply by offering this example that individuals with a high level of knowledge will always agree. It is important to note that knowledge does not guarantee agreement, especially in domains of social sciences and humanities, or in the frontier research areas of the physical and life sciences.

Not only knowledge and beliefs, but also affect can constrain processing. As an example, assume that an American-Japanese trade agreement has just been concluded that will likely lead to the sale of more Japanese-made automobiles in the United States. An American auto worker may have little knowledge of the economics involved but nevertheless have considerable interest because the agreement could affect him and his job. This apprehension could generate negative affect about the agreement and about the Japanese in general, even though the individual is making essentially no effort to understand the agreement.

In addition to knowledge and affect, motivation can influence processing and learning. The powerful role of motivation in learning can be demonstrated by examples from out-of-school learning. Carraher, Carraher, and Schliemann (1985), and Schliemann and Acioly (1989) have shown that unschooled individuals can do extremely well in performing complex arithmetic operations such as selling lottery tickets. This is a testament to the ability of individuals to learn when it becomes essentially a matter of necessity, that is, when one's values, like eating and having shelter, dictate goals. Interestingly, Carraher et al. (1985) also found that unschooled individuals tend to show less flexibility in problem solving than schooled, because they apparently rely more on computational rules and thus experience difficulty when a rule does not directly apply. In related work, Hatano and Inagaki (1987) have argued that differences in level of comprehension, (deeper understanding versus more superficial comprehension) may be attributed to differences in motivation, and that those with a deep comprehension are more able to adapt to circumstances, see, and even explore different facets of the issue at hand. Moreover, the motivation Hatano and Inagaki (1987) are referring to may be regarded as interest-generated, for it is when someone has a strong interest in a subject that he or she is most likely to find out how something works or find out more about it.

Thus far we have described, in quite general terms, a theoretical framework for learning, summarized in Figure 1. In this framework, learning involves the

---

Insert Figure 1

---

perception, interpretation, and storage of information about the environment under particular motivational conditions that are generated by goals and/or interests. The acquired knowledge and beliefs are then subsequently utilized to accomplish goals and to fulfill interests. In addition, knowledge and beliefs influence the perception and interpretation of new information. This new information may include feedback indicating whether goals are being achieved. In some circumstances, information from the environment may lead to the revision of goals and interests, which in turn provide the motivational conditions for additional perception, interpretation, and learning. Thus, both value-based and intellectual "equipment" affect how individuals perceive and learn from the world. In turn, when learning occurs from observation of or interaction with the environment, both forms of equipment may be modified. We now consider some mechanisms of learning.

Some Mechanisms of Learning

Attention and concentration. It is assumed that processing is related to attention. The environment is filled with stimulation, and the individual attends only to a small portion of it at any given time. But selection is not random; the individual attends to what is personally salient. Attention is selective, and selection is based upon goals and interests. Because of their relationships to particular goals, stimuli can alert the individual so that events of potential salience receive special attention, for example, the "cocktail-party effect" (Cherry, 1953), in which the individual is sensitized to hearing his or her own name. However, much of what an individual attends to is under voluntary control, as in reading a book or watching a television program. These acts are related, of course, to one's interests and goals, because the individual selects what will be attended to, although attention may be overridden by a stimulus perceived as more salient. Absorption in a movie, for example, may give way to the smell of smoke.

Attention is also guided by expectations or predictions about what is going to happen in the environment, based upon one's models of contingent events, such as that when a stoplight turns red, cars will usually stop. Expectations can also be general, such as anticipating a topic of conversation without having specific predictions regarding what will be said. Both general and specific expectations thus direct attention, while the individual works to confirm or disconfirm them. Indeed, Schank (1979) emphasizes the discrepancy of an expectation and the actual event as being a source of interest. Expectations, of course, have both benefits and costs. The primary benefit is that they facilitate processing. The primary costs are that expectations may produce bias or distorted interpretations, and that unexpected events may not be observed (Bruner, 1957).

More intense attention may be referred to as concentration, which usually involves mental effort exerted upon something relatively specific. One "concentrates" upon hitting a baseball or upon solving a problem. Similarly, when we say a person is not concentrating, we mean that a performance deficit exists due to the person's not "paying enough attention" to the issue at hand. Concentration is thus regarded as a facilitating factor in learning and performance.

Two related processes are assumed to be basic to attention and concentration: excitation and inhibition. Greater attending and/or greater concentrating activate representations in memory that are related to the input issue and its context. Excitation plays a major role in the direction of the activation established and in relating the new input to the existing knowledge, beliefs, affect, interests, and goals. The excitation process does not necessarily expand the number of interpretations, but may result in exploring one interpretation in greater depth or in building a stronger relationship.

Possibly the most important realization in recent decades about the role of associations in learning is that the links are labelled; that is, associations are not mere connections but relationships, an idea largely attributable to Selz (1922). Thus, the strength of the relationships between elements is not simply a function of the frequency of their contiguous occurrence (although it may be) but of the nature of their relationship. In the present context, excitation is assumed to establish these relationships, with greater excitation serving to direct and to strengthen them.

It is furthermore assumed that attending or concentrating produces inhibition of information that is related to what is being processed but not relevant to the on-going interpretation. The role of inhibition may be illustrated by the observation that when reading a novel, the individual constructs a representation of the plot that is generally directly related to what was read. However, he or she is apparently able to inhibit associations of the plot or characters, and does not go off mentally in all directions. Instead, constraints are enforced. Similarly, when given the digits "2" and "3" and told to "add," a person does not say "-1" or "6." This capacity to construct the appropriate representation and inhibit others is a rather profound capability, and it certainly facilitates learning, for if the associates of given concepts were highly activated, they would quite likely produce a great deal of interference in learning. Thus, via inhibition, concentration enables one to keep the mental interference to a minimum; the "noise" is kept out of the way, a process parallel to focussing attention on a particular object and interpreting it (excitation) while at the same time disregarding other environmental events. But it also is true that just as attention can be shifted when an event of high salience occurs in the environment, so can concentration be broken and shifted to a different topic.

Of considerable importance is the idea that excitation and inhibition are also related to motivation. Just as motivation influences attention in the selection of environmental information, so motivation influences concentration in the search and selection of the information in memory that provides an interpretation of that information. Furthermore, greater motivation is assumed to produce a more developed representation, deepening the interpretation and increasing the inhibition of potentially interfering information. Thus, learning is a by-product of processing because the excitation-inhibition processes provide for integration of the new information with what is already known, and the excitation-inhibition processes are a function of knowledge, beliefs, values, affect, interests, and goals. But learning is not always efficient. Indeed, it rarely is so, and in the context of the present model, ineffective learning is produced by ineffective processing. A brief discussion of factors that may produce ineffective processing follows.

Factors Producing Ineffective Processing

Knowledge, beliefs, and affect. How these factors constrain interpretation has already been indicated. One cannot develop an appropriate interpretation when one does not have the knowledge or beliefs that relate to the input. It is possible, however, for individuals to construct an interpretation based primarily upon input information, especially if they are novices (cf. Finicher-Kiefer, Post, Greene, & Voss, 1988). The resulting interpretation is generally inferior to that of more knowledgable individuals. Beliefs can also influence processing by yielding an interpretation based upon the individual's perspective. Such processing may not be ineffective, but it may restrict alternative interpretations. Again, affect can have a similar effect.

Motivation: Values, interests, and goals. It has been noted that these factors direct processing and influence the amount of processing. When they are maximally related to the task at hand so that motivation is substantial ("on task"), learning may be effective even though it is constrained by knowledge, beliefs, and affect. However, motivation that is not relevant to the task at hand can lead to ineffective processing. In the classroom, for example, poor motivation and subsequent poor processing can result from lack of interest in schoolwork or lack of learning goals, each of which may also involve negative affect pertaining to the teacher and/or classroom environment. The lack of a relevant interest or goal may even be due to a failure to value a school-based education.

Distraction. Motivation can produce distraction, if goals other than those required for the task at hand produce a breakdown in the inhibitory process. If an individual is attending to or concentrating on a given issue and something related to a different goal occurs, the inhibition process breaks down and the excitation process is disrupted. While some striking environmental events, such as smelling smoke, will obviously have this effect, other more subtle events may also produce it, such as observing what another person is doing. Similarly, a person can be distracted internally by letting his or her mind "wander" to an unrelated problem or subject. Indeed, classroom attention and concentration require considerable focus, and thinking about seemingly "more important" but unrelated issues can readily disrupt the excitation-inhibition process.

Criteria for understanding. The criteria that individuals use for establishing what is "understood" or "learned" is critical. Individuals will suspend processing when they believe learning has reached a desired or required criterion, and people are known to overestimate what they know (Glenberg, Wilkinson & Epstein, 1982; Vesonder & Voss, 1985). Some individuals seem to feel that material is learned when they have obtained an "impression" of the given subject matter, while others will examine a subject in depth. For example, recent work concerning students' learning with a complex computer-based laboratory (Schauble, Glaser, Raghavan, & Reiner, in press a) found that successful students engaged in both broad and deep search through the space of possible experiments and generated explanations of their results that were consistent both internally (that is, with other knowledge) and externally (that is, with the available data). In contrast, the unsuccessful students explored very shallowly, designing only a few of the possible experiments, and their experimentation was primarily data- rather than theory-driven. They were content with post hoc explanations of unexpected results, holding no regard to whether those explanations were consistent with other knowledge they held about the phenomenon or data they had previously generated. In school, where so much attention is given to test-taking and grades, satisfaction with a very shallow degree of understanding may be extremely prevalent. For example, students studying for a test, especially those with low motivation, may study to the point of "impression" or a little beyond, especially given their tendency to overestimate their performance.

Having identified factors related to ineffective processing, this section is concluded with a brief, speculative answer to the question, "What factors determine an individual's intellectual performance?" It can be argued that high quality intellectual performance is a function of at least four ingredients. As previously described, one is the individual's values, interests, and goals. A second is the person's knowledge, beliefs, and related affect. A third is experience in knowledge utilization; greater intellectual performance is associated with greater experience in using knowledge under a variety of environmental contexts and motivational states. The fourth is the effective operation of the excitation-inhibition process, leading to precise and appropriate interpretation. Thus, intellectual ability is related to the differentiation and integration of information and to the ability to relate input appropriately to what is in memory. Indeed, the last point is critical with respect to how a person generates new ideas and interprets input in ways other individuals do not. Knowledge and motivation are important, but in addition, the precision of the interpretation process is critical.

Values, Interest, and Goals in Schooling and Instruction

Having sketched a model of learning in which values and interests, on the one hand, and knowledge and beliefs, on the other, play an integral role, we now turn to considering the implications of this model for schooling and instruction. There are two classes of implications. The first concerns our society's ideas about the nature and purpose of schooling, and how these ideas influence the values and interests of individuals. Second, the implications of our model are worked out in a finer-grained analysis within a specific subject-matter content area, science. The purpose is to illustrate how particular student errors in knowledge or strategy, often assumed to be exclusively cognitive, may in fact result from mismatches between the goals of instruction and the goals of students.

Values, Interests, and Goals in Society

Educational values are established by the culture and society in which the education takes place. They continually change in response to historical events and fluctuations in cultural notions about the nature of learning. For example, current concern about science and math education has been spurred by the poor showing of American students on cross-cultural tests (International Association for the Evaluation of Educational Achievement, 1988). This current wave of consternation is only the most recent of a series of calls for curriculum and teaching reform that regularly accompany a climate of national concern about whether American students and industry will maintain a competitive position with respect to other nations (Klopfer & Champagne, 1990).

Aside from concerns about world competitiveness, over the past two decades swings in the prevailing views about education have occurred with ever-increasing frequency. Periodically the emphasis on child-centered, discovery learning gives way to Back-to-Basics movements, and mainstream notions about what is important in education shift back and forth from a focus on problem solving and higher-order reasoning to emphasis on drill and mastery of skills. In the United States, where education is perceived as a fundamental mechanism for achieving equal opportunity, the basic values that underlie education will probably always be subject to change and public debate. From time to time, Federal and privately funded commissions generate new recommendations for educational change and publish revised lists of national goals (for example, those published by the Carnegie Commission, and by the 1989 Education Summit with the President and State Governors in Charlottesville, Virginia). In spite of such resolve, there is probably less national unanimity on educational values than the documents imply or the public perceives.

Some of these value differences are obvious. In a number of American households, education is regarded as important, but the perceived importance appears to have more to do with obtaining a "good job" or going to the "right college" than intrinsic respect for the process of learning or the ability to think. Consistent with these values, pressure is high on students in some schools to obtain good grades so they can be admitted to prestigious colleges; in fact, in some circles achievement pressure begins even at preschool ages. In contrast to this near obsession with achievement and success, other families value education as an activity in its own right. Arguably, these are the familial and cultural values most likely to encourage interest in academic subject matter. And of course there are families and individuals who simply regard schooling as something that must be "put up with" until you are sixteen or until you graduate and can get a job, thus achieving a benchmark of adulthood and independence from parents.

Educational research, including most research on domains such as mathematics and science learning, typically views school learning as a process independent of the cultural context. The real question, however, is that of values.

What is it that our society and students value? The columnist Mike Royko perhaps put his finger on this point when he wrote, in a column appearing in the *Pittsburgh Press* on July 1, 1990, that students know quite a bit about rock music, drugs, and sports, but cannot point to China on a map. He further asked how many parents of these same children will turn off their television set to read a book. It may therefore be unrealistic for educators to expect that children will necessarily bring to school a well-developed interest in school subject-matter or value for the activities of schooling. One primary objective of instruction within subject-matter disciplines is therefore to assist students in adopting, or at least in "trying on," the goals and interests consistent with learning for understanding.

Values, Interests, and Goals in the Classroom

An example of an experimental project with these objectives is Cheche Konnen (meaning, roughly, "Search for Knowledge" in Haitian Creole), developed to teach science and literacy in language minority classrooms (Warren, Rosebery, & Conant, in press). The objective of Cheche Konnen is to introduce students to scientific literacy by engaging them in scientific activity. Instead of working on problems and experiments presented by the teacher or the textbook, students learn to pose their *own* questions, collaboratively plan and implement research to explore these questions, analyze and interpret the data, and draw conclusions based on their research. For example, one group of students wondered why water from fountains at various locations in their school did not taste the same. The students began their exploration of this phenomenon by conducting polls of students to confirm the existence of a preference for a particular fountain, and then by conducting blind taste tests. Deciding how to carry out and interpret the results from the polls and the tests resulted in a series of discussions about issues like bias, effect size, and statistical reliability. The program of inquiry eventually led the students to conduct bacterial cultures of water samples at various sites, including not only the water fountains but also local ponds and water supplies.

In the Cheche Konnen project, students do not engage in "recipe-following" laboratory exercises in which they follow prescribed procedures and hope to achieve the "right" answer (known by the teacher in advance). Instead, the questions and issues of interest to students are used to motivate the kinds of information sought and the scientific methods employed. The purpose of the approach is not to serve as a substitute for the acquisition of basic science knowledge, but to provide a context for that acquisition. The process reflects the way that values and interests motivate the learning in the practice of real science, in contrast to the more typical case where students are required to learn a set of disembodied facts and procedures. In addition, it provides experience in scientific thinking, including the often neglected issue of how a research problem is defined in the first place. This project can be characterized with respect to our framework of learning in Figure 1 as beginning with students' interests, the value-based "equipment" depicted in the learning framework. These interests motivate goals, which in turn organize activity with respect to the "intellectual equipment," including information-seeking, search for understanding, and decisions about the specific strategies of scientific inquiry that should be employed.

However, it is equally possible to start with the "intellectual equipment," as does reciprocal teaching, originally developed by Brown and Palinscar (1984) to improve reading comprehension and now being applied and extended in experimental work to teach conceptual understanding in science, specifically, the molecular theory of matter (Anderson & Palinscar, 1988) and ecological cycles (Brown & Campione, 1990). In reciprocal teaching, the instructional emphasis is on developing strategies for the construction of meaning from textual material. A special role is taken by the teacher, who initially models strategies for querying phenomena and constructing explanations, but who gradually transfers control of the learning activity to the students as they become more proficient. At first, primary emphasis is placed upon strategies for monitoring one's own comprehension (e.g., question, clarify, summarize, predict). As mastery of the comprehension-monitoring strategies increases, students are introduced to what Brown and Campione call "comprehension-extending activities," including drawing analogies, generating causal explanations, evaluating evidence, engaging in plausible reasoning, and conducting argumentation. Students take turns serving as group discussion leader who, supported by the teacher, guides the group in interpreting, evaluating, and summarizing information. The idea is that these processes of critical thinking and learning, first modeled by the teacher and supported by the social group, will eventually become internalized in the individual, and thenceforth be available for application to novel content and even other subject matter.

The focus, then, is squarely on the acquisition of knowledge, beliefs, and strategies, the "intellectual equipment" in our learning framework. However, the focus is by no means exclusively cognitive. The cooperative nature of the procedure is an essential feature. The goal of reciprocal teaching is joint construction of meaning, and the role of the instruction in strategies is mainly to provide heuristics for getting that procedure started. New material is interpreted and evaluated by relating it to previous knowledge and beliefs, but no one person in the reciprocal teaching group, including the group leader, is responsible for knowing all the answers. Instead, the questions and knowledge resources of the group are to be drawn upon, and the entire group shares responsibility for coming to understand the material. Thus, not only are individual students' interests engaged, but in addition, the group members come to understand the goal of meaning-making by practicing it, supported by the modeling of specific roles in a social learning group.

We have described two experimental projects in science instruction. In the first, learning is organized around students' values and interests. In the second, learning is organized around strategies for constructing meaning. Note that in both these projects, goal orientation plays a central role, as it does in the adaptive learning framework. In Cheche Konnen, students engage in scientific activity which is inherently goal-directed because it is organized in relation to questions that they themselves pose. In reciprocal teaching, students internalize the goal of reading to comprehend by engaging in social group practice organized around that goal.

An important feature of both these projects is that they focus on the theoretical links between goals and performance. However, too frequently values have been disregarded in models of learning, in spite of the fact that it is values and beliefs that guide the setting of goals and the development of interests. Indeed, while a primary assumption of information processing approaches to psychology is that thinking is organized in relation to a hierarchy of goals and subgoals, what the goals are and how they are established in the first place is rarely studied. More frequently, the goal is taken as the given, and research focuses exclusively on how search toward the goal proceeds. Yet, our discussion to this point suggests that there will be an interactive relationship between understanding and adopting the goal of a learning activity, on the one hand, and developing the associated values and interests, on the other.

Typically school students are not expected to come to school with a mastery of the knowledge relevant to school domains; it may be useful, in addition, to take the perspective that instruction should also be directed toward helping students acquire related values, interests, and a generative understanding of the goal of complex and possibily unfamiliar learning activities, such as experimentation, explanation, and reading for comprehension. Typically, failure to learn is attributed to breakdown in one or another component in our functional model of learning, with little attention given to the interrelations among components. This kind of analysis is similar to psychology's multiple and fragmented pictures of mental functioning, described at the beginning of the chapter. To return to our original theme, education requires a more complex view of student learning and reasoning, one that views learning in the context of the student's overall mental funcitoning.

To exemplify the distinction between the traditional fragmented view and a more integrated view of learning, consider that motivation-based theories of psychology may attribute poor achievement in science to lack of interest, whereas a problem solving theory may hypothesize that the student has weaknesses in particular cognitive strategies, for example, the widely-studied scientific reasoning strategies involved in designing and interpreting experiments (e.g., Kuhn, Amsel, & O'Loughlin, 1988). However, a wider perspective on learning raises the possibility that if students show no interest in a topic or activity, this may be because they have realistic doubts about the relation between the learning activities in school and their personal long-term or immediate goals (e.g., Resnick, 1987). It is these kinds of relations that the Cheche Konnen project makes apparent. Similarly, if experimentation strategies are viewed not as basic abilities that spontaneously emerge at particular periods in development (Inhelder & Piaget, 1958), but rather as socially-supported and encultured modes of thinking, it is possible to consider how their development can be enhanced by the right kinds of cultural modelling and support. It is these kinds of links that reciprocal teaching focuses upon.

It is worth noting that this wider vision of science education, in which interests and values take an important place alongside knowledge and strategies, is in fact consistent with changes in views concerning how professional scientists reason. Inductive, positivist models of scientific reasoning have been replaced by a new attention to the social and historical character of science, in which the relevant problems for exploration, methodologies for discovery, and formal justification procedures are negotiated among the society as a whole and the community of practitioners. For the student, as opposed to the professional scientist, schooling provides the cultural milieu in which naturally-evolving skills, like general induction abilities involved in reproducing favorable outcomes, can be gradually transformed into educated skills, like those required in generating and interpreting experiments. In this way, the relations between social values and schooling practices are twofold. Cultural values play a role in defining the desirable goals of schooling, such as the ability to engage in a specialized mode of thinking like scientific experimentation, and also in establishing a context where those goals can be systematically developed.

Conclusion

In this chapter we have been concerned with the role of interest in instruction. We have addressed this issue by considering how interest fits within larger questions about the nature of learning. We have sketched a model of learning which is broad-based and related to previous conceptions of learning as well as to motivation and perception. In doing so, we have tried to enlarge the modern cognitive conception of learning, one in which interest plays a major role. We have described interest as following and deriving from values, and, in turn, as generating the goals that motivate and direct processing. Such processing, when taken in conjunction with perceptual factors based upon what has been learned, provide at least a shadow, if not a picture, of a value-based, flexible organism quite sensitive to a wide range of physical and social stimuli and capable of learning an incredible amount about his or her environment. But what is learned, and what goals and interests a person develops, are fundamentally an issue of value.

Footnotes

1. This paper was supported by grants to the Learning Research and Development Center of the University of Pittsburgh, by the Mellon Foundation and by the Office of Educational Research and Improvement of the Department of Education (Center for the Study of Learning). The views expressed do not necessarily constitute those of any of these organizations.

References

Anderson, J. R. (1982). Acquisition of cognitive skill. Psychological Review, 89, 369-406.

Anderson, C., & Palinscar, A. S. (1988). Teaching for conceptual understanding and self-regulation through collaborative problem solving (Proposal submitted to the National Science Foundation). East Lansing: Michigan State University.

Atkinson, R. C., & Wickens, T. D. (1971). Human memory and the concept of reinforcement. In R. Glaser, (Ed.), The nature of reinforcement (pp. 66-120). New York: Academic Press.

Bolles, R. C. (1975). Theory of motivation (2nd Ed.). New York: Harper and Row.

Brown, A. L., & Campione, J. C. (1990). Communities of learning and thinking, or a context by any other name. In D. Kuhn (Ed.), Developmental perspectives on teaching and learning thinking skills. Contributions to Human Development, 21, 108-125.

Brown, A. L., & Palinscar, A. (1984). Reciprocal teaching of comprehension-fostering and monitoring activities. Cognition and Instruction, 1(2), 175-177.

Bruner, J. S. (1957). On perceptual readiness. Psychological Review, 64, 123-152.

Carr, H. A. (1925). Psychology, a study of mental activity. New York: Longmans.

Carraher, T. N., Carraher, T. N., Carraher, D. W., & Schliemann, A. D. (1985). Mathematics in the streets and in the schools. British Journal of Developmental Psychology, 3, 21-29.

Cherry, E. C. (1953). Some experiments on the recognition of speech with one and two ears. Journal of the Acoustical Society of America, 25, 975-979.

deGroot, A. D. (1983). Heuristics, mental programs, and intelligence. In R. Groner, M. Groner, & W. F. Bischof (Eds.), Methods of heuristics (pp. 109-129). Hillsdale, NJ: Erlbaum.

Dewey, J. (1896). The reflex arc concept in psychology. Psychological Review, 3, 357-370.

Dewey, J. (1913). Interest and effort in education. Boston: Houghton Mifflin.

Dweck, C. S. (1986). Motivational processes influencing learning. American Psychologist, 41, 1040-1048.

Fincher-Kiefer, R., Post, T. A., Greene, T. R., & Voss, J. F. (1988). On the role of prior knowledge and task demands in the processing of text. Journal of Memory and Language, 27, 416-428.

Glenberg, A. M., Wilkinson, A. C., & epstein, W. (1982). The illusion of knowing: Failure in the self assessment of comprehension. Memory and Cognition, 10, 597-602.

Hatano, G., & Inagaki, K. (1987). A theory of motivation for comprehension and its application to mathematics instruction. In T. A. Romberg & D. M. Steward (Eds.), The monitoring of school mathematics: Background papers (Vol. 2). Implications from psychology, outcomes of instruction. (Program Rep. No. 87-2, pp. 27-66). Madison, WI: Wisconsin Center for Educational Research.

Hull, C. L. (1943). Principles of behavior. New York: Appleton-Century-Crofts.

Inhelder, B., & Piaget, J. (1958). The growth of logical thinking from childhood to adolescence. New York: Basic Books.

International Association for the Evaluation of Educational Achievement (1988). Science achievement in seventeen countries: A preliminary report. Oxford, England: Pergamon Press.

Izard, C. E. (1977). Human emotions. New York: Plenum.

Johnson-Laird, P. N. (1983). Mental models. Cambridge, MA: Harvard University Press.

Klopfer, L. E., & Champagne, A. B. (1990). Ghosts of crisis past. Science Education, 44, 133-154.

Koffka, K. (1935). Principles of Gestalt psychology. New York: Harcourt Brace.

Kuhn, D., Amsel, E. D., & O'Loughlin, M. (1988). The development of scientific thinking skills. San Diego: Academic.

Pavlov, I. P. (1927). Conditioned reflexes. (G. V. Anrep, Trans and Ed.). Oxford: Oxford University Press.

Piaget, J. (1981). Intelligence and affectivity: Their relationship during child development. (Translated and edited by T. A. Brown & C. E. Kaegi). Annual Reviews Monograph. Palo Alto, CA: Annual Reviews.

Renninger, K. A. (1989). Individual patterns in children's play interests. In L. T. Winegar (Ed.), Social interaction and the development of children's understanding (pp. 147-172). Norwood, NJ: Ablex.

Resnick, L. B. (1987). Learning in school and out. Educational Researcher, 15(9), 13-20.

Ryle, G. (1949). The concept of mind. London: Hutchinson.

Schank, R. C. (1979). Interestingness: Controlling inferences. Artificial Intelligence, 12, 273-297.

Schank, R., & Abelson, R. (1977). Scripts, plans, goals, and understanding. Hillsdale, NJ: Erlbaum.

Schauble, L., Glaser, R., Raghavan, K., & Reiner, M. (in press a). Causal models and experimentation strategies in scientific reasoning. Journal of the Learning Sciences.

Schauble, L., Glaser, R., Raghavan, K., & Reiner, M. (in press b). The integration of knowledge and experimentation strategies in understanding a physical system. Applied Cognitive Psychology.

Schliemann, A. D., & Acioly, N. M. (1989). Mathematical knowledge developed at work: The contribution of practice versus the contribution of schooling. Cognition and Instruction, 6, 185-221.

Sechenov, I. M. (1965). Reflexes of the brain. Cambridge, MA: The M.I.T. Press.

Selz, O. (1922). Zur psychologie des produktiven denkens. Bonn: Cohen.

Spilich, G. J., Vesonder, G. T., Chiesi, H. L., & Voss, J. F. (1979). Text processing of domain-related information for individuals with high and low domain knowledge. Journal of Verbal Learning and Verbal Behavior, 18, 275-290.

Vesonder, G. T., & Voss, J. F. (1985). On the ability to predict one's own responses while learning. Journal of Memory and Language, 24, 363-376.

Voss, J. F. (1978). Cognition and instruction: Toward a cognitive theory of learning. In A. M. Lesgold, J. W. Pellegrino, S. D. Fokkema, & R. Glaser (Eds.), Cognitive psychology and instruction (pp 13-26). New York: Plenum.

Voss, J. F. (1979). Organization, structure and memory: Three perspectives. In R. C. Puff (Ed.), Memory, organization, and structure (pp 375-400). Hillsdale, NJ: Academic Press.

Warren, B., Rosebery, A. S., & Conant, F. R. (in press). Cheche Konnen: Science and literacy in language minority classrooms. *Cognition and Instruction.*

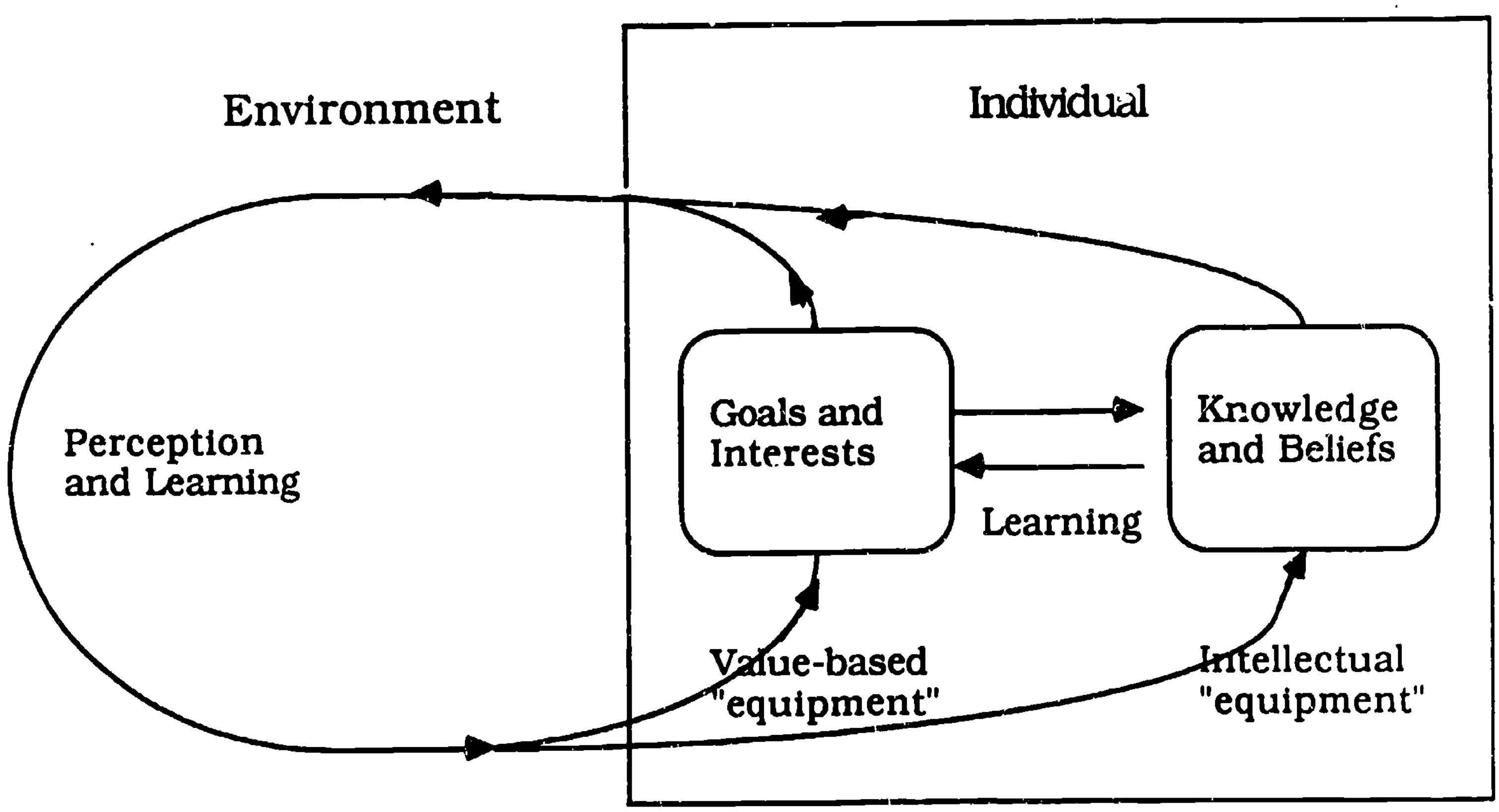

Figure 1. Sketch of a general model of learning