is often equated with making an overt response; indeed, to make overt responses, people must retrieve something from their long-term memory. Cognitive processes, such as performing addition problems, also entails retrieval." Along these lines, Klausmeier (1985) includes in his information processing flow chart a *response generator* which transforms input from working memory into impulses that guide the effectors in producing overt responses. Thus, when information is retrieved and moved into short-term or working memory, vocal and motor actions are generated which are observable as responses in the environment. Gagné (1985) adds that the response generator sometimes can be brought into play to generate a suitable response directly from long-term memory, without the mediating phase of short-term or working memory (e.g., when well-practised responses such as writing are made). This is consistent with the claim by Lefrancois (1985) that "long-term memory describes a more *passive, unconscious* process".

This presentation of the information processing model is incomplete in many respects of detail. What has been presented is a synthesis of the interpretations of this model currently presented in a book by Gagné on the conditions of learning and six recent and widely used textbooks in the area of educational psychology.

6.2 Why should teachers, educators know about this model of learning?

Few if any would disagree with the claim that memory (i.e., remembering) plays a critically important role in the child's learning and becoming. Consequently, to study a model that claims to provide insight into memory should be of relevance to an adult involved in helping a child learn and become in the direction of adulthood.

Gage and Berliner (1984) say, "we are concerned with how attention and memory work, for we want a certain part of what we teach to be attended to and remembered", and Klausmeier (1985) states that "cognitive information-processing theory provides many useful ideas for arranging instruction and for diagnosing a student's learning difficulties".

In comparison to signal and operant learning, the information processing model provides a more analytic scheme for trying to identify and remedy particular causes of learning difficulties. Does the difficulty stem from the manner in which the information is encoded, is the problem attending, retrieval, etc.?

What are some of the practical applications said to be derived from this model? The authors of all six textbooks consulted provide very explicit suggestions. Also, there is essential agreement across all of them with respect to the implications of an information processing model for teachers and educators to help learners attend to, encode, store, and retrieve information.

Without being exhaustive, some of the recommendations made by the various authors are: foster the intention to remember, use techniques that will allow the learned content to be integrated with what is already stored in long-term memory (e.g., by rehearsal, massed and distributed practice, overlearning, stressing meaningfulness), teach strategies to aid retrieval such as mnemonic devices (e.g., rhyming, pegwords).

Regarding the flow of information through various processes preparatory to storage and retrieval, Gagné (1985) suggests a broad array of external effects that can be exerted by a teacher, or even the learner in some cases, on the internal processes of learning. Regarding the reception of stimuli, he says, "stimulus change produces arousal (attention)". As far as selective perception, he says, "enhancement and differentiation of object features facilitates selective perception". Concerning semantic encoding required to move the information from short-term to long-term storage, he notes, "suggestion or display of cues such as diagrams, tabular arrays, rhymes, aid retrieval". Regarding the organisation of responses in the response generator, Gagné says, "verbal instructions about the objective of learning inform the learner about the class of performance expected". Finally, with respect to the two aspects of executive control, he says, "instructions establish sets that activate and select appropriate strategies" (regarding information flow) and "informing the learner of the objective establishes a specific expectation for performance" (regarding the motivational aspects of executive control). The upshot of all of this is that there is general consensus among educational psychologists that the information processing model of learning is a significant advance over previous models and that it

has direct implications for facilitating learning under normal circumstances and for "diagnosis and remediation" where learning is not proceeding as it should.

6.3 A phenomenological view of the information processing model

Unlike signal and operant learning which refer to describable experiential phenomena, the information processing model to a large extent is metaphorical. This makes it very difficult to study this model phenomenologically. Still, there is much that can be said about it phenomenologically and otherwise.

The possibility, for example, that human learning may not be a matter of stimulus and response is not raised. But this need not be surprising because human beings are not a source of data for this model – except as they perform in highly artificial experimental situations designed to find evidence confirming the model if at all possible.

Although we are warned by many authors that this model is metaphorical and should not be taken literally, still this model *is taken literally* when experiments are designed and data are interpreted. What needs to be shown is whether this model as metaphor has heuristic value or whether it is inadequate and misleading.

The point of departure for the construction of this model is *not* a human being learning and remembering something. Rather, it has its roots in the field of computer science. This model is premised on the thesis that "the computer is an appropriate analogy for human thought and cognition and for learning" (Rosser and Nicholson, 1984). The question underlying this model is *if*, in transforming stimulus input so a behavioural output occurs, the human being "acts" like a computer, what are the structures and functions that must take place? This is a big and very limiting if and, as Dreyfus (1972) says, "there are good reasons to doubt that there is any 'information processing' going on, and therefore reason to doubt the validity of the claim that the mind functions like a digital computer".

Human information processing is said to parallel the three phases of computer information processing, namely, input, process, output. This model is a variation of the basic stimulus-

response paradigm even though its emphasis is on the processing assumed to occur between the stimulus and the response rather than on the stimulus (Pavlov) or on the response (Skinner). Correctly, it is described as a more complete model than that offered by Pavlov or by Skinner. Still, it carries all of the inherent weaknesses of any stimulus-response model. For example, as with all stimulus-response models, this one is based on a faulty philosophical anthropology which, if it doesn't deny, at least it ignores human intentionality as *directedness to* and *openness for*, in the existential phenomenological sense of being-there (Dasein) in direct relation to and involvement with things, people, and events.

If "empirical" means to be related to or based on experience, then this model clearly is not empirical. The claim that stimuli from the environment stimulate the receptors which transform stimuli into neural information which enter the sensory register is in direct contradiction with everyday experience. No one ever has seen a stimulus as such let along the neural information in the sensory register. This is a throw-back to a view of perception which cannot be verified phenomenologically, namely, that sensations, stimuli are prior to objects and things; to perceive objects, etc. we must give meaning to the stimuli registered in our nervous system (for a critique of this view, see Merleau-Ponty, 1962; McConville, 1978). However, the primacy of perception over stimuli is evident in the language of every author discussing this model. They all erroneously equate stimuli and objects (e.g., "A student in a classroom faces a multitude of stimuli – a teacher, a textbook, bulletin boards, students and many others", according to Rosser and Nicholson, 1984). As Straus (1966) shows in his inimitable way, stimuli and objects belong to different levels of reality. He goes on to say, "Stimulus is a central concept of behaviourism; but, whenever it is used, there is a good chance that it will be badly misused, signifying things rather than stimuli." In addition, he emphasizes, "the hyphenated term 'stimulus-object' is a sham".

But the misuse of "stimulus" shares the company of admixtures of terms from the biological-physiological, the computer, and human domains as though such combining raises no conceptual problems or ambiguities. This line of criticism will not be pursued here.

How anyone can attend to the neural information held in the sensory register is a complete mystery which is further compounded by the claim that selective perception identifies features of this information such as "sides", "slopes", etc. The idea is that a perceived object is built up by means of the detection of the features of the information held in the sensory register. Dreyfus (1972) characterizes this kind of thinking as a "new form of gibberish". Phenomenologically, a perception is not built up in this way. As will be evident in Chapter 3, perception always begins on a global, general level and proceeds to differentiations via analyses and syntheses of that global whole.

The ideas of a "response generator" and an "executive control" also are problematic and unverifiable structures. They seem to be necessary, given the initial unverified assumption that neural information has to go through a series of transformations (processing) to attain psychological status (e.g., to become a learned response). The executive control, conceived as "the decision-making center that supervises the entire information-processing operation" (Lindgren and Suter, 1985), is a vague and muddled idea, the main purpose of which is to take the place of an experiencing, sensing person. This "super" programme apparently does all kinds of things we usually attribute to persons, namely, supervise, decide, etc.

To keep this chapter at a realistic length, these troublesome points will not be pursued. Rather, since this model is claimed to contribute to an understanding of human memory, the final phenomenological focus will be on short-term and long-term memory and retrieval.

For an excellent account of how the information processing model provides a distorted and inadequate account of human memory, the reader is referred to the article by Sardello (1978). Although not addressed directly to the information processing model, the articles by Kvale (1974) and by diSibio (1982) underline the extent to which this model misses the mark regarding human memory.

As with signal and operant learning, the information processing model has difficulty with data not objectively present. Therefore, it is not surprising that long-term memory is conceived as a limitless store of the items of memory (these items sometimes merge to form schemata or nodes) not unlike a large library. As are the

books in the library, the memories are *present*. They are said to be in long-term storage, even if they can't be retrieved. Thus, the problem in remembering is gaining access to (retrieving) the stored memories. But how something present (e.g., as a memory trace) can refer to the past is not even asked.

In retrieving information from long-term memory, often it is claimed that this long-term store is *searched* for the needed item. This spatial metaphor is extremely misleading. In remembering or trying to remember something, one does not search a storehouse containing the memory as present, like an object merely to be found. One reopens the temporal horizon of retentions and recollections belonging to the lived present. This is our only access to the past as past. Thus, one "searches" one's past but always from the vantage point of the present. In reopening this temporal horizon of the present, one does not travel to and arrive at the past moment being remembered. That moment is *recalled* to the present (but as past). Thus, one cannot remember an event exactly as it was because one can remember it only from the future of that very event (i.e., one's present) which was possibly anticipated but unknown at the time of the original event.

In contrast to remembering an event lived-through, what about remembering where one left a tool, say a hammer, which now is needed to complete a task? Does one search his memory to find (recall) where it was left? One may search the house for it, but not one's memory. Rather, as with an event lived in the past, to recall where the hammer was left, one must reopen the horizon of retentions and recollections of one's present by trying to recall when it was last seen or used, where it was used, for what purpose, etc. If one searches anything it is one's past activities with the hammer. These past activities are not "in" one's memory as a hammer is "in" a tool chest; these past activities are an aspect of one's past as past and are accessible only through present acts of remembering, of recollecting that past.

And what of a formula or technique that one wants to use but can't immediately remember? Does one search his memory? Again, the answer is the same. The formula, say for the statistical variance of a distribution of scores, is not "in" one's memory, but rather it is in one's past dealings with such problems and formulas. It is to these past problems, to this past context that one must penetrate via acts of remembering from the present.

However, even though the *act* of remembering has the same temporal structure whether one is remembering a summer experience of one's youth or the location of a misplaced tool, the *objects* remembered are different. I cannot repeat or relive that summer of many years ago as it was; however, I can reuse the tool once I remember where it is. Not only that, I can use it again in basically the same way that I have used it many times before. In other words, if the object of remembering is a technique or tool, for example, it can be abstracted from the past as past. If the object of remembering is an experience, it cannot be abstracted from the past as past in the same way. Furthermore, what can be abstracted from the past as past can become an automatism which then does not need to be remembered but needs to be actualized to make it present or functional.

As noted here and spelled out in Chapter 3, remembering means to make present something from the past *as past*. Generally, this relation to past as past is absent in the accounts of the information processing model. Remembering is a matter of retrieving information from long-term storage so it can be entered into short-term memory. It is present all the time but moved from one storage to another, rather like moving a pair of shoes from a storage crate to a closet so they more easily can be used. This slighting of the past as past gives rise to another confusion pointed out by Straus (1970) and elaborated on by Sardello (1978). Sardello says, "Effects carried forward from the past do not have anything to do with memory." One learns to write but does not remember the past as past in writing. Such automatisms as walking, reading, and talking are not examples of remembering. One might say, "after all of these years on a desert island, he still remembers how to read". But this is a misleading statement, a more accurate statement is ". . . he still can actualize his potential (or skill) to read". Thus, contrary to the information processing model, skills, aptitudes, etc. are not memories stored in long-term memory. Without an explicit acknowledgement that remembering has to do with recalling something past as past, the model cannot provide anything but a distorted understanding of memory and remembering.

What of short-term memory? On a superficial level, short-term "memory" is similar to what was described earlier as a momentary present. A significant difference is that accounts of the nature of

short-term memory do not acknowledge the horizons of retentions and anticipations which are part of the temporal structure of conscious life. Short-term or working memory does deal with retentions, but they are viewed as acts of remembering. Rehearsing a phone number in the present while one prepares to dial it is not an act of remembering the number; it is a way of keeping it present (retaining it). It is not remembered because it is still retained as part of the momentary present (it has not become past). We are told an item retrieved from long-term memory may enter short-term memory. If it does enter short-term memory, it does so only by being or by having been recalled. This makes the remembered content present, and it must now be retained as part of the momentary present while one "works" with it. Retaining a memory in a momentary present is to retain it as having been remembered, and this is not the same as the act of remembering it, making it present in the first place.

A thorough phenomenological analysis and evaluation of the information processing model easily could become a book-length endeavour. Therefore, the above brief comments will have to suffice. At this point, one can easily agree with Skinner (1974) when he says, "The metaphor of storage in memory, which has seemed to be so dramatically confirmed by the computer, has caused a great deal of trouble. The computer is a bad model – as bad as the clay tablets on which the metaphor was probably first based." Of course, in agreeing with this statement, one does not have to agree with all of the reasons Skinner has for making it.

6.4 An evaluation of the information processing model

Owing to the metaphorical nature of this model, many evaluative comments already have been made and they need not be repeated. The theoretical side of this model, when viewed against the background of the psychic life (Chapter 2) and the modes of learning (Chapter 3) of the child in a situation of education, is bankrupt. If so, why is it heralded as the latest advance in the psychology of learning? Perhaps the answer lies in its practical applications. But, as already noted, even this line of thought is not too promising in that most of the suggested applications are not tied directly to this model. Even so, an evaluation of some of these suggested applications is in order.