

Instructional Design for Teaching by Satellite

James W. King
IANR Communications and Computing Services
University of Nebraska - Lincoln
Lincoln, NE 68583-0918

A. The Purpose of This Paper:

This paper will

- define cognition,
- explain a model of cognition applicable to distance learning efforts,
- list seven generalizations from cognitive psychology, and
- introduce their implications for message design.

My focus is on instructional design for teaching by satellite. Why? If a satellite presentation, a print piece, video, or computer screen is unfamiliar to the audience, it may be a problem to be solved rather than an aid to understanding the message (Kosslyn, 1985; Lewandowsky and Spence, 1989).

B. The Process of the Mind: Cognition:

Mental activities are the processes of the mind - cognitive processes. Such processes include remembering, self-awareness, thinking, reading, writing, problem solving, and creativity. With principles from cognitive psychology, we can improve the effectiveness of our teaching and design of instructional messages. As a result, our audiences will better understand us.

Blending cognitive psychology and communication, we can say that learning is a constructive process. Learning results when internal human processes act on and transform incoming data and messages (Wildman, 1981). Thus, learning is a very lively process. Background and experience contribute to the development of meaning and understanding (Wildman and Burton, 1981). While we cannot control the internal processing of other people, we can design messages which best take advantage of particular media.

C. An Information Processing Model:

Researchers model cognitive processes in the human using three major information processing components -- sensory registers, working memory, and long-term memory.

Sensory Registers: Sensory registers are our eyes, ears, and nose (and skin/nerves). Each receptor discriminates between stimuli which can cue or prompt certain responses in the person. Media have certain attributes that may stimulate certain receptors. Limitations in a person's sense receptors affect information processing. Perception, determining the meaning of what is sensed, is an important cognitive element. If you cannot give meaning to something you perceive, you may not have sensed it well or have not learned to sense, process, and give meaning to that thing. Perception is not immediate. Cognitive processing requires time. It also requires other components of cognition, such as the linking mechanism to other, stored meanings, the long-term memory. Perceptions build on what we already know. We know that exposure and attention to a message do not always develop into understanding and behavioral change.

Long-Term Memory: The fixed storehouse of our information is long-term memory.

Information is anything which reduces uncertainty. Therefore people perceive and receive messages and data, not information. Through their own interpretation and linkage with other things they learn or with other stored data and messages, they make the new messages and data into information. People themselves reduce the uncertainty of the world around them. Information develops in the mind of the individual, through the process we are now describing, and exists only in that person's mind.

Dervin (1989) says the "whatever one group of individuals calls 'information' or 'knowledge' at any given point in time is applicable only to that time and space and to the self-interests and observing capacities of that 'observers'" (p. 70). She also develops the theory of information as construction, "...information is created by human observers, is inherently a product of human self-interest, and can never be separated from the observers who created it..." (p. 72.) Messages must be "...understood as subjective and transmitted as subjective..." (Dervin, 1981; p. 75).

When people have information which enables them to give meaning to new communication stimuli, those messages and data become important.

Another concept is that of schemata -- "...how our knowledge is represented in memory" (Bonner, 1988; p.4). As new messages and data are perceived, we modify our schemata. Think how implications of schemata might relate to instruction:

- New messages are stored in previously formed schemata.
- Schemata influences recall of previous information.
- A schema gives us a tool to develop inferences to fill the holes in messages we perceive.
- People can evaluate and modify schemata. (Bonner, 1988).

Working Memory: "Thinking" occurs in the working memory; it is our consciousness. Our working memory controls perception, makes judgments, answers questions, and creates new information which we may store in long-term memory. We rehearse the messages we have just perceived, we compare the new messages to information in the long-term memory, and we may integrate the new and the old (Gagne and Glaser, 1987).

Processing includes getting and altering incoming messages, reviewing and comparing them to what we already know, and making decisions about what to do with the messages. Attention, the focusing on messages, is one important cognitive process in the working memory. Attention is limited and selective.

What we call short-term memory is part of working memory. The basic processing, practicing, and transferring of incoming messages are the main tasks in short-term memory. It brings together new messages with old messages (which now may be information), and through "thinking processes" may transform and reform them into new information. This new information may be lost, briefly used, or stored in long-term memory.

Within the cognitive paradigm, forgetting becomes an unsuccessful search and retrieval process (Gagne, 1985), or "deficient retrieval strategies" (Hannafin and Reiber, 1989a).

Summary: This information processing model of cognition accentuates connections. When everything is working well, linkages between components are efficiently made.

Meaningfulness is a major element of cognition, and of all new messages. "Meaning organizes our perception, attention, short-term memory, long-term memory, and our ability to integrate these components into problem solving and creativity".

Another important cognitive process is metacognition, -- thinking about thinking. Being aware of, checking, and adjusting thought processes help people monitor and change their behaviors or ideas. Metacognition includes the strategies we use while solving problems or making decisions.

D. Why Is the Study of Human Cognition Important? Some Generalizations:

Sudman and Schwartz (1989; p. 49) point out that people "rarely retrieve all the information that is potentially relevant to the judgment at hand. Rather, they truncate the search process as soon as enough information has come to mind to form a judgment with sufficient subjective certainty (Bodermhausen and Wyer, 1987; Wyer and Srull, 1986)."

From the research and writings on cognition, several generalizations emerge. They are important because they can help us identify ways to shape messages.

1. People are active processors of messages and data.

- Choose content which is or can be made meaningful to the audience.
- Employ questions and role playing so people learn inquiry strategies and basic data and messages.
- Provide active learning environments where practice is possible.

2. Learning occurs best when messages and data are meaningful to people.

- Include audience analysis techniques, such as the Myers-Briggs Type Indicator or the Kolb Learning Styles Inventory to match topic and approach.
- Relate topic to the strong interests of the audience.
- Ask participants to relate the message to things they already know. Have them verbalize these relationships. Require them to apply their own knowledge base.
- Identify new concepts and define and describe them. Provide examples and non-examples.
- Point out or ask for the implications of the message or data.

3. Information is stored in an organized framework (the schema.)

- Employ active techniques to help participants retrieve information.
- Develop hooks so audiences can link new data to existing knowledge.
- Be specific because vagueness offers no assistance in using existing information.

4. How people learn may be more important than what they learn.

- Use techniques which encourage questioning, evaluation, and solving problems. (These methods will promote thinking.)
- Structure messages so participants have opportunities and time to "think about thinking."
- Ask audiences how they remember and learn things.

5. Cognitive processes become automatic with repeated use.

- Embed practice in messages.
- Repeat messages in a variety of ways and media.
- Sustain interactivity over time.
- Fade prompts and offer a mixture of feedback routines.
- Use drill and practice to enhance participant accuracy, speed, and performance.

6. Metacognitive skills can be developed.

- Use the structured aspects of the interaction of the message and the medium to enhance skills, such as outlines, key words, headlines.
- Build into message design skills such as summarizing and self-questioning. For example, have participants identify and delete meaningless data and messages. Ask them to remove redundant messages or data. Model how they can replace general terms for lists.
- Tell participants that certain messages may be difficult or may make cognitive demands on them.
- Give examples of messages organization (headings, summaries, number one, etc.).

7. Internal motivation is important for learning.

- Sustain attention by providing some unclear, unfinished, or uncertain messages or data (which have been designed that way).
- Present situations in which conflict and/or different points of view exist.
- Stress personal outcomes of the messages for the audience or ask them to identify the implications.
- Note to the audience that learning from a given medium will require some effort from them, and that they cannot be passive.
- Discuss alternative conclusions with audiences to enhance their ability to reconcile a variety of materials.

8. Information processing capabilities of an "audience" are wide-ranging. "...adolescent and adult structures of knowledge and individual differences are often uneven and nonlinear" (Foster, 1986, p. 237).

- Design messages to offer a variety of pacing.
- Arrange messages so breaks exist; offer participants opportunities to reflect, process, or review ideas,

E. How Can I Use These Ideas: Applications

We can apply these ideas to the design and development of satellite instruction. Below are several application steps of cognition for particular media.

1. Video/TV/Satellite (visually-intensive, viewing, reading and notetaking, medium controlled, interaction possible but dependent on hardware and program design, access variable depending on the particular media):

- Provide models of and show the targeted activities and behaviors. Imagery can aid rehearsal, meaning, and long-term storage of messages.
- Identify program topics early into the program for the participants.
- Present fewer ideas, and show them in depth; show relationships, draw analogies, suggest variations, use redundancy.
- Call on participants (with interactive methods) to state their goals and to anticipate what they will learn. Use audio links to provide feedback and guidance.
- Change between oral/visual and only visual presentations.
- Have talent think aloud so viewers can understand the thinking process.
- Use approaches which stress comprehension strategies.
- Remind the audience that learning materials from video/TV/satellite will require them to exert mental effort and that we are expecting them to pay attention to understand certain material. Cue audience to use particular learning strategies.
- Develop structured outlines and notes for audience use during the program. Embed questions, summaries, and response opportunities. Endorse notetaking.
- State the differences in pacing for younger and older audiences.

2. Print (text-intensive, reading, audience control, cognitively engaged but overtly passive, easy access):

- Explain how the content links to other materials through references and examples.
- List the content topics and/or overtly outline the structure of the message.
- Discriminate distinctly between main and supporting ideas.
- Chunk messages to attract attention and stimulate interest. (Also use queuing or ordering, filtering, and abstracting [see Martin, 1989]).
- Use mnemonics and imaging/visualization techniques.
- Urge participants to reread and/or review the materials. Devise participatory learning activities.
- Remove irrelevant data in pictures.

- Supplement text messages with pictures and illustrations which have special processing instruction
- Repeat critical content; increase the number of examples; provide different categories of visuals (charts, graphics, line drawings).
- Present or given questions at the end of the material for the audience to discuss or individually answer.
- Design text for optimum readability so reader motivation is enhanced.

3. Computer programs (text-intensive, reading, audience and machine pacing, responsive to the level of participation of the program, questionable access):

- Include drill and practice techniques to help participants gain automaticity of skills.
- Use spaced practice sessions, rather than massed practice.
- Provide maps and menus to aid participants in thinking about what they are learning.
- Limit on-screen reading to major issues; use supplemental materials for large reading assignments.
- Develop advanced organizers and state objectives.
- Review the latest literature on reinforcement of correct and wrong answers. There are many novel suggestions to nurture learning which are just now being discovered.
- Supply a very visible and visual formal footing and trail when using hypertext programming.

F. This Is Interesting, But So What? Closing Notes:

In a very provocative article, Taylor and Brown (1988) point out that people have:

- overly positive self-evaluation,
- exaggerated perceptions of control or mastery, and
- unrealistic optimism about themselves and the future.

While these illusions promote healthy functioning, they can cause trouble when we try to communicate.

"Evidence from social cognition research suggests that, contrary to much traditional psychological wisdom, the mentally healthy person may not be fully cognizant of the day-to-day flotsam and jetsam of life. Rather, the mentally healthy person appears to have the enviable capacity to **distort reality in a direction that enhances self-esteem, maintains beliefs in personal efficacy, and promotes an optimistic view of the future.**" (Taylor and Brown, 1988; p. 203-204).

To me, this means we must understand and be responsive to our target audiences who receive the messages, to the clientele who use our services, and to ourselves.

Tying Taylor and Brown's ideas with Dervin's (1989) statement that "...communication cannot be conceptualized as *transmission*. Rather, it must be conceptualized in terms of both parties involved in creating meaning, by means of *dialogue* (p. 72), I believe we are led to see the following:

"...that the hardware of technology are but means we have to use the "peopleware" of technology in designing our instructional messages."

The future will go to those who realize that audience-sender dialogue and participation will undergrid tomorrow's communication efforts, if they are to succeed.

References:

- Anderson, T. G. 1987. Beyond Einstein. In A. Ambron and K. Hooper (eds.), *Interactive Multimedia*. Redmond, WA: Microsoft.
- Bettman, J. R., J. W. Payne, R. Staelin. 1986. Cognitive considerations in designing effective labels for presenting risk information. *J. Public Policy and Marketing*. 5. 1-28.
- Bodenhause, G., and R. S. Wyler. 1987. Social cognition and social reality. In H. J. Hippler, N. Schwarz, and S. Sudman (eds.), *Social Information Processing and Survey Methodology*. New York: Springer-Verlag, Inc.
- Bohlin, R.M., W.D. Milheim, and K.J. Viechnicki. 1993. The development of a model for the design of motivational adult instruction in higher education. *J. Educational Technology Systems*. 22(1): 3-17.
- Bonner, J. 1988. Implications of cognitive theory for instructional design: revisited. *ECTJ (Educational Communications and Technology J.* 36(1). 3-14.
- Bonner, J. 1982. Systematic lesson design for adult learners. *J. Instructional Development*. 6(1). 34-42.
- Bonwell, C.C. and J.A. Eison. 1991. *Active learning: Creating excitement in the classroom*. ASHE-ERIC Higher Education Report 1. 1991. Washington, D.C. George Washington Univ. School of Education and Human Development.
- Bracey, G. 1990. Results of cognition research could help improve educational software. *Electronic Learning*. 9(4). 18, 20.
- Bromage, B. K. and R. E. Mayer. 1986. Quantitative and qualitative effects of repetition on learning from technical text. *J. Educational Psychology*. 78(4). 271-278.
- Brundage, D. and D. MacKeracher. 1980. *Adult learning principles and their application to program planning*. Toronto: O.I.S.E.
- Bruning, I. L. 1983. An information processing approach to a theory of instruction. *ECTJ. [Educational Communications Technology J.]* 31(2). 91-101.
- Cacioppo, J. T. and R. E. Petty. 1989. Effects of message repetition on argument processing, recall, and persuasion. *Basic and Applied Social Psychology*. 10(1). 3-12.
- Carrier, C. A. 1983. Notetaking research. *J. Instructional Development*. 6(3). 19-25.
- Clark, S.K. 1994. Training implication for our graying work force. *Performance and Instruction*. 33(1): 30-32.
- Cook, L. K. and R. E. Mayer. 1988. Teaching readers about the structure of scientific text. *J. Educational Psychology*. 80(4). 448-456.
- Cranton, P. and M. Kompf. 1989. Adult education and health professions training: a paradox? *J. Educational Thought*. 23(1). 15-26.
- Cyrs, T.W., and F.A. Smith. 1990. *Teleclass teaching*. Las Cruces, NM. Center for Educational Development, College of Human and Community Services, New Mexico State University.
- Dempsey, J. V. and S. U. Wager. 1988. A taxonomy for the timing of feedback in computer-based instruction. *Educational Technology*. 28(10). 20-25.
- Dervin, B. 1989. Audience as listener and learner, teacher and confidante: the sense-making approach. In R. E. Rice, and C. K. Atkin, *Public Communication Campaigns (2nd Edition)*. Newbury Park: Sage. 67-86.
- Dervin, B. 1983. Information as a user construct: the relevance of perceived information needs to synthesis and interpretation. In S. A. Ward and L. J. Reed (eds.) *Knowledge Structure and Use: Implications for Synthesis and Interpretation*. Philadelphia: Temple University Press. 575-607.
- Dervin, B. 1981. Mass communicating: changing conceptions of the audience. In R. E. Rice and W. J. Paisley, *Public Communication Campaigns (1st Edition)*. Beverly Hills: Sage. 71-87.
- Deshler, D. and G. Gay. 1986. Educational strategies for interactive videodisc design. *Educational Technology*. 26(12). 12-17.
- Duchastel, P. C. 1988. Display and interaction features of instructional texts and computers. *British J. Educational Technology*. 19(1). 58-65.
- Duffy, T. M., L. Higgins, B. Mehlengacher, C. Cockran, D. Wallace, C. Hill, D. Haugen, M. McCaffrey, R. Burnett, S. Sloane, and S. Smith. 1989. Models for the design of instructional text. *Reading Research Quarterly*. 24(4). 434-457.
- Dwyer, C. A. and F. M. Dwyer. 1989. Improving visual learning: strategies and procedures. Paper presented at the annual convention of the Association for Educational Communications and Technology. Dallas, TX. February 1989.
- Earl, T. and K. Meyer-Hartwig. 1986. Video presentations that have to teach. *J. Educational Television*. 12(3). 167-173.
- Edell, J. A. and K. L. Keller. 1989. The information processing of coordinated media campaigns. *J. Marketing Research*. 26(2). 149-163.
- Fleming, M. L. 1977. The picture in your mind. *AVCR (Audio-Visual Communication Review)*. 25(1). 43-62.
- Foster, S. F. 1986. Ten principles of learning revised in accordance with cognitive psychology: with implications for teaching. *Educational Psychologist*. 21(3). 235-243.
- Gagne, R. M. 1985. *The conditions of learning and theory of instruction (4th edition)*. New York: Holt, Reinhart and Winston.

- Gagne, R. M. and W. Dick. 1983. Instructional psychology. *Annual Review of Psychology*. 34. 261-295.
- Gagne, R. M. and R. Glaser. 1987. Foundations in learning research. In R. M. Gagne (ed.), *Instructional Technology: Foundations*. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers. 49-83.
- Glover, J. A. and R. H. Bruning. 1987. *Educational Psychology: Principles and Applications (2nd Edition)*. Boston: Little, Brown and Company.
- Greenfield, P. and J. Beagles-Roos. 1988. Radio vs. television: their cognitive impact on children of different socioeconomic and ethnic groups. *J. Communication*. 38(2). 71-92.
- Hannafin, M. J. and T. L. Phillips. 1987. Perspectives in the design of interactive video: beyond tape versus disc. *J. Research and Development in Education*. 21(1). 44-60.
- Hannafin, M. J. and L. P. Reiber. 1989a. Psychological foundations of instructional design for emerging computer-based instructional technologies: part 1. *ETR&D (Educational Technology, Research, and Development)*. 37(2). 91-101.
- Hannafin, M. J. and L. P. Reiber. 1989b. Psychological foundations of instructional design for emerging computer-based instructional technologies: part 2. *ETR&D (Educational Technology, Research, and Development)*. 37(2). 102-114.
- Helsel, D. G. and L. B. Hughes, Jr. 1983. Instructional improvement through cognitive psychology. *J. Agronomic Education*. 12. 80-83.
- Jacoby, J. and W. D. Hoyer. 1989. The comprehension/miscomprehension of print communication: selected findings. *J. Consumer Research*. 15(4). 434-443.
- Johnson, J.J. 1994. Cognition and aging: a practical analysis. *Performance and Instruction*. 33(1): 33-35.
- Kiewra, K. A. 1985. Providing the instructor's notes: an effective addition to student notetaking. *Educational Psychologist*. 20(1). 33-39.
- King, J. W. 1990. Using media in teaching. *Teaching at UNL*. 11(3). 1-3.
- Knight, J. 1988. 7 strategies for improving instruction. *NACTA J*. 32(1). 13-16.
- Kozma, R. B. 1986. Implications of instructional psychology for the design of educational television. *ECTJ (Educational Communications and Technology J.)* 34(1). 11-19.
- Kozma, R. B. 1987. The implications of cognitive psychology for computer-based learning tools. *Educational Technology*. 27(11). 20-25.
- Kolb, D. 1984. *Experiential Learning: Experience as the source of learning*. Englewood Cliffs, NJ:Prentice-Hall.
- Kosslyn, S. M. 1985. Graphics and human information processing. *J American Statistical Association*. 80. 499-512.
- Krendl, K. A. 1986. Media influence on learning: examining the role of preconceptions. *ECTJ (Educational Communications and Technology J.)* 34(4). 223-234.
- Lanese, L. D. 1983. Applying principles of learning to adult training programs. *Educational Technology*. 23(3). 15-17.
- Lewandowsky, S. and I. Spense. 1989. The perception of statistical graphs. *Sociological Methods and Research*. 18(2&3). 200-242.
- Lin, C. A. and K. W. Creswell. 1989. Effects of televised lecture presentation styles on student learning. *J. Educational Television*. 15(1). 37-52.
- MacLachlan, J. 1984. Making a message memorable and persuasive. *J. Advertising Research*. 23(6). 51-59.
- Malone, T. W. 1981. Toward a theory of intrinsically motivating instruction. *Cognitive Science*. 4. (333-369).
- Martin, M. 1989. The semiology of documents. *IEEE Transaction on Professional Communication*. 32(3). 171-177.
- Martin, M. 1988. Visual development of documents. In. *Proceedings: 35th ITCC*. Washington, D.C.:Society for Technical Communications. (pages) VC-48 - VC-50.
- Mayer, R. E. 1989. Models for understanding. *Review of Educational Research*. 59(1). 43-64.
- Mayer, R. E. 1989. Systematic thinking fostered by illustrations in scientific text. *J. Educational Psychology*. 81(2). 240-246.
- Myers, I. B. 1987. *Introduction to Type: A description of the theory and applications of the Myers-Briggs Type Indicator (4th Edition)*. Palo Alto, CA: Consulting Psychologists Press.
- Owens, D. 1988. Designing instruction for older adults. *Programmed Learning and Educational Technology*. 25(1). 23-27.
- Paivio, A. 1980. Imagery as a private audiovisual aid. *Instructional Science*. 9. 295-309.
- Perkins, D., E.Jay and S.Tishman. 1993. New conception of thinking: from ontology to education. *Educational Psychologist*. 28(1): 67-85.
- Peterson, P. L. 1988. Making learning meaningful: lessons from research on cognition and instruction. *Educational Psychologist*. 23(4). 365-373.
- Rambally, G. K. and R. S. Rambally. 1987. Human factors in CAI design. *Computers and Education*. 11(2). 149-153.
- Reif, F. 1987. Instructional design, cognition, and technology: applications to the teaching of scientific concepts. *J. Research in Science Teaching*. 24(4). 309-324.
- Reilly, S. S. and J. W. Roach. 1986. Designing human/computer interfaces: a comparison of human factors and graphic arts principles. *Educational Technology*. 26(1). 36-40.

- Richardson, P. 1990. Telecommunications and Adult Learning. *New Direction for Continuing Education*. 5: 31-40.
- Salisbury, D. F. 1990. Cognitive Psychology and its implications for designing drill and practice programs for computers. *J. Computer-Based Instruction*. 17(1). 23-30.
- Salisbury, D. F., B. F. Richards, and J.-D. Klein. 1985. Designing practice: a review of prescriptions and recommendations from instructional design theories. *J. Instructional Development*. 8(4). 9-19.
- Salomon, G. 1984. Television is "easy" and print is "tough": the differential investment of mental effort in learning as a function of perceptions and attributions. *J. Educational Psychology*. 76(4). 647-658.
- Salomon, G. and H. Gardner. 1986. The computer as educator: lessons from television research. *Educational Researcher*. 15(1). 13-19.
- Salomon, G. and T. Leigh. 1984. Predispositions about learning from print and television. *J. Communication*. 34(2). 119-135.
- Samuels, S. J., R. Tennyson, L. Sax, P. Mulcahy, N. Schermer, H. Hajovy. 1988. Adults' use of text structure in the recall of a scientific journal article. *J. Educational Research*. 81(3). 171-174.
- Shneiderman, B. 1987. *Designing the User Interface: Strategies for Effective Human-Computer Interaction*. Reading, MA: Addison Wesley.
- Shuell, T. J. 1986. Cognitive conceptions of learning. *Review of Educational Research*. 56(4). 411-436.
- Snow, R. E. and D. F. Lohman. 1984. Toward a theory of cognitive aptitude for learning from instruction. *J. Educational Psychology*. 76(3). 347-376.
- Steinberg, E. R. 1989. Cognition and learner control: a literature review, 1977-1988. *J. Computer-Based Instruction*. 16(4). 117-121.
- Stewart, A. 1989. Cognitive and affective dimensions of readability. Paper presented at the annual convention of the Association for Educational Communications and Technology. Dallas, TX. February 1989.
- Stewart, A. 1986. Principles for the design of instructional text. Paper presented at the annual meeting of the American Educational Research Association. San Francisco. April 1986.
- Story, N. O. and H. J. Sullivan. 1986. Factors that influence continuing motivation. *J. Educational Research*. 80(2). 86-92.
- Strohmer, J. C. 1989. ITV: from talking head to cognitive processing. *Educational Technology*. 29(1). 27-29.
- Suchman, L. 1988. Designing with the user. *ACM Transactions on Office Information Systems* 6(2). 173-183.
- Sudman, S. and N. Schwarz. 1989. Contribution of cognitive psychology to advertising research. *J. Advertising Research*. 28(3). 43-53.
- Sypher, H. E. and E. T. Higgins. 1989. Social cognition and communication. *Communication Research*. 16(3). 309-313.
- Taylor, S. E. and J. D. Brown. Illusion and well-being: a social psychological perspective on mental health. 1988. *Psychological Bulletin*. 103(2). 198-210.
- Tennyson, R. D. and Rasch, M. 1988. Linking cognitive learning theory to instructional prescriptions. *Instructional Science*. 17(4). 369-385.
- Vogt, C. 1989. A new paradigm in computer assisted instruction. Paper presented at the World Future Society. Washington, D.C. July 1989.
- Waddill, P. J., M. A. McDaniel, and G. O. Einstein. 1988. Illustrations as adjuncts to prose: a text-appropriate processing approach. *J. Educational Psychology*. 80(4). 457-464.
- Wager, W. and S. Wager. 1985. Presenting questions, processing responses, and providing feedback in CAI. *J. Instructional Development*. 8(4). 2-8.
- Wagner, E. D. and J. F. Riddle. 1990. Cognitive and affective issues in instructional teleconferencing: a distance learning case study. Paper presented at the annual convention of the Association for Educational Communications and Technology. Anaheim, CA. January 1990.
- Walker, C. H. and B. J. F. Meyer. 1980. Integrating information from text: an evaluation of current theories. *Review of Educational Research*. 50(3). 421-437.
- Wildman, T. M. 1981. Cognitive theory and the design of instruction. *Educational Technology*. 21(7). 14-20.
- Wildman, T. M. and J. K. Burton. 1981. Integrating learning theory with instructional design. *J. Instructional Development*. 4(3). 5-14.
- Winn, W. 1982. Visualization in learning and instruction: a cognitive approach. *ECTJ. (Educational Communications Technology J.)*. 30(1). 3-25.
- Wyer, R. W. and T. K. Srull. 1986. Human cognition in its social context. *Psychological Review*. 93(3). 322-359.