Another reason to study media in teaching is that there is a historically recurring expectation that student motivation and performance may be enhanced by them. At least since Thorndike suggested the use of pictures as labor-saving devices at the turn of the century, each new medium has created a wave of interest and positive enthusiasm on the part of educators. More recent media are widely used in classroom teaching. More than half of the school teachers in the United States are television material in class, particularly for teaching science and social sciences; 75% report using audiotapes and radio; and 62% use computers (Riccobono, 1984).

In this light, it becomes important to examine the research in the field for at least two reasons. First, we must discover what we know about the utility and effectiveness of media for instructional purposes. What in the media exerts what kinds of influence on whom and in what situational and instructional contexts? Second, the recent explosion of interest in the computer as an instructional tool requires that we examine the lessons learned from more veteran media and apply them to the study of new ones (Clark, in press; Salomon & Gardner, 1984).

The reader is cautioned that space prevents a comprehensive review of the great quantity of published material in this area. Excellent reviews and position papers are easily available. A number of articles and books exist that offer a more thorough treatment of problems than will be given here (Clark, 1983; Clark & Snow, 1975; Fleming and Levine, 1978; Heidt, 1978; Jamison, Suppes, & Welles, 1974; Kearsley, Hunter & Seidel, Leifer, 1976; Lesgold & Reif, 1983; Salomon & Clark, 1977; Salomon & Gardener, 1984; Schramm, 1977a; Sheingold, et al., 1983; Suppes, 1979; Wilkinson, 1980).

Our goal is to acknowledge and examine some of the difficulties that the field of research on media in instruction faces. We will analyze the results of past research and describe current significant changes in those questions. We will then discuss the way lessons of past media research impinge on future directions.

Review: Who Is the Fairest of them All?

Any profession concerned with the improvement of human life, as Glaser (1982, p. 292) points out,
bases it activities on beliefs about human nature. The field of media in instruction is no exception. Media research began during the behaviorist era in education, so early researchers assumed learners to be reactive, responding to external stimuli which are designed to control their behavior. Many early researchers operated on the belief that media in instruction offered great advantages in increased control of learning behaviors. Skinner’s teaching machines fit this model very well, as did the early hopes voiced by audio-visual advocates (Saettler, 1968). Divergent views urging cognitive interactive questions by early researchers such as Freeman (1924, quoted by Saettler, 1968) were largely ignored.

The perceptions of learners as reactive and under stimulus control led to an intensive search for the ‘one best medium,” a _____ stimulated by the great excitement that each new medium aroused and the many hopes this excitement cultivated (Clark, 1975). This early research was long on the enthusiastic advocacy of media comparison questions and short on the development of theories concerning the way media might be made to influence learning (Wartella & Reeves, 1983).

**Media Comparison Studies**

In the 1960s, Lumsdaine (1963) and others (e.g., Mielke, 1968) argued that gross comparisons of the influence of different media on learning might not be useful. They implied that media, when viewed as no more than collections of electromechanical devices such as television and movies, were simple delivery instruments and that when everything else was held constant, they would not be found to influence learning directly in and of themselves. And while it has been the case that subsequent research has borne out their suspicion, many researchers continued to search for overall learning benefits from media. But, as has become evident, learning from instruction is a much more complicated process that often involves interactions between specific tasks, particular learner traits, and various components of medium and method. In this mix, the effects of gross, undifferentiated “medium” variables could not be productive. Part of the reason for the continued reliance on media comparisons was that earlier reviewers held the door open to media influences on learning by blaming much of the _____ of systematic findings in prior research on poor research design and on a lack of adequate theory.

As a result, Lumsdaine (1963), writing in the first *Handbook of Research on Teaching*, dealt primarily with adequate studies which had utilized defensible methodology, and in which significant differences were found between media treatments. With the benefit of hindsight, it is not surprising that in most of the studies he reviewed media were employed as simple vehicles for the delivery of instructional materials, and researchers manipulated such variables as text organization, size of step in programmed instruction, cueing, or repeated exposures and prompting. None of these variables was generic to the media that the researchers purported to study. This is an example of what Salomon and Clark (1977) have called research with media, which they distinguished from research on media. Only in research on media are generic media variables examined. In the former type, media are used as mere conveyances for the treatments being examined. Although media often were not the focus of study, the results were erroneously interpreted as suggesting that learning benefits had been derived from various media.

An example of instructional research with media would be a study that contrasts a logically versus a randomly organized slide-tape presentation on photosynthesis (cf. Kulik, Kulik, & Cohen, 1979 for a review of a number of similar studies). Such a comparison could be carried out by any medium, thus failing to single out for study any distinguishable or unique attribute of a medium that could be expected to contribute to achievement gains.

A decade later, chapters in the *Second Handbook of Research on Teaching* by Glaser and Cooley (1973) and Levine and Dickie (1973) were cautious about the media comparison studies that were still being conducted in apparently large numbers. Levine and Dickie (1973) noted that most overall media comparison studies to that date had been fruitless and suggested that most learning objectives could be attained through “instruction presented by any of a variety of different media” (p. 859). This observation was echoed by Schramm (1977), according to whom “learning seems to be affected more by what is delivered than by the delivery system” (p. 273). At that time, televised education was still a lively topic and studies of computerized instruction were just beginning to appear. In the intervening decade, more effort has been made to analyze and refocus the results of existing comparison studies.

**REVIEWS AND META-ANALYSIS OF MEDIA STUDIES**

A comprehensive and often cited review by Jamison et al. (1974) surveyed comparisons of traditional instruction with instruction via computers, television, and radio. Their survey utilized a “box score” tally of existing studies, evaluations, and reviews of research. They concluded that a small
number of studies reported advantages for media and others indicated more achievement with traditional instruction, but the most typical outcome was “no significant difference” between the two. As they explained, “when highly stringent controls are imposed on a study, the nature of the controls tends to force the methods of presentation into such similar formats that one can only expect the ‘no significant differences’ which are found” (p. 38). However, there have been criticisms of the box score method of summarizing past media research (e.g., Clark & Snow, 1975). Many of these criticisms have been accommodated by newer “meta-analytic” methods of teasing generalizations from past research (Glass, 1976). A recent series of meta-analysis of media research was conducted by James Kulik and his colleagues at the University of Michigan (Cohen, Ebling, & Kulik, 1981; Kulik, Bangert, & Williams, 1983; Kulik et al., 1979; Kulik, Kulik, & Cohen, 1980). Such meta-analyses allow for a more precise estimate of treatment effect sizes than was possible a few years ago. Meta-analytic procedures yield effect size estimates which are converted to percentage of standard deviation gains on final examination scores due to the more powerful treatment, if any. Most of the meta-analytic surveys of media research demonstrate a typical learning advantage for “newer” media of about .5 standard deviations on final examination performance, compared with “conventional” treatments. In the case of computer-based instruction studies in college environments, for example, this advantage translated to an increase from the 50th to the 66th percentile in final examinations in a variety of courses (Kulik et al., 1980). This is an impressive accomplishment if one accepts it at face value.

Confounding in Media Comparison Studies. Clark (1983) has reviewed existing meta-analysis of media research. His conclusion was that while most analyses showed positive learning effects for newer media over more conventional treatments, there was compelling evidence for confounding in the reviewed research. Two Illustrations from Clark’s (1983) discussion will provide an example of these two types of confounding. The sizeable effect of .5 standard deviations on final exams that has been attributed to computers in the college setting has been used to justify computer-based instruction (CBI) for teaching. However, this effect reduced to .13 standard deviations in those studies wherein one teacher planned and presented both the computer and the conventional courses. Clark (1983) claimed that this was compelling evidence that the larger effects were due to systematic but uncontrolled differences in content, novelty, and/or teaching method between conventional and media treatments but not to CBI per se. Even when the same teacher designs both treatments it is possible that slightly different and more productive presentations of content or method could be included in the computer condition which accounted for the .13 advantage. But this slight learning advantage could have been produced by any of a variety of media.

Another source of confounding, novelty, was evidence by a decrease in the differences between media and conventional treatments over time. Clark and Snow (1975) reported that most media treatments in published studies at that time averaged about 20 minutes with a very small standard deviation. Kulik et al. (1983) reported that when computer treatments lasted less than 4 weeks, average effects were .56 standard deviations over conventional treatments. This diminished to .3 standard deviations after 5 to 8 weeks and further to .2 standard deviations after 8 weeks of student work with CBI. It is plausible to hypothesize a novelty effect in these studies and to suggest that students are becoming more familiar with the medium and expend less effort in learning from it over time. Clark (1983) has also argued that similar confounding could account for reports of reductions in study time for computers or other media.

A Conclusion About Media Comparisons. General media comparisons and studies pertaining to their overall instructional impact have yielded little that warrants optimism. Even in the few cases where dramatic changes in achievement or ability were found to result from the introduction of medium such as television, as was the case in El Salvador (Schramm, 1977), it was not the medium per se that caused the change but rather the curricular reform that its introduction enabled. This is itself is an important observation, for the introduction of a new medium often allows the production of high quality materials and novel experience, or leads to organizational and practice changes not otherwise afforded.

One would need to distinguish here between the potential effects of a medium’s generic attributes (e.g., ways to shape information that cultivate cognitive skills), and the effects of the medium’s introduction. Gross media attributes, but failing to identify and carefully manipulate specific attributes, they fell short of their goal (Clark, 1978, 1983; Clark & Snow, 1975; Levie & Dickie, 1973;Salomon, 1979;Salomon & Clark, 1977). Nor did they illuminate the process and effects of media introduction for they focused on direct learning outcomes, not on the consequences of curricular or organizational changes in the schools.
The study of media’s effects on learning precludes their treatment as unitary tools such as “television,” “radio,” or “computer.” The common denominator of all television instances transcending differences of content, task, method of presentation, instructional context, symbolic and formal features used and the like is much to narrow. It does not warrant comparisons of “televised instruction” (or, for that matter, “computer-based instruction”) with an equally undifferentiated alternative. This is certainly the case with computers-whose variety of forms, usages, contents, and the activities they allow exceeds anything known before.

The shortcomings of overall media comparisons do not render such studies useless for all purposes. The evaluation of particular products, the weighting of a medium’s overall cost effectiveness, and the close monitoring of a medium’s employment in practice can all benefit from one or another kind of media comparison. However, such gross comparisons have little utility for the study of those specific media attributes that may make a difference in learning for some learners on specific tasks. This lesson appears to be of special importance when applied to research on computers for, unlike TV, their instructional potential is still largely unexplored.

Cognizant of these and similar considerations, researches shifted their attention to other types of questions. These newer approaches were based more on cognitive than behavioral approaches to learning. They were addressed at specific media attributes, assumed to be inherent to the medium under study and of potential relevance to learning-related cognitions. Hypothesis typically dealt with the interactions of particular media attributes, teaching methods, tasks, and learner traits, and focused on the cognitive consequences of different combinations for different students. While the historical vestiges of this type of question date back at least to the 1920’s (e.g., 1924, quoted by Saettler, 1968, 1968), most of the research activity has taken place in the last decade. However, as we will see, the shift to a cognitive approach has led the field away from practical research on media as it was formerly conceptualized.

The Shift of Focus: Cognitive Aspects Of Media Attributes

The media comparison questions were discarded at the same time that instructional psychology was replacing behaviorist with more cognitively oriented views. In the cognitive approach, more attention is devoted to the way various media attributes, such as the visualization and imagery-evoking properties of stimuli (see review by Winn, 1981, 1982), interact with cognitive processes to influence learning. Thus, it became necessary to examine how specific elements of an instructional message might effect or activate particular cognitions for certain learners under specific task conditions. No wonder, therefore, that aptitude-treatment interaction (ATI) research has been welcomed by media researchers who expected it not only to suggest which specific media attributes were most effective for whom (e.g., Clark, 1975; Clark & Snow, 1975; Schramm, 1977), but also to indicate the kinds of cognitions that are or may become involved in the processing of differently packaged and coded materials (Salomon, 1971; 1979).

Related Questions Concerning Information Processing

There is also a growing body of research on developmental cognitive processes which are relevant to the understanding of media attributes. That research ranges from the study of reading acquisition (e.g., Resnick & Weaver, 1979) to the comprehension of stories (e.g., Stein & Glen, 1979); and from the study of how children learn to process artistic depictions (Gardner, 1980), to the study of how one learns to process narration (e.g., Collins, 1981; Jaglom & Gardner, 1981) and handle computers (e.g., Turkle, 1984).

Other literature of increasing volume is concerned with neuropsychology and the psychobiology of processing symbolic information. Unfortunately, although this research opens up a new area of interest, it still yields many contradicting interpretations, particularly in the area of hemispheric dominance or brain lateralization (Gardner, 1982). As it turns out, popular claims about an instructionally important division of labor between the two brain hemispheres are not clearly supported by research (Hellige, 1980). It is apparently the case that the left hemisphere has momentary advantage in dealing with the basic building blocks of simple, familiar, digital elements and in such logical processes as classification. The right hemisphere is the initial processor of unfamiliar, pictorial, and spatial material. Yet the right hemisphere turns out to play a role in the comprehension of stories, metaphors, puns, jokes, and other linguistic material that requires paralinguistic “scaffolding” for comprehension (Gardner, 1982). So prevailing speculations that there may be a clear hemispheric specialization. The different media attributes appear to be premature.

Unlike previous research concerned with the instructional utility of media, the more current research into the way different modes of information
presentation are processed and how these processing capabilities develop appear to yield important implications for instruction. Thus, for example, Anderson and Lorch (1983) have found that children attend to televised material that is comprehensible to them, implying that comprehensibility determines attention rather than the other way around. This finding suggests that instructional production techniques should be oriented to conveying comprehensible information rather than attracting attention. Newer media literacy programs are attempting to draw on this research and apply it to instructing children on how to get more selective knowledge out of mediated instruction (e.g., Dorr, Graves, & Phelps, 1980; Singer, Zuckerman, & Singer, 1980).

By and large, there were at least two results of the shift in focus in media research. First, there was the need to identify critical attributes of media which not only distinguish between media in meaningful ways but which also affect learning-relevant cognitions. This team was expected to lead to clearer distinctions between the means of information delivery and manipulation (e.g., radio, computers, television, books) and other components of media, notably their intrinsic modes of information presentation and the kinds of mental operations they afford. The second result was the long-overdue development of theories. The chapter turns next to a brief description of three of these theories which have evolved in the last decade and to the disputes they have generated.

GOODMAN’S SYMBOL SYSTEM THEORY

The idea that media attributes or the modes of information presentation in instruction are crucial to learning has been around for some time. However, it was not until Gardner, Howard, and Perkins (1974) introduced Goodman’s (1968) theory of symbol systems that the constructs of “modes of presentation” could be systematically examined.

Following Goodman (1968), Gardner et al. (1974) explained that a symbol is anything that can be used in a referential way, and that can be organized into systems. They offered a number of semantic and syntactic conditions to distinguish among symbol systems – including the way they are structured and the way they map upon their respective fields of reference. They offered specific dimensions of symbol systems to illustrate the way they differ.

One of the structural characteristics of symbol systems is notationality. This is the extent to which a symbol system can be unambiguously mapped onto a frame of reference. Here, for each of the system’s characters there must be one, and only one, equally differentiated element in the field of reference. The system of musical notations is a prime example of notationality. Symbol systems differ in notationality. For example, verbal systems are more notational than pictorial ones, a distinction that leads to specific psychological and educational implications. Less notational symbol systems (e.g., pictures) are neither easier nor more difficult to comprehend or learn, as there is nothing inherent in these systems that makes them “easy.” Nor does any system necessarily “resemble” its referents more than another. Rather, symbol systems, and hence the media of communication and tools of information manipulation that carry them, exhibit differential information biases (e.g., Meringoff, 1980) and activity biases (Salomon and Gardner, 1984). Thus, TV tends to highlight action properties of a narrative while print versions of the same material highlight figurative language. Each such presentation bias is correlated with an information pickup bias – televiewers place the narrative in a spatial imagery framework and storybook listeners place it in a temporal-descriptive one.

The introduction of a formal theory of symbol systems could potentially offer a bridge between research on media and research on cognition and symbolic behavior. Indeed, this development led to the creation of new theories and research questions by media researchers. Those theories are briefly described next. However, these new theories led away from the study of media as complex communication systems characterized by television, books, and other means of delivering messages. Current research based on symbol system theories is no longer focused on media in instruction, for as Gardner (1982) pointed out, there is no necessary one-to-one correspondence between media and symbol systems. We will return to this issue later on.

OLSON’S THEORY OF INSTRUCTIONAL MEANS

Olson bases his theory on Bruner’s contention (1964) that the introduction of technologies and techniques is accompanied by the development of relevant cognitive skills, and on McLuhan’s interest in the forms and structures of information media. Olson (1976; Olson & Bruner, 1974) argued that any account of human activity must begin with an understanding of the activities whereby information is picked up from the environment, mentally transformed, and stored. Different kinds of activities yield not only different aspects of the world but also engage and develop different mental skills. Olson thus distinguished between the knowledge one
acquires and the skills that are involved in and are developed during the process. From observing a picture, argued Olson, one acquires knowledge about the depicted object as well as develops cognitive skills related to observation.

Olson (1976) offered a theory of instructional means. The theory attempts to show “how in…instruction, the content of the medium [is] related to the knowledge acquired, while the means employed (the code in which the message is represented) is related to the skills, strategies and heuristics that are called upon and developed” (1976, p. 26). Each of these elements may result in a different kind of transfer of learning: The content components results in transfer of rules and principles (a set of features that is invariant across different activities), whereas the codes or the means of instruction may result in the transfer of skills “assumed or developed in the course of relying upon that means” (1976, p. 23). These skills are the mental operations that are invariant across different contents. Each system of codes, symbols, or methods requires a different set of activities. While all such instructional means may ultimately map upon the same knowledge structure, they differ with respect to the cognitive processes they activate and cultivate (Olson & Bruner, 1974). Thus, Olson suggested (1974) that perhaps the function of media that present new symbol systems is not so much to convey old knowledge in new forms but rather to cultivate new skills for exploration and internal representation.

One important extension of Olson’s theory is his distinction between “utterance” and “text” (Olson, 1977). According to Olson (1977), oral language “is a flexible, unspecialized, all purpose instrument with a low degree of conventionalization” in which the meanings of sentences must be “negotiated in terms of the social relations, the context and the prior world knowledge of the participants” (p. 10). On the other hand, written language, “by virtue of its demands for explicitness of meaning, its permanence…and its realignment of social and logical function, serves the intellect in several ways” (Olson, 1977, p. 11). It serves the cultivation and maintenance of analytic, scientific, and philosophical knowledge (as contrasted with commonplace knowledge). In school, “intelligence” is skill in the medium of text. This Olson (1977) calls the “literacy bias.”

Olson’s distinction between cultures of utterance and text, and between similar developmental phases in a child’s schooling, is of particular relevance to hypotheses concerning the cognitive effects of computer programming. Programming is a highly structured and analytic activity in a rigidly constrained symbol system (Pea & Kurland, 1985). It may – if sufficiently intense and continuous – lead to new “literacy biases” exceeding the ones attributed by Olson to texts.

**SALOMON’S MEDIA ATTRIBUTES THEORY**

Extending the work of Olson and Gardner, Salomon offered a theory (1979) based on the assumptions that (a) both the media and the human mind employs symbols to represent, store, and manipulate information: and (b) that some of the symbol systems employed in cognition are acquired from the symbol systems employed by media. Salomon conceptualized technologies that allow the development of unique symbol systems and combinations thereof, just as the development of the technologies of maps, films, or computers led to the development of cartography, cinematics, and programming languages. The more distinctive or contrived the symbol system used to represent information, the more distinctive the mental skills that are required and called upon. Hence, Salomon (1974a) distinguished, for example, between televised instruction that only employs the technology of television without much emphasis on the medium’s unique symbolic potentialities, and televised instruction that does utilize these features fully. Only the latter might make a difference in the kind of knowledge acquired and the meanings derived from instruction as it calls upon different sets of mental skills (Salomon & Cohen, 1977).

There are a number of instructionally relevant features to the Salomon theory. He hypothesized (1979) that an instructional presentation can be “closer to” or “more distant from” the way a learner tends mentally to represent the information presented under given task requirements. The closer the match between the communicational symbol system and the content and task-specific mental representations, the easier the instructional message is to recode and comprehend. Certain symbolic modes of representation can thus “save” the learner taxing mental transformations from communicational to mental symbolic forms depending on their aptitudes, the task, and the subject matter to be learned.

A second feature of the Salomon theory is his contention that some of the symbolic features of instruction, under some conditions, can be internalized by learners and henceforth serve as “tools of mental representation.” He presented evidence (Salomon, 1974a) that students deficient in cue attending are able to internalize the “zooming” of a camera lens into a stimulus field and thus increase their cue-attending skill. Another possibility here is that these same features may merely activate and strengthen partly mastered cognitive skills for other students, and in some instances such features may
actually inhibit learning by preventing the use of previously acquired but more efficient skills that serve the same ends. Research following the theory has provided evidence that skills cultivation and inhibition, though limited in scope, take place under natural conditions such as exposure to a new medium like television. Salomon (1979) reported such effects on Israeli children exposed to “Sesame Street” and Schramm (1977) found similar effects on the nonverbal skills of El Salvadorian children exposed to instructional television for the first time. However, it should be remembered that Salomon’s research demonstrates that symbolic features of media can be made to cultivate cognitive effects, not that those effects necessarily occur naturally as a result of uninvolved exposure to a medium. The occurrences of cognitive effects depends on a number of factors including the effort invested, depth of processing, and special aptitudes of individual learners (Salomon, 1983a).

OTHER SYMBOL SYSTEM THEORIES

The development of the three related theories briefly described above was paralleled by other, more symbol-system- or do-main-specific theories: theories pertaining to the processing of words and pictures (e.g., Fleming, 1979; Pressley, 1977), televiing and listening (Meringoff, 1980), artistic depiction (Gardner, 1980), diagrams (Winn, 1982), and more. Common to these undertakings was a growing concern with the cognitive processing of differently coded materials. Questions of instructional effectiveness were generally abandoned.

Issues Related to Symbol System Theories

Most of these newer theories have at least one important assumption in common: that cognitive representations and processing are carried out in various symbolic modes that are influenced by the symbol system employed by media, that some of these cognitions are unique counterparts of communicational symbol systems, and thus can be cultivated by symbol systems. This general assumption has been challenged by critics who suggested that the type of symbolic mode employed in instructional representations may not serve any unique function in cognition and learning. Clark (1983, in press), for example, has argued that many of the different symbolic representational modes used in instruction may serve the same basic function in cognitive processing. If this turns out to be the case, the choice of symbol system may be less important for instruction and learning than the symbol system theories imply. Instructional designers and curriculum planners could then choose the less expensive or more convenient medium for instruction, provided that its symbolic modes were sufficient to yield the necessary cognitive transformations required by the learning task and learner. This issue is similar tone currently being discussed in the larger arena of cognitive science, that is, the concern about whether images or propositions are the more “basic” representational modes for information in cognition.

Imagery and Propositions in Thought

A particularly important topic and ongoing theoretical debate in cognition was, and continues to be, concerned with the nature and foundations of images or “analogous” mental representations as contrasted with “propositions” (e.g., Anderson, 1983; Olson & Bialystock, 1983). An example of the difference between the two would be a trace image of an object in memory (an analogous representation) versus a description of the criterial attributes of the object (a proposition).

The image-versus-proposition argument to some extent replaces earlier dual trace arguments concerning whether information is stored in memory as words, pictures, or both (e.g., Paivio, 1977). It is part of the general search for a deeper understanding of information processing, a topic of special relevance to research on media in teaching since different theory and practice implications appear to follow from the two approaches. Space limitations allow only a brief description of the two approaches and their related implications.

THE DUAL-MODALITY APPROACH

Kosslyn (1981), Kosslyn and Pomerantz (1977), Paivio (1977), and Shepard (1978) have claimed that images constitute a distinct class of cognitive representations, parallel and equal in importance to semantic propositions. Shepard (1978) argued that the perception of a mental image is a process that is analogous to the perception of actual objects. Kosslyn (1981), basing his approach on computer simulation models, argued that images have both “surface representation” and “deep representation” components. Surface representations occur in a spatial mode and are a visual depiction of objects. This underlies the experience of mental imagery. The deep structure component entails a literal representation (some encoding of appearance) and a prepositional element (a description of the object). The deep representation is a long-term memory trace.
The dual-modality side of this argument bears a general resemblance to media attribute theories. If images bear a direct resemblance to externally depicted objects, the acquisition of communicatively provided images of events and processes should enrich a learner’s store of cognitive images and operations. Salomon’s (1979) theory of the internationalization of symbolic forms and Olson and Bruner’s (1974) claim that intelligence is skill in a medium appears to be related to the dual-modality argument.

THE PROPOSITIONAL APPROACH

Pylyshyn (1973) denied a central role for imagery components in cognition by describing them as “epiphenomena.” He relegated their alleged role in cognitive representation and processing to “abstract descriptions accessed by computationally primitive semantic interpretation functions” (Hampson & Morris, 1978). More recently, however, Pylyshyn (1981) has narrowed the debate to the question of whether images are or are not similar to what goes on when people observe corresponding events actually happening. “Similarity,” he argued, is an illusory and unclear construct that is based on our commonsense knowledge. More specifically, the argument was that images are not intrinsic properties of the mind which are “wired in,” such that they cause it to behave as it does. Rather images are “cognitively penetrable.” They are governed conceptual, rational knowledge – by propositions – rather than exclusively by the actual features of the objects perceived. Therefore, the images we form of external reality are not determined by our direct perceptions of the features of the objects (or their pictorial representation) but by “a tacit physical theory which is good enough to predict most ordinary natural events correctly most of the time” (Pylyshyn, 1981, p. 41).

Research evidence for the prepositional argument includes the finding that children who are blind from birth perform as well as sighted children on tasks that seem to require imagery (e.g., Zimler & Keenan, 1983). These findings and others challenge the dual-modality/imagery theories and suggest that the mental representations used by both the blind and the sighted take a semantic, prepositional form. Additionally, one should take into account recent evidence provided by Kyllonen, Lohman, and Snow (1984), who imply that spatial thought and strategies are most useful for solving only simple problems. As problems solving (including spatial problems) becomes more difficult, learners tend to switch to the more semantic-analytical strategies.

IMPLICATIONS OF THESE APPROACHES

The dual- (or multiple-) modality approaches lead to implications similar to the ones developed earlier by Olson, Bruner, and Salomon. The prepositional approach leads to different hypotheses, implying that the particular surface-symbolic appearance of a message may be relatively less consequential in learning, as it is going to be handled prepositionally anyway during deeper processing. Thus, all images used in cognition may be “constructed” following prepositional “rules.” Imagery knowledge, and thus the symbol-system-specific cognitive skills cultivated from symbolic attributes, may only serve in the decoding of instruction delivered via different media.

Salomon (1983b) has recently proposed that the symbolic carriers of information mainly affect the early phrases of decoding but not subsequent phases of mental elaboration of the already recoded and mentally represented material. The latter phases, he argued, include such operations as inference generation and are symbol system independent. Indeed, Salomon and Ben-Moshe have recently found that when sixth graders are taught to view television more mindfully and invest more effort in processing televised instruction, their reading comprehension scores increase significantly. This suggests that the operations involved in the deeper processing of television and print material may share a number of important procedural or strategic components.

More generally, it follows that if most basic cognitive operations rest in prepositional structures, then the issue of symbol system and medium diversity in instruction may not be as important in learning as was initially assumed by the symbol system theories. We should entertain the possibility that symbol systems affect differently only initial decoding. For it is quite possible that information presented in some symbolic form is more easily recoded into (internal) propositions than when presented in another form. It is also possible that as each symbolic form offers a different information bias (highlighting selected aspects of the information), each such form may lead to different kinds of internal propositions. Thus, according to the view, media’s symbolic forms make not call upon and cultivate different skills; still, they may result in easier or more difficult learning. They may also result in more or less stereotypic or varied sets of internal propositions that complement each other (Olson & Bialystock, 1983).
Another issue concerns the conditions that surround the cultivation and transfer of cognitive skills. We turn next to a brief discussion of these issues and how they might influence our understanding of media symbol system theories.

**Skill Cultivation: Questions of Uniqueness and Transfer**

Salomon (1979), and more recently Greenfield (1984), have reviewed research where symbolic features of mediated experiences and instruction were shown to affect differentially the skills activated in the service of knowledge acquisition and on the master of these skills. Such research was inspired by Bruner’s (1964) argument that internal representations and operations partly depend on learning “precisely the techniques that serve to amplify our acts, perceptions and our ratiocinative activities” (p. 2).

Such a Vygotskian view implies that unique coding or structural elements of the media (e.g., filmic causal sequences or uniquely effects on related mental skills. Thus, the employment of a coding element such as a close-up, or the allowance for students’ manipulation of input data (e.g., Lesgold & Reif, 1983), may activate specific mental operations that facilitate the acquisition of knowledge as well as their improved mastery.

But the possibility of the skill activation and cultivation from specific media attributes also raises new conceptual and empirical questions. If media’s symbolic modes of information presentation can activate, even cultivate mental operations and skills, are these skills unique? What is their utility? How far do they transfer, if at all? These questions are of particular interest with respect to the use of computers in instruction (Papert, 1980, Pea & Kurland, 1985; Tikomirov, 1974), for many computer-afforded activities are rationalized in terms of their unique effects on transferable skills. Writes Paper (1980, p. 27): “By providing [a] very concrete, down-to-earth model of a particular style of thinking, work with the computer can [foster]…a ‘style of thinking’…that is to say learning to think articulately about thinking.”

It is very difficult to provide evidence to support the uniqueness argument since it might always be claimed that substitutions are or could be made available. More importantly, one could question the assumption implied in this approach that there is a one-to-one correspondence between coding elements and afforded activities, on the one hand, and specific modes of mental representation and operation, on the other. Wittrock’s (1978) generative model of instruction suggests that when, for example, learners fail to generate relevant relationships, they should be made explicit for the learners in any means or medium available. This assumes functional equivalence between various devices for delivering instruction and various symbolic modes for representing information.

Indeed, it is possible that nominally different modes of instructional presentation (including symbolic attributes) accomplish the same function in learning, and thus activate the same operations and therefore serve instruction equally well. Blake (1977) taught chess moves to high- and low-visual-ability undergraduates using still pictures, animated arrows within pictures, or a motion film plus a narration. While all three conditions worked equally well for the higher ability learners, low visualizers learned the chess moves equally well from the arrow and motion which were significantly more effective than the static pictures. Blake’s poor visualizers profited from two different operational definitions of the necessary model, animated arrows and moving chess pieces. It seems that the necessary process for learning chess moves was the visualization of the entire move allowed each piece. It could be operationalized in any of a variety of equally sufficient conditions for successful performance.

The possibility that alternative coding and structural elements, within and across symbol systems, may be functionally equivalent suggests two things. First, it suggests that research ought not to seek the unique cognitive effects of one or another discrete media element but rather focus on the cognitive functions accomplished. Filmic zooms can visually supplant part-whole relations, but so can other elements as well. And the acquisition of some sequential logic, although facilitated by computer programming, may be similarly facilitated by direct tutoring. Second, it may well be that media selection decisions (e.g., Reiser & Gagne, 1982) ought not be based on their different surface capacities to influence achievement, for a focus on surface appearance differences overlooks the possibility that whatever we think goes on is not necessarily what goes on, cognitively.

The other important issue concerns the transferability of the skills wrested from a medium’s symbol system or exercised during a computer-afforded activity. One would need to distinguish between, say, the acquisition of a particular image or operation, on the one hand, and the cultivation of imagery ability or generalized skills, on the other. It is one thing if children learn from televiewing only how to become better televiewers or from programming Logo how to better Logo programmers: it is another if they show skill cultivation that transfers beyond the boundaries of that medium or
activity. Work by Scribner and Cole (1981) concerning the effects of acquiring basic literacy skills in nonschool settings serves as a warning against unwarranted optimism here. Contrary to earlier claims they found no evidence to show that literacy affected abstract thinking or, for that matter, any other generalizable ability. The Vai may have been denied what Olson (1977) has called a “culture of literacy” that may amplify the effects of basic literacy into transferable skills. For such participation would enable the literate individuals to apply the initially specific operations in a variety of complex tasks and situations, thus to allow the generalizability of these into skills.

Salomon and Perkins (1984) have recent suggested that the acquisition of knowledge and skill can potentially lead to their transfer if either one of two roads are taken: (a) The acquired skill or knowledge is mindfully and deliberately decontextualized, that is, recoded in a representational code that affords abstraction; or (b) it is practiced to the point of automaticity in a large variety of instances demanding good performance. Exposure to, say, television’s codes, or extensive exploratory activity with Logo geometry could, according this view, lead to the cultivation of transferable skills provided either one of the roads is taken. But this is not easily achieved because the first (mindful) road demands the motivated expenditure of effort, and the second (automatic) demands more and more varied practice than usually afforded in schools. Neither road was taken by the Vai tribesman studied by Scribner and Cole, hence yielding no transfer effects from their new “literacy” to other cognitive tasks. The poor transfer effects of children’s (usually limited) experience with Logo (Pea & Kurland, 1984) may be explained in the same way (Clark & Voogt, in press).

The road from possible to actual transfer is fraught with difficulties. It is certainly not a matter of one-shot, brief experiences and encounters, except in the unlikely event that such mental effort is expended in reaching transferable conclusions, formulate rules, or generating guiding metacognitions. Transfer is somewhat more likely as a consequence of prolonged, continuous, and intensive application of newly developed skill and knowledge, as may be the case after years of televiewing or prolonged focused computer activity.

In all, it appears that media’s symbolic forms and computers’ afforded activities may have skill-cultivating effects, but that these are not necessarily unique nor easily transferable. Future research, particularly that concerned with computer-afforded learning activities will do well to ask not just whether particular skills are acquired but also how else they could be developed, and under what instructional, contextual, and psychological conditions they can be made to transfer.

A Paradigm for Future Development

Thus far, research on media in instruction, much like all research on teaching, has centered on the means of instruction as independent variables and on learning outcomes in the form of knowledge or skill acquisition as dependent variables. In this respect, the basic paradigm which originates from the behavioristic assumptions about human learning has not changed even though cognitive processes have been introduced as mediators between stimuli and responses. Yet, once cognitions are seriously considered one can not escape examining them, not only as mediators but also as partial determiners of the way learners experience the stimulus.

The basic assumption here is that learners often affect the way they experience the so-called stimulus through their previously acquired attributions, personal and socially shared expectations and beliefs, personal interests, and the like. As Shulman (1980) pointed out, “The teacher’s pedagogical actions merely set the task environment for pupil learning, which task environment predictably is transformed by the pupil into his or her own problem space” (p. 7).

Acknowledgement of these phenomenological inputs as factors that affect the way stimuli are experienced, thus handled, reflects the current shift of paradigms for it ascribes the learner a far more active and less externally controlled role. It examines the process of learning as an ongoing transaction or reciprocal interaction between learners and their phenomenologically perceived environment (e.g., Bandura, 1978; Olweus, 1977; Salomon, 1981; Shulman, 1980; Wittrock, 1978).

Media are thus perceived as external devices which along with other factors, set the stage for some cognitive activities precisely because they are part of a learner’s a priori anticipations. What the student thinks or believes to be the case about a particular mediated presentation or class of media can come therefore to exert at least as much influence over learning as the medium itself. This may include beliefs about the medium’s difficulty level, its entertainment potential, the type of information usually presented, and typical instructional demands. Some of these anticipations are socially generated and shared. Shulman (1981), while reviewing the literature on how students invent incorrect problem-solving procedures, pointed out the role of perceived social context in influencing the way problems are treated by students: “The social context of the
classroom changes the meaning of instructional tasks in significant ways. Thus, a problem-to-be-solved and an assignment-to-be-completed are psychologically quite distinct, even if the specific exercise and its attendant solutions are identical in both instances” (p. 19).

Research that uses the reciprocal paradigm is relatively new, but it carries with it a good measure of theoretical and application potential. Only a brief review, suggestive of the types of questions asked, will be attempted here because of space limitations.

**Attitudes Toward Media**

Hess and Tenezakis (1972) explored the affective responses of predominantly Mexican-American, low-SES seventh, eight, and ninth graders to remedial mathematics presented either by computer or teacher. Among a number of interesting findings was an unanticipated attribution of more fairness to the computer than to the teachers. The students reported that the computer treated them more equitably (kept promises, did not make decisions based on stereotypes) than some of the teachers. Students consistently trusted the computer more but found it to be less “flexible,” as well as unresponsive to student desires to change the course of content of the instruction. Similarly, Stimmel, Common, McCaskill, and Durrett (1981) found a strong negative affect toward computers and computerized instruction among a large group of preservice teachers. These same teacher trainees had similar reactions to mathematics and science teaching and may have associated computers with these disciplines. It would be interesting to study how the perceptions and attitudes of computer users guide their strategies for learning from computers, how these different strategies influence learning, and how work with computers changes or maintains these perceptions reciprocally.

**Perceived Learning Demands from Different Media**

Presumably, differences in the qualities attributed to different media may influence learning-related behaviors of students. Ksobiech (1976) and Salomon (1981) have reported studies wherein student beliefs about the different demands placed on them by different media influenced their approach to learning tasks. Ksobiech (1976) told 60 undergraduates variously that televised and book lessons were to be evaluated by them, were to be entertaining, or were to be the subject of a test. The test group performed best on a subsequent examination with the evaluation group next best, and the students who expected to be entertained showing the poorest exam performance. Some subjects were allowed to push a button and receive more video or more narrative content from the televised treatment. The test group consistently chose more narrative (verbal) information, presumably because they believed that it was a surer route to the factual information they needed to succeed at the test. Also, the subjects who believed that a test awaited them persisted longer than the other groups.

Salomon (1981) has recently suggested a model for conceptualizing these differences in mental effort expenditure that result from different attributions to the media.

According to Salomon’s model, the amount of mental effort invested in nonautomatic elaboration of material (i.e., the extent of mindful processing) depends primarily on two factors: the learners’ perception of the learning-relevant characteristics of the medium and task, and their own perceived self-efficacy in elaborating the information they will receive. In a series of studies (see Salomon, 1983a for summary) he found that television is perceived to be mentally less demanding than print material of comparable content and that learners report investing less mental effort in television. This, in turn, led the more able students to generate fewer inferences from such material. Manipulating the learners’ perceived task demands positively affected the amount of effort they invested and the amount of inferential learning they achieved from television. Students also came to mobilize their abilities more readily, thus moving the more able students ahead of their less able peers.

Merrill (1984) tried to affect learners’ control over content, pace, display, and other input variables through the careful design of TICCIT computer-assisted instruction. None of the manipulated control variables accounted for learning differences. The only variable that did account for learning differences was an estimate of the amount of effort invested provided by the learners themselves on a posttreatment questionnaire. These findings can be taken to support the claim that learners’ choices of effort investment strategies affect learning quite independently of the manipulation of instructional program features. The Merrill data suggest that effort investment, an important facilitator of nonautomatic processing of material, is very much “cognitive penetrable” and not totally subject to the “objective” attributes of media.

**Student Choice of Media and Method**

Another area that provides consistent evidence for the perceived learning demands of media is the recent literature on student choice of instructional
conditions. Saracho (1982), Machula (1978-1979), and Clark (1982) reported studies wherein student enjoyment of instructional media and their subsequent achievement were negatively correlated. The results of these studies suggest that allowing students to choose the medium or method they prefer may not always result in maximum learning outcomes.

In a yearlong study involving over 250 third to sixth grade students, Saracho (1982) found that those assigned to computer-assisted instruction in basic skills like the computer less but learned more than from other media. Similarly, Machula (1978-1979) gave instruction to over 100 undergraduates via television, voice recording, and printed text. Students liked the television less but learned more from it than from the voice recording, which they liked more.

Clark (1982) has reviewed similar studies and has suggested that students use erroneous a priori rules to choose media or methods which often result in less learning than when their aptitudes are used to assign them to instructional conditions. Students incorrectly assess the extent to which the instructional methods associated with the medium will allow them the most efficient use of their effort. Strong interactions with general ability are often found in this research. Higher ability students seem to like methods and media that they perceive as better structured and more directive because they think these demand less effort to achieve success. However, more structured methods prevent these higher ability students from employing their own considerably skills and therefore yield poorer achievements than methods that require them to structure their own learning activities. Lower ability students, on the other hand, seem to like the less structured and more discovery-oriented methods and media. They seem to want to avoid investing the effort required by the more structured approaches, which they may expect to result in failure. Since investing more effort to achieve the same disappointing results is less attractive, they prefer the unstructured approaches whereby they can control the effort they invest and remain relatively anonymous in the process. These lower ability students, however, need more structure and so they tend to achieve less with the instructional methods they prefer more.

The change we anticipate in the basic paradigm on media and technology is not from an instructionally centered (“situational”) approach to a learner-centered (“personological”) one. Rather, it is a shift from a unidirectional view to a reciprocal view. The instructional powers do not reside solely in the media, for the way one perceives media influences the way one treats them. Nor, however, are learners the sole power brokers, for their perceptions are founded on the kinds of media they actually encounter and the activities they are actually afforded. Research in this domain, if it is to follow a reciprocal paradigm, may benefit from the recent advances made in other fields – such as personality research (e.g., Mischel, 1984), spatial cognition (e.g., Olson & Bialystock, 1983), aptitude processes (Kyllonen et al., 1984), and person environment interaction (Magnusson, 1981) – where such a paradigm is used.

Summary and Conclusion

The history of our experience with media in teaching has been characterized by ambivalent expectations. One the one hand, each new medium has raised our hopes for benefits to instruction and learning similar to those achieved in the entertainment, communication, and information-handling arenas. These hopes are encouraged by large industries who hope to sell newer electronic media to schools. The extraordinary development of the computer and video disc technologies in the past decade has been the most recent source of this expectation.

On the other hand, there has been a historical concern on the part of parents and educators over the impact of increased exposure to newer media. This concern carries with it a fear that children might be somehow harmed or misdirected if they spend too much time with newer mediums such as video games or television.

These expectations and fears have stimulated a great deal of research interest in the past decade and a number of attempts to build models and theories. Perhaps the most positive outcome of this effort has been a shift in the focus of research questions about media. Earlier studies, initially generated during the behavioral emphasis on external events in instruction, emphasized gross, undifferentiated comparisons of the learning impact of newer media such as television with more “traditional” media such as classroom instruction. Recent studies have exchanged the behavioral based comparison between media with more cognitively oriented questions. We moved form asking which medium was a better teacher to a concern with which “attributes” of media might combine with learner traits under different task conditions and performance demands to produce different kinds of learning. So, for example, these newer questions ask about the possible cognitive effects of explicit filmic supplantation of cognitive operations on students’ mastery of related skills: or about the relative effectiveness of animating actual
object movement in teaching allowable moves in chess.

Most important during the past decade was the development of long-overdue theories and models. The theories that have attracted the most attention are those concerned with the cognitive processes activated and cultivated as a result of instruction based in media attributes. These “symbol system” theories have led to a number of engaging hypotheses such as Olson’s (1977) claim that “intelligence is skill in a medium,” and Salomon’s (1979) expectation that student comprehension will be aided when symbolic modes of instruction more closely match student cognitive representations.

The symbol system theories have generated controversy as might be expected when the focus of a field shifts. It is interesting to note that the disputes surrounding the symbol system theories have close parallels with questions that are currently being debated in the general cognitive sciences. For example, one implicit claim of early symbol system theory inspired by Bruner (1964) was that different symbolic modes might result in the cultivation of unique cognitive skills. This expectation provided impetus for a now-considerable body of research. To date, the results of that research have suggested that different symbolic attributes of media can, under special conditions, cultivate cognitive skills. However, the issue of whether these skills are the unique products of media attributes or symbolic modes and whether the attributes serve functionally different cognitive operations is still being discussed.

The research evidence seems very similar to what has been found in the dispute between dual coding and proposition proponents in the general cognitive literature (e.g., Kosslyn, 1981; Pylyshyn, 1981). Dual encoding research provides evidence that different types of images can have unique influences on learning and memory. Other data are offered to support an alternative view that images are coded into abstract, semantic propositions for storage and later recalled to “construct” or “reconstruct” specific images. Here a logical extension of existing arguments would suggest that many different images could be coded in the same proposition and that the form of an instructional representation has less of an effect than initially assumed.

Generally, it appears that media do not affect learning in and of themselves. Rather, some particular qualities of media may affect particular cognitions that are relevant for the learning of the knowledge or skill required by students with specific aptitude levels when learning some tasks. These cognitive effects are not necessarily unique to one or another medium or attribute of a medium. The same cognitive effect may often be obtained by other means, which suggests a measure of “functional equivalence.” This implies that there may be “families” of functionally equivalent but nominally different instructional presentation forms.

It is also important to note that uniqueness is not an all-or-nothing concept. Some “families” may be relatively small and many of these functionally equivalent groups will contain forms that are more difficult or expensive to duplicate than others. For example, the kind of cognitive effects that Papert expects the programming activities “logo” to produce could, in principle, be replicated by direct teaching of logic. However, in actuality, this functional equivalence would be extremely difficult to obtain in most classrooms given current curricular realities. Moreover, direct instruction may be functionally equivalent to programming in one respect (e.g., facilitation of procedural logic) but not in others (e.g., addressing some learners’ need for control).

Lessons for Future Research

As we suggested in the beginning of this chapter, there are lessons to be discerned from past research that may inform future research questions addressed at new media. It is to these lessons that we turn at last.

There is an already rapidly growing body of studies comparing computer-based instruction with more conventional means (e.g., Kulik et al., 1980 have identified over 500 such studies reminiscent of the old TV-versus-traditional-instruction question). There is also a growing interest in the cognitive effects of media-related activities such as inductive thinking skills affected by computer games (e.g., Greenfield, 1984), which is a renewal of similar questions asked in reference to television. It seems that as each new medium comes along, researchers select questions previously addressed to older media (Clark, in press; Gardner, 1982; Wartella & Reeves, 1983). Some of these questions seem, on the basis of past experience, to be more useful than others. Our summary of some of the most important lessons and questions follows:

1. Past research on media has shown quite clearly that no medium enhances learning more than any other medium regardless of learning task, learner traits, symbolic elements, curriculum content, or setting.

Gross comparisons of computers or video disc technologies versus more conventional media for instruction are not likely to provide to be more useful in the future than they have been in the past. All such research to date is subject to compelling rival
hypotheses concerning uncontrolled effects of instructional content, method, and novelty. We do not expect that any known or to-be-developed media will alter this expectation. However, evaluations of developed and developing media-based programs might usefully compare alternative forms of delivering and shaping instruction on the basis of cost efficiency, and appeal to students without making inferences about “learning” or “performance” advantages due to the medium selected. This would also suggest that future media selection schemes (e.g., Reiser & Gagne, 1982) should be based on appeal and efficiency rather than presumed learning benefits.

2. Any new technology is likely to teach better than its predecessors because it generally provides better prepared instructional materials and its novelty engages learners.

While media are not causal factors in learning, they often provide the focus for curricular reform. As each new medium is developed and gradually introduced to educational settings, it provides the opportunity for trying out novel and often engaging instructional design strategies. This is particularly true if the new medium is held in as much awe as computers.

So, as each new medium is put into educational use, researchers might consider a number of different questions. For example, we might ask about the impact of a medium’s introduction on the setting (e.g., organizational climate, interactions between provider and user groups, allocation of resources), and the changes the setting undergoes (e.g., Sheingold, et al., 1983). It would be useful to have more investigation of two aspects of the problem: first, the way that such innovations naturally influence educational settings and resources, and ways that such introductions might be made to influence desirable outcomes. This latter type of question is particularly important in the case of computers since their available modes of use and their actual influence on education are still far from their potential.

Aside from organizational and resource changes, newer media also afford convenient and often novel ways to shape instructional presentations. Of course, there is evidence from past symbol system and general cognitive science research that many different symbolic representations, such as those resulting from exposure to different media attributes, sometimes serve the same or similar functions in cognitive processing. Yet, we should notice that newer media such as computers allow for flexible and local construction of the conditions that facilitate skill cultivation, even though these materials might also be constructed in other ways. In this fashion, newer media serve as a proxy for the causal variables that influence learning and performance. Here the researcher is relatively unconcerned with the way that media attributes naturally influence learning. As in the case of organizational change, the concern is with the way that media attributes and the instructional presentations they afford can be directed in the most efficient way to achieve learning goals.

Finally, researchers might wish to follow upon the issue of the “functional equivalence” between nominally different media attributes. It appears that there are “families” of attributes that may have similar cognitive consequences when they are used in instruction. It would be interesting to learn whether there are ways to predict such family “memberships” and whether these families vary in uniqueness, size, and impact. For example, does functional equivalence follow from structural similarity? Or, is structural similarity irrelevant?

Researchers should also note that few, if any, profound cognitive effects of the kind often expected from computer-afforded learning activities can be expected from brief exposures and occasional engagements. If, for example, essay writing on word processors is to effect essay-writing ability (e.g., Kane, 1983), then no short-term, out-of-context experience with the tool is likely to show much of an effect. The activity must be central, continuous, consequential, and mindfully carried out in order to render observable effects.

3. Future research on media should be conducted in the context of and with reference to similar questions in the general cognitive sciences.

One of the truly important changes to take place in media research in the past decade is the change from an externally oriented, behavioral approach to a more cognitive, interactive, reciprocal focus. Current views suggest that instructional efficacy does not reside in either external or internal events alone, but that complex interactions between events in each domain will characterize the most productive hypotheses. These newer questions, particularly those associated with the symbol system theories, bear a strong resemblance to those in various domains of cognitive sciences such as artificial intelligence, information processing, attribution theory, dual coding, and imagery, and studies of the antecedents of various kinds of transfer of learning and training. While different perspectives on the same problems have a strong and productive history in most sciences, George Mandler’s recent caution (1984) is that we might find it “useful to learn more
about the achievements and disasters of other scientific enterprises, lest the blinding insights that you discover at regular intervals turn out to be somebody else’s old says” (p. 314).

4. In the future, researchers might ask not only how and why at medium operates in instruction and learning, but also why it should be used at all.

The final ethical question raised by the history of media use in teaching is the pattern of its use by educators. In the past there has been a pattern of adoption by schools in response to external pressures from commercial and community special interests rather than as a result of an identified and expressed need. Most new media are not developed with educational applications as their foremost goal. Consequently, decisions to adopt them occur before there is clear evidence about their efficacy or the availability of superior materials. This was certainly the ease with television and is as clearly the cast with microcomputers. While the enthusiasms that surround the introduction of a new medium lend a certain currency and legitimacy to schools, they also take scarce resources away from already identified priorities. Not everything that is available for empirical study is, when seen in perspective, also desirable to study.

This is not to imply, however, that the very availability of TV or computers is in itself a poor justification for their demands on the educational system. The conscientious researcher may, on occasion, recommend that schools postpone their entry into a “higher tech” era before a number of basic questions have been addressed. For example, we need to know how media might be made to support instructional objectives and other roles it takes on, what the teachers’ role will be when children receive most of their instruction from computers, and how already overburdened schools will accommodate the special demands of newer media. The study and development of media in education are aimed at the improvement of the education, not the glorification of the media. This, then, suggests a new class of questions to be asked: not only what technology, for whom, and so forth, but why this technology now? The lesson was best expressed by Seymour Sarason (1984), who pointed out that “Because something can be studied or developed is, in itself, an insufficient base for doing it however wondrous it appears to be in regard to understanding and controlling our world” (p. 480).