Cognitive Physics Education Research§

This bibliography has been compiled primarily for the purpose of helping individuals get started in physics education research and/or helping them make use of this research in their teaching. While an attempt has been made to make the bibliography reasonably extensive, no attempt has been made to be exhaustive. The materials included are concerned with cognitive research, i.e., investigations of such matters as attitude, motivation, and learning style, to name a few, have been excluded. Most of the papers listed come out of a particular theoretical framework such as Diagetian or Information-Processing.

The materials in this bibliography have been categorized, hopefully to make it easier to find something of interest. The categories below have been generated by one individual so they are clearly not meant to be definitive. These categories, and their titles, should be thought of as rough identifiers designed to help narrow any search. In the same way the descriptions found with each category title are only intended as a rough guide to what the category contains.

Finally the categories are not mutually exclusive. In fact they tend to overlap in several ways. For example, all of the theoretical frameworks involve research on problem solving. In the same way information processing psychologists are interested in both declarative knowledge, closely related to what we have called conceptual understanding below, and procedural knowledge, such things as problem solving and mathematical skills. The articles in the various categories have been placed, as best we can, in the category associated with their major emphasis.

Three other aspects of the bibliography are intended to aid the beginner. First, articles which are primarily of an overview or review nature, rather than a specific research report, are indicated with an asterisk. Second, a group of books relating to cognitive and/or physics education research have been listed in the last section. Third, a list of journals, their publishers, and sponsoring organizations is given at the end of the bibliography. A number of these journals are typically found only in larger libraries.

Finally, since it is the hope of the AAPT Committee on Research in Physics Education that this bibliography will be useful, any suggestions for modifications, revisions, and additions would be appreciated. Please send any such items to:

David P. Maloney
Physics Department
Indiana University-Purdue University at Fort Wayne
Fort Wayne, IN 46805-1499

1) Conceptual Understanding

The articles in this section are concerned with the qualitative understanding of physics. For example, what do students typically understand as the meaning of terms such as velocity and acceleration? Many of the articles found in this category deal with "alternate conceptions," a phrase used first by Driver and Easley, to describe the way students think of some physical concept. Probably the most familiar example, to a physics teacher, is the "heavier falls faster" alternate conception.

Albert, E., "Development of the Concept of Heat in Children," Sci. Educ. 62:389-399 (1978).

Aguirre, J.M., "Student Preconceptions about Vector Kinematics," The Phy. Tcher. 26:212-216 (1988).

Aguirre, J.M. and G. Rankin, "College Students' Conceptions about Vector Kinematics," Phy. Educ. 24:290-294 (1989).

Aguirre, J. and G. Erickson, "Students' Conceptions about the Vector Characteristics of Three Physics Concepts," J. Res. Sci. Tching. 21:439-459 (1984).

Arons, A.B., "Phenomenology and Logical Reasoning in Introductory Physics Courses," Amer. J. Phy. 50:31-20 (1982).

Barowy, W. and J. Lochhead, "Transformational Reasoning in Rotational Physics," Problem Solving 3:6 (1981).

Berg, T. and W. Brouwer, "Teacher Awareness of Student Alternate Conceptions about Rotational Motion and Gravity," J. Res. Sci. Tching. 28(1):3-18 (1991).

Bliss, J., I. Morrison, and J. Ogborn, "A Longitudinal Study of Dynamics Concepts," Int. J. Sci. Educ. 10:99-110 (1988).

Bliss, J., J. Ogborn, and D. Whitelock, "Secondary School Pupils Commonsense Theories of Motion," Int. J. Sci. Educ. 11:261-272 (1989).

Bowden, J., G. Dall'Alba, E. Martin, D. Laruillard, F. Morton, G. Masters, P. Ramsden, A. Stephanou, and E. Walsh, "Displacement, Velocity, and Frames of Reference: Phenomenographic Studies of Students' Understanding and Some Implications for Teaching and Assessment," Amer. J. Phy. 60:262-269 (1992).

Brook, A.J. and P. Wells, "Conserving the Circus?," Phy. Educ. 23:80-86 (1988).

Brown, D.E., "Students' Concept of Force: The Importance of Understanding Newton's Third Law," Phy. Educ. 24:353-358 (1989).

Boyle, R.K. and D.P. Maloney, "Effect of Written Text on Usage of Newton's Third Law," J. Res. Sci. Tching. 28(2):123-140 (1991).

Champagne, A., L.E. Klopfer, and J.H. Anderson, "Factors Influencing the Learning of Classical Mechanics," Amer. J. Phy. 48:1074-1079 (1980).

Champagne, A., L.E. Klopfer, and R.F. Gunstone, "Cognitive Research and the Design of Science Instruction," Educ. Psy. 17:31-53 (1982).

Champagne, A. and L.E. Klopfer, "A Causal Model of Students' Achievement in a College Physics Course," J. Res. Sci. Tching. 19:299-309 (1982).

Clement, J., "Students' Preconceptions in Introductory Mechanics," Amer. J. Phy. 50:66-71 (1982).

Clough, E.E. and R. Driver, "Secondary Students' Conceptions of the Conduction of Heat: Bringing Together Scientific and Personal Views," Phy. Educ. 20:176-182 (1985).

Clough, E.E. and R. Driver, "A Study of Consistency in the Use of Students' Conceptual Frameworks Across Different Task Concepts," Sci. Educ. 70:473-496 (1986).

Cohen, R., B. Eylong, and U. Ganiel, "Potential Difference and Current in Simple Electric Circuits: A Study of Students' Concepts," Amer. J. Phy. 51:407-412 (1983).

Cross, R.T. and J. Mehegan, "Young Children's Conception of Speed: Possible Implications for Pedestrian Safety," Int. J. Sci. Educ. 10:253-265 (1988).

Cross, R.T. and A. Pitekethly, "Speed, Education and Children as Pedestrians: A Cognitive Change Approach to a Potentially Dangerous Naive Concept," Int. J. Sci. Educ. 10:531-540 (1988).

de Berg, K.C., "Students' Thinking in Relation to Pressure - Volume Changes of a Fixed Amount of Air: the Semi-quantitative Context," Int. J. Sci. Educ. 14:295-303 (1992)

Dibar Ure, M.C. and D. Colinvaux, "Developing Adults' Views on the Phenomenon of Change of Physics State in Water," Int. J. Sci. Educ. 11:152-160 (1989).

di Sessa, Andrea A., "Unlearning Aristotelian Physics: A Study of Knowledge-Based Learning," Cog. Sci. 6:37-75 (1982).

di Sessa, Andrea A., "Momentum Flow as an Alternative Perspective in Elementary Mechanics," Amer. J. Phy. 48:365-369 (1980).

Domenech, A., E. Casasus, and M.T. Domenech, "The Classical Concept of Mass: Theoretical Difficulties and Students' Definitions," Int. J. Sci. Educ. 15:163-174 (1993)

*Driver, R. and J. Easley, "Pupils and Paradigms: A Review of Literature Related to Concept Development in Adolescent Science Students," Studies in Sci. Educ. 5:61-84 (1978).

Driver, R., "Pupils Alternative Frameworks in Science," Eur. J. Sci. Educ. 3:93-101 (1981).

Driver, R. and G. Erickson, "Theories in Action: Some Theoretical and Empirical Issues in the

Study of Students' Conceptual Framework in Science," Studies in Sci. Educ. 10:37-60 (1983).

Driver, R. and L. Warrington, "Students' Use of the Principle of Energy Conservation in Problem Situations," Phy. Educ. 20:171-176 (1985).

Duit, R., "Understanding Energy as a Conserved Quantity," Eur. J. Sci. Educ. 3:292-301 (1981).

Duit, R., "Learning the Energy Concept in School: Empirical Results from the Philippines and West Germany," Phy. Educ. 19:59-66 (1984).

Eckstein, S.G. and M. Shemesh, "Development of Children's Ideas on Motion: Intuition vs. Logical Thinking," Int. J. Sci. Educ. 11:323-336 (1989).

Erickson, G.L., "Children's Conceptions of Heat and Temperature," Sci. Educ. 63:291-299 (1979).

Erickson, G.L., "Children's Viewpoints of Heat: A Second Look," Sci. Educ. 64:323-336 (1980).

Eylon, B-S. and U. Ganiel, "Macro-Micro Relationships: The Missing Link Between Electrostatics and Electrodynamics in Students' Reasoning," Int. J. Sci. Educ. 12(1):79-94 (1990).

Eylon, B-S. and F. Reif, "Effects of Knowledge Organization on Task Performance," Cog. and Instr. 1:5-44 (1984).

Eylon, B-S., R. Ben Zvi, and J. Silberstein, "Hierarchial Task Analysis -- An Approach for Diagnosing Students' Conceptual Difficulties," Int. J. Sci. Educ. 9:187-196 (1987).

Feher, E. and K. Rice, "Pinholes and Images: Children's Conceptions of Light and Vision I," Sci. Educ. 71:629-639 (1987).

Feher, E. and K. Rice, "Shadows and Anti-Images: Children's Conceptions of Light and Vision II," Sci. Educ. 72:637-649 (1988).

Feher, E. and K.R. Meyer, "Children's Conceptions of Color," J. Res. Sci. Tching. 29:505-520 (1992).

Fetherstonhaugh, H. and, D.F. Treagust, "Students' Understanding of Light and its Properties: Teaching to Engender Conceptual Change," Sci. Educ. 76:653-672 (1992).

Finegold, M., and P. Gorsky, "Students' Concepts of Force as Applied to Related Physical Systems: A Search for Consistency," Int. J. Sci. Educ. 13:97-114 (1991).

Fischbein, E., R. Stavy, and H. Ma-Naim, "The Psychological Structure of Naive Impetus Conceptions," Int. J. Sci. Educ. 11:71-81 (1989).

Fischler, H., and M. Lichtfeldt, "Modern Physics and Students' Conceptions," Int. J. Sci.

Educ. 14:181-190 (1992).

Fredegge, N. and J. Lochhead, "Student Conceptions of Simple Circuits," The Phy. Tcher., 18:194-198 (1980).

Galili, I., "Weight and Gravity: Teachers' Ambiguity and Students' Confusion About the Concepts," Int. J. Sci. Educ. 15:149-162 (1993).

Galili, I., and V. Bar, "Motion Implies Force: Where to Expect Vestiges of the Misconception?" Int. J. Sci. Educ. 14:63-81 (1992).

Gilbert, J.K., D.M. Watts, and R.J. Osborne, "Students' Conceptions of Ideas in Mechanics," Phy. Educ. 17:62-66 (1982).

Gilbert, J.K. and D.M. Watts, "Concepts, Misconceptions and Alternative Conceptions: Changing Perspectives in Science Education," Studies in Sci. Educ. 10:61-98 (1983).

Goldberg, F., and L.C. McDermott, "Student Difficulties in Understanding Image Formation by a Plane Mirror," The Phy. Tcher. 24:472-480 (1987).

Goldberg, F. and L.C. McDermott, "An Investigation of Student Understanding of the Real Image Formed by a Converging Lens or Concave Mirror," Amer. J. Phy. 55:108-119 (1987).

Grimellini-Tomasini, N., B. Pecori-Balandi, J.L.A. Pacca, and A. Villani, "Understanding Conservation Laws In Mechanics: Students' Conceptual Change in Learning About Collisions," Sci. Educ. 77:169-189 (1993).

Gunstone, R.F. and R.T. White, "Understanding Gravity," Sci. Educ. 65:291-299 (1981).

Gutierrez, R. and J. Ogborn, "A Causal Framework for Analyzing Alternative Conceptions," Int. J. Sci. Educ. 14:201-220 (1992).

Halloun, I.A. and D. Hestenes, "The Initial Knowledge State of College Physics Students," Amer. J. Phy. 53:1043-1055 (1985).

Halloun, I.A. and D. Hestenes, "Common Sense Concepts about Motion," Amer. J. Phy. 53:1056-1065 (1985).

Halloun, I.A. and D. Hestenes, "Modeling Instruction in Mechanics," Amer. J. Phy. 55:455-462 (1987).

Hammer, D., "Two Approaches to Learning Physics," The Phy. Tcher. 27:664-670 (1989).

Hashweh, M., "Descriptive Studies of Students' Conceptions in Science," J. Res. Sci. Tching. 25:121-134 (1988).

Heller, P.M., and F.N. Finley, "Variable Uses of Attentive Conceptions: A Case Study in

Current Electricity," J. Res. Sci. Tching. 29:259-275 (1992).

Helm, H., "Misconceptions in Physics Amongst South African Students," Phy. Educ. 15:92-105 (1980).

Hewson, M.G., "The Acquisition of Scientific Knowledge: Analysis and Representation of Student Conceptions Concerning Density," Sci. Educ. 70:159-170 (1986).

Jacobs, G., "Word Usage Misconceptions Among First-Year University Physics Students," Int. J. Sci. Educ. 11:395-399 (1989).

Johsua, S., "Students' Interpretation of Simple Electrical Diagrams," Eur. J. Sci. Educ. 6:271-275 (1984).

Johsua, S. and J.J. Dupin, "Taking into Account Student Conceptions in Instructional Strategy: An Example in Physics," Cog. and Instr. 4:117-135 (1987).

Jones, B.L., P.P. Lynch, and C. Reesink, "Children's Understanding of the Notions of Solid and Liquid in Relation to Some Common Substances," Int. J. Sci. Educ. 11:417-427 (1989).

Kaiser, M.K., M. McCloskey, and D.R. Proffitt, "Development of Intuitive Theories of Motion: Curvilinear Motion in the Absence of External Forces," Dev. Psych. 22:67-71 (1986).

Kaiser, M.K., J. Jonides, and J. Alexander, "Intuitive Reasoning about Abstract and Familiar Physics Problems," Memory and Cog. 14:308-312 (1986).

Kesidou, S., and R. Duit, "Students' Conceptions of the Second Law of Thermodynamics - An Interpretive Study," J. Res. Sci. Tching. 30:85-106 (1993).

Kruger, C., "Some Primary Teachers' Ideas About Energy," Phy. Educ. 25:86-91 (1990).

LaRosa, C., M. Mayer, P. Patrizi, and M. Vincentini-Missoni, "Commonsense Knowledge in Optics: Preliminary Results of an Investigation into the Properties of Light," Eur. J. Sci. Educ. 6:387-397 (1984).

Lawson, R.A. and L.C. McDermott, "Student Understanding of the Work-Energy and Impulse-Momentum Theorems," Amer. J. Phy. 55:811-817 (1987).

Leboutet-Barrell, L., "Concepts of Mechanics in Young People," Phy. Educ. 11:462-466 (1976).

Lijnse, P.L., H.M.C. Eijkelhof, C.W.J.M. Klaassen, and R.L.J. Scholte, "Pupils' and Mass-Media Ideas about Radioactivity," Int. J. Sci. Educ. 12(1):67-78 (1990).

Linder, C. and G. Erickson, "A Study of Tertiary Physics Students' Conceptualizations of Sound," Int. J. Sci. Educ. 11:491-501 (1989).

Maloney, D.P., "Proportional Reasoning and Rule-Governed Behavior with the Balance Beam,"

Sci. Educ. 67:245-254 (1983).

Maloney, D.P., "Rule-Governed Approaches to Physics: Newton's Third Law," Phy, Educ. 19:37-42 (1984).

Maloney, D.P., "Rule-Governed Approaches to Physics: Conservation of Mechanical Energy," J. Res. Sci. Tching. 22"261-278 (1985).

Maloney, D.P., "Rule-Governed Physics: Some Novice Predictions," Eur. J. Sci. Educ. 7:295-306 (1985).

Maloney, D.P., "Charged Poles?," Phy. Educ. 20:310-316 (1985).

Maloney, D.P., "Novice Rules for Projectile Motion," Sci. Educ. 72:501-513.

Marioni, C., "Aspects of Students' Understanding in Classroom Settings (Age 10-17): Case Study on Motion and Inertia," Phy. Educ. 24:273-277 (1989).

Maurines, L., "Spontaneous Reasoning on the Propagation of Visible Mechanical Signals," Int. J. Sci. Educ. 14:279-293 (1992).

Mc Afee, E.A., and D.R. Proffitt, "Understanding the Surface Orientation of Liquids," Cog. Psych. 23:483-514 (1991).

McClelland, J.A.G., "Alternative Frameworks: Interpretation of Evidence," Eur. J. Sci. Educ. 6:1-6 (1984).

McClelland, J.A.G., "Misconceptions in Mechanics and How to Avoid Them," Phy. Educ. 20:159-162 (1985).

McCloskey, M. and D. Kohl, "Naive Physics: The Curvilinear Impetus Principle and Its Role in Interactions with Moving Objects," J. Exp. Psych: L, M, and C 9:146 (1983).

McCloskey, M., A. Washburn, and L. Felch, "Intuitive Physics: The Straight Down Belief and Its Origin," J. Exp. Psych: L, M, and C 9:636 (1983).

*McDermott, L.C., "Research on Conceptual Understanding in Mechanics," Phy. Today 37(7):24-32 (1984).

*McDermott, L.C., "Problems in Understanding Physics (Kinematics) Among Beginning College Students - With Implications for High School Courses," in Education for the 80's - Science, Mary Budd Rowe (ed), National Education Assn., Washington DC (1982).

McDermott, L.C., M.L. Rosenquist, and E.H. Van Zee, "Student Difficulties in Connecting Graphs and Physics: Examples from Kinematics," Amer. J. Phy. 55:503-513 (1987).

Millar, R., and T. King, "Students' Understanding of Voltage in Simple Series Electric Circuits,"

Int. J. Sci. Educ. 15:339-349 (1993).

Minstrell, J., "Explaining the 'At Rest' Condition of an Object," The Phy. Tcher. 20:10-20 (1982).

Minstrell, J., "Conceptual Development Research in the Natural Setting of a Secondary School Science Classroom," in Education for the 80's - Science (1982).

Mohapatra, J.K., "Induced Incorrect Generalizations Leading to Misconceptions -- An Exploratory Investigation about the Laws of Reflection of Light," J. Res. Sci. Educ. 25:777-784 (1988).

Mohapatra, J.K. and S. Bhattacharyya, "Pupils, Teachers, Induced Incorrect Generalization and the Concept of 'Force'," in Education for the 80's - Science (1982).

Mohapatra, J.K., "Induced Incorrect Generalizations Leading to Misconceptions -- An Exploratory Investigation about the Laws of Reflection of Light," J. Res. Sci. Educ. 25:777-784 (1988).

Mohapatra, J.K. and S. Bhattacharyya, "Pupils, Teachers, Induced Incorrect Generalization and the Concept of 'Force'," Int. J. Sci. Educ. 11:429-436 (1989).

Nicholls, G., and J. Ogborn, "Dimensions of Children's Conceptions of Energy," Int. J. Sci. Educ. 15:73-81 (1993).

Noce, G., G. Totosantucci, and M. Vincentini, "The Floating of Objects on the Moon: Prediction from a Theory or Experimental Facts?," Int. J. Sci. Educ. 10:61-70 (1988).

Novick, S. and J. Nussbaum, "Junior High School Pupils' Understanding of the Particulate Nature of Matter: An Interview Study," Sci. Educ. 62:273-281 (1978).

Novick, S. and J. Nussbaum, "Pupils' Understanding of the Particulate Nature of Matter: A Cross Age Study," Sci. Educ. 65:187-196 (1981).

Osborne, J.F., P. Black, J. Meadows, and M. Smith, "Young Children's (7-11) Ideas About Light and Their Development," Int. J. Sci. Educ. 15:83-93 (1993).

Osborne, R.J. and J.K. Gilbert, "A Technique for Exploring Students' Views of the World," Phy. Educ. 15:376 (1980).

Osborne, R.J. and J.K. Gilbert, "A Method for Investigating Concept Understanding in Science," Eur. J. Sci. Educ. 2:311-321 (1980).

Osborne, R.J. and M.M. Cosgrove, "Student Conceptions of the Changes of States of Water," J. Res. Sci. Tching. 20:825-838 (1983).

Osborne, R., "Children's Dynamics," The Phy. Tcher. 22:504-508 (1984).

Palacios, F.J.P., F. M. Cazorla, and A.C. Madrid, "Misconceptions on Geometric Optics and Their Association with Relevant Educational Variables," Int. J. Sci. Educ. 11:273-286 (1989).

Peters, P.C., "Even Honors Students Have Conceptual Difficulties with Physics," Amer. J. Phy. 50:501-508 (1982).

Peters, P.C., "The Role of Induced Emf's in Simple Circuits," Amer. J. Phy. 52:208-211 (1984).

Preece, P.F.W., "Intuitive Science: Learned or Triggered," Eur. J. Sci. Educ. 6:7-10 (1984).

Reif, F., "Interpretation of Scientific or Mathematical Concepts: Cognitive Issues and Instructional Implications," Cog. Sci. 11:395-416 (1987).

Reif, F., and S. Allen, "Cognition for Interpreting Scientific Concepts: A Study of Acceleration," Cog & Instr. 9:1-44 (1992).

Reynoso, E., E. Fierro, G. Torres, M. Vicentini-Missoni, and J. Perez de Celis, "The Alternative Frameworks Presented by Mexican Students and Teachers Concerning the Free Fall of Bodies," Int. J. Sci. Educ. 15:127-138 (1993).

Rogan, J.M., "Development of a Conceptual Framework of Heat," Sci. Educ. 72:103-133 (1988).

Rollnick, M. and M. Rutherford, "African Primary School teachers - What Ideas do They Hold on Air and Air Pressure?," Int. J. Sci. Educ. 12(1):101-114 (1990).

Roncato, S. and R. Rumiati, "Naive Statics: Current Misconceptions on Equilibrium," J. Exp. Psych.: L, M, and C 12:361-377 (1986).

Rozier, S., and L. Viennot, "Students Reasonings in Thermodynamics," Int. J. Sci. Educ. 13:159-170 (1991).

Russell, T., W. Harlen, and D. Watt, "Children's Ideas about Evaporation," Int. J. Sci. Educ. 11:566-576 (1989).

Saltiel, E. and J.L. Malgrange, "'Spontaneous' Ways of Reasoning in Elementary Kinematics," Eur. J. Phy. 1:73-80 (1980).

Saxena, A.B., "The Understanding of the Properties of Light by Students in India," Int. J. Sci. Educ. 13:283-289 (1991).

Sere, M., "A Study of Some Frameworks Used by Pupils Aged 11-13 Years in the Interpretation of Air Pressure," Eur. J. Sci. Educ. 4:299-308 (1982).

Sere, M., "Children's Conceptions of the Gaseous State, Prior to Teaching," Eur. J. Sci. Educ. 8:413-425 (1986).

Shipstone, D.M., "A Study of Children's Understanding of Electricity in Simple DC Circuits," Eur. J. Sci. Educ. 6:185-198 (1984).

Solomon, J., "Is Physics Easy?," Phy. Educ. 18:155-160 (1983).

Solomon, J., "Prompts, Cues, and Discrimination: The Utilization of Two Separate Knowledge Systems," Eur. J. Sci. Educ. 6:277-284 (1984).

Solomon, J., "Teaching the Conservation of Energy," Phy. Educ. 20:165-170 (1985).

Solomon, J., P. Black, V. Oldham, and H. Stuart, "The Pupils View of Electricity," Eur. J. Sci. Educ. 7:281-284 (1985).

Solomon, J., P. Black, and H. Stuart, "The Pupils View of Electricity Revisited -- Social Development or Cognitive Growth," Int. J. Sci. Educ. 9:13-22 (1987).

Stavy, R., "Children's Conception of Gas," Int. J. Sci. Educ. 10:553-560 (1988).

Stavy, R., "Children's Conception of Change in the State of Matter: From Liquid (or Solid) to Gas," J. Res. Sci. Tching. 27:247-266 (1990).

Terry, C., G. Jones, and W. Hurford, "Children's Conceptual Understanding of Forces and Equilibrium," Phy. Educ. 20:162-165 (1985).

Terry, C. and G. Jones, "Alternative Frameworks: Newton's Third Law and Conceptual Change," Eur. J. Sci. Educ. 8:291-298 (1986).

Tornkvist, S., K.-A. Petterson, and G. Transtromer, "Confusion by Representation: On Students' Comprehension of the Electric Field Concept," Amer. J. Phy. 61:335-338 (1993).

Trowbridge, D.E. and L.C. McDermott, "Investigation of Student Understanding of the Concept of Velocity in One Dimension," Amer. J. Phy. 48:1020-1028 (1980).

Trowbridge, D.E. and L.C. McDermott, "Investigation of Student Understanding of the Concept of Acceleration in One Dimension," Amer. J. Phy. 49:242-253 (1981).

Trumper, R., "Children's Energy Concepts: A Cross-age Study," Int. J. Sci. Educ. 15:139-148 (1993).

Van Hise, Y.A., "Student Misconceptions in Mechanics: An International Problem?," The Phy. Tcher. 26:498-502 (1988).

Van Heuvelen, A., "Learning to Think Like a Physicist: A Review of Research-Based Instructional Strategies," Amer. J. Phy. 59(10):891-897 (1991).

Van Heuvelen, A., "Overview, Case Study Physics," Amer. J. Phy. 59(10):898-906 (1991).

Viennot, L., "Spontaneous Reasoning in Elementary Dynamics," Eur. J. Sci. Educ. 1:205-221 (1979).

Viennot, L., "Common Practice in Elementary Algebra," Eur. J. Sci. Educ. 3:183-194 (1981).

Viennot, L., "Analyzing Students' Reasoning: Tendencies in Interpretation," Amer. J. Phy. 53:432-436 (1985).

Viennot, L., "Analyzing Students' Reasoning in Science: a Pragmatic View of Theoretical Problems," Eur. J. Sci. Educ. In Press.

Viennot, L., and S. Rainson, "Students' Reasoning About the Superposition of Electric Fields," Int. J. Sci. Educ. 14:475-487 (1992).

Villani, A. and J.L.A. Pacca, "Students' Spontaneous Ideas about the Speed of Light," Int. J. Sci. Educ. 9:55-56 (1987).

Watts, D.M. and A. Zylbersztajn, "A Survey of Some Children's Ideas about Force," Phy Educ. 16:360-365 (1981).

Watts, D.M., "Gravity - Don't Take It for Granted," Phy. Educ. 17:116-121 (1982).

Watts, D.M., "Some Alternative Views of Energy," Phy. Educ. 18:213-217 (1983).

Watts, D.M., "A Study of Schoolchildren's Alternative Framework of the Concept of Force," Eur. J. Sci. Educ. 5:217-220 (1983).

Watts, D.M., "Student Conceptions of Light: A Case Study," Phy. Educ. 20:183-187 (1985).

Whitaker, R.J., "Aristotle is Not Dead: Student Understanding of Trajectory Motion," Amer. J. Phy. 51:353-357 (1983).

White, B.Y., "Sources of Difficulty in Understanding Newtonian Dynamics," Cog. Sci. 7:41-65

(1983).

White, R.T., "Relevance of Practical Work to Comprehension of Physics," Phy. Educ. 14:384-387 (1979).

Yates, J., M. Bessman, M. Dunne, D. Jertson, K. Sly, and B. Wendelboe, "Are Conceptions of Motion Based on a Naive Theory or on Prototypes?," Cog. 29:151-275 (1988).

2) Problem Solving

How people solve problems has become an active area of research in cognitive psychology. A reasonable portion of this research is concerned with solving the type of physics problems that are typically assigned in college general physics courses.

Anzai, Y. and Y. Yokoyama, "Internal Models in Physics Problem Solving," Cog. & Instr. 1:397-450 (1984).

Bascones, J. & J.K. Novak, "Alternative Instructional Systems and the Development of Problem-Solving Skills in Physics," Eur. J. Sci. Educ. 7(3):253-261 (1985).

Bassok, M., "Transfer of Domain-Specific Problem-Solving Procedures," J. Exp. Psych.: Learning, Memory, & Cognition 16(3):522-533 (1990).

Bassok, M. & K.J. Holyoak,"Interdomain Transfer Between Isomorphic Topics in Algebra and Physics," J. Exper. Psych.: Learning, Memory and Cognition 15(1):153-166 (1989).

Bhaskar, R. and H.A. Simon, "Problem Solving in Semantically Rich Domains: An Example from Engineering Thermodynamics," Cog. Sci. 1:193-215 (1977).

Briars, D.J. and J.H. Larkin, "An Integrated Model of Skill in Solving Elementary Word Problems," Cog. & Instr. 1:245-296 (1984).

Bromage, B.K. and R.E. Mayer, "Relationship Between What is Remembered and Creative Problem-Solving Performance in Science Learning," J. Educ. Psych. 73:451-461 (1981).

Chi, M.T.H., M. Bassok, M.W. Lewis, P. Reimann, and R. Glaser, "Self-Explanations: How Students Study and Use Examples in Learning to Solve Problems," Cog. Sci. 13:145-182 (1989).

Chi, M.T.H., P.J. Feltovich, and R. Glaser, "Categorization and Representation of Physics Problems by Experts and Novices," Cog. Sci. 5:121-152 (1981).

Chi, M.T.H., R. Glaser, and E. Rees, "Expertise in Problem Solving," in Advances in the Psychology of Human Intelligence, Robert J. Sternberg, Ed. Lawrence Erlbaum Associates, Hillsdale, NJ (1983).

Clement, J., "Observed Methods for Generating Analogies in Scientific Problem Solving," Cog. Sci. 12:563-586 (1988).

de Jong, T. and M.G.M. Ferguson-Hessler, "Cognitive Structures of Good and Poor Novice Problem Solvers in Physics," J. Educ. Psych. 78:279-288 (1986).

de Kleer, J., "Multiple Representations of Knowledge in a Mechanics Problem-Solver," Proceedings of 5th International Joint Conference on Artificial Intelligence, 299-304 (1977).

Elio, R. and P.B. Scharf, "Modeling Novice-to-Expert Shifts in Problem-Solving Strategy and Knowledge Organization," Cog. Sci. 14:579-639 (1990).

Eylon, B. and F. Reif, "Effects of Knowledge Organization on Task Performance," Cog. & Instr. I(1):5-44 (1984).

Ferguson-Hessler, M.G.M. and T. de Jong, "Studying Physics Texts: Differences in Study Processes Between Good and Poor Performers," Cog. & Instr. 7(1):41-54 (1990).

Finegold, M. and R. Mass, "Differences in the Process of Solving Physics Problems Between Good Physics Problem Solvers and Poor Physics Problem Solvers," Res. Sci. & Tech. Educ. 3:59-67 (1985).

*Frederiksen, N., "Implications of Cognitive Theory for Instruction in Problem Solving," Rev. Educ. Res. 54:363-407 (1984).

*Fuller, R.G., "Solving Physics Problems - How Do We Do It?," Phy. Today 35(9):43 (1982).

Garrett, R.M., "Issues in Science Education: Problem-Solving, Creativity and Originality," Int. J. Sci. Educ. 9:125-137 (1987).

Garrett, R.M., "Problem-Solving in Science Education," Studies in Science Education, 13:70-95 (1986).

Garrett, R.M., D. Satterly, and J. Martinez-Torregrosa, "Turning Exercises into Problems: An Experimental Study with Teachers in Training," Int. J. Sci. Educ. 12(1):1-12 (1990).

Gil Perez, D. and J. Martinez-Torregrosa, "A Model for Problem Solving in Accordance with Scientific Methodology," Eur. J. Sci. Educ. 4:448-457 (1983).

*Glick, M.L., "Problem-Solving Strategies," Educational Psychologist 12:99-120 (1986).

Good, R., "Scientific Problem Solving by Expert Systems," J. Res. Sci. Tching. 21:331-340 (1984).

Gorodetsky, M., R. Hoz, and S. Vinner, "Hierarchical Solution Models of Speed Problems," Sci. Educ. 70:565-582 (1986).

Graen, B.F., M. McCloskey, and A. Caramazza, "The Relation of Knowledge to Problem Solving with Examples from Kinematics," in Thinking and Learning Skills Vol. 2, S.F>

Chipman, J.W. Segal, and R. Glaser (Eds.), Lawrence Erlbaum Associates, Hillsdale, NJ (1985).

Heller, J.I. and F. Reif, "Prescribing Effective Human Problem-Solving Processes: Problem Description in Physics," Cog. & Instr. 1:177-216 (1984).

Johsua, S., and J-J. Dupin, "In Physics Class, Exercises Can Also Cause Problems...," Int. J. Sci. Educ. 13:29-302 (1992).

Larkin, J.H., "Understanding, Problem Representations, and Skill in Physics. Thinking & Learning Skills, Chipman, S.F. Segal, J.W., & Glaser, R. (Eds.), Erlbaum, II:141-159 (1985).

Larkin, J.H., "The Role of Problem Representation in Physics," Mental Models, D. Gentner & A.L. Stevens, Erlbaum Assoc., Hillsdale, NJ., 75-98 (1983).

Larkin, J.H., "Enriching Formal Knowledge: A Model for Learning to Solve Textbook Physics Problems," Cognitive Skills and Their Acquisition, J.R. Anderson (Ed.), Erlbaum (1981).

Larkin, J.H., "Enriching Formal Knowledge: A Model for Learning to Solve Textbook Physics Problems," in Cognitive Skills and Their Acquisition, J.R. Anderson (Ed.), Lawrence Erlbaum Associates, Hillsdale, NJ (1981).

Larkin, J.H., "Skilled Problem solving in Physics: A Hierarchical Planning Model," J. Structural Learning 1:271-297 (1980).

Larkin, J.H., "Teaching Problem Solving in Physics: The Psychological Laboratory and the Practical Classroom," In D.T. Tuma and F. Reif (Eds.), Problem Solving and Education: Issues in Teaching and Research, New York: Wiley (1980).

Larkin, J.H., "Processing Information for Effective Problem Solving," Eng. Educ. December:285-288 (1979).

Larkin, J., J. McDermott, D.P. Simon, and H.A. Simon, "Expert and Novice Performance in Solving Physics Problems," Sci. 208:1335-1342 (1980).

Larkin, J.H., McDermott, J., Simon, D.P., & H.A. Simon, "Models of Competence in Solving Physics Problems," Cog. Sci. 4:317-345 (1980).

Larkin, J.H. and F. Reif, "Understanding and Teaching Problem Solving in Physics," Eur. J. Sci. Educ. 1:191-203 (1979).

Larkin, J.H., F. Reif, J. Carbonell, and A. Gugliotta, "FERMI: A Flexible Expert Reasoner with Multi-Domain Inferencing," Cog. Sci. 12:101-138 (1988).

Maloney, D.P., and R.S. Siegler, "Conceptual Competition in Physics Learning," Int. J. Sci. Educ. 15:283-295 (1993).

McMillan, C. and M. Swadener, "Novice Use of Qualitative Versus Quantitative Problem Solving in Electrostatics," J. Res. Sci. Tching. 28(8):661-670 (1991).

Mettes, C.T., A. Pilot, and H.J. Roosink, "Linking Factual and Procedural Knowledge in Solving Science Problems: A Case Study in a Thermodynamics Course," Instruc. Sci. 10:333-361 (1981).

Mohapatra, J.K., "Can Problem Solving in Physics Give an Indication of Pupil's Process Knowledge?," Int. J. Sci. Educ. 9:117-123 (1987).

Reif, F., "Teaching Problem Solving -- A Scientific Approach," The Phy. Tcher. 19:310-317 (1981).

Reif, F., J.H. Larkin, and G.C. Brackett, "Teaching General Learning and Problem-Solving Skills," Amer. J. Phy. 44:212-217 (1976).

Reif, F.R. and J.I. Heller, "Knowledge Structure and Problem Solving in Physics," Educ. Psych. 17:102-127 (1982).

Reusser, K., "Problem Solving Beyond the Logic of Things: Contextual Effects on Understanding and Solving Word Problems," Instruc. Sci. 17:209-338 (1988).

Robertson, W.C., "Detection of Cognitive Structure with Protocol Data: Predicting Performance on Physics Transfer Problems," Cog. Sci. 14:253-280 (1990).

Simon, D.P. and H.A. Simon, "Individual Differences in Solving Physics Problems," in Children's Thinking; What Develops? Robert S. Siegler, Ed., Lawrence Erlbaum Associates, Hillsdale, NJ (1978).

Snider, R.M., "Using Problem Solving in Physics Classes to Help Overcome Naive Misconceptions," in D. Gabel (Ed.), What Research Says to the Science Teacher: Problem Solving, Washington, DC: National Science Teachers Association (1989).

Sweller, J., R.F. Mawer, and M.R. Ward, "Development of Expertise in Mathematical Problem Solving," J. Exp. Psych.:Gen. 112(4):639-661 (1983).

Sweller, J., "Cognitive Load During Problem Solving: Effects on Learning," Cog. Sci. 12:251-285 (1988).

Veldhuis, G.H., "The Use of Cluster Analysis in Categorization of Physics Problems," Sci. Educ. 74(1):105-118 (1990).

Ward, M. and J. Sweller, "Structuring Effective Worked Examples," Cog. & Instr. 7:1-39 (1990).

Woods, Donald R. (Ed.), "P S Corner," Continuing Section on Problem Solving in the J. Coll. Sci. Tching.

Zajchowski, R., and J. Martin, "Differences in the Problem Solving of Stronger and Weaker Novices in Physics: Knowledge, Strategies, or Knowledge Structure?" J. Res. Sci. Tching. 30:459-470 (1993).

3) Theories of Cognition and Cognitive Development

This category contains articles describing research within a particular theoretical framework or describing some aspect of a theory. The four theories included here are included primarily because they are currently the most active research paradigms. The first article listed below is a comparison among three theories and so does not fit within any one theory.

Mason, E.J., Gegelka, P., Lewis, R., Henry, S., Larkin, J., and F. Danner, "Three Approaches to Teaching and Learning in Education: Behavioral, Piagetian, and Information-Processing," Instr. Sci. 12:219-241 (1983).

A) Piagetian Theory

Aiello-Nicosia, M.L. and R.M. Sperandeo-Mineo, "An Experimental Study of the Relationship Between Formal Thinking and Physics Achievement," Eur. J. Sci. Educ. (1982).

Arons, A. and J. Smith, "Definition of Intellectual Objectives in a Physical Science Course for Preservice Elementary Teachers," Sci. Educ. 58:391-400 (1974).

Arons, A.B., "Cognitive Level of College Physics Students," Amer. J. Phy. 47:650-651 (1979).

Arons, A.B. and P. Karplus, "Implications of Accumulating Data on Levels of Intellectual Development," Amer. J. Phy. 44:396 (1976).

Billeh, V.Y. and K. Khalili, "Cognitive Development and Comprehension of Physics Concepts," Eur. J. Sci. Educ. (1982).

*Lawson, A.E., "The Developmental Learning Paradigm," J. Res. Sci. Tching. 16:501-515 (1979).

Lawson, A.E., "The Reality of General Cognitive Operations," Sci. Educ. 66:229 (1982).

Lawson, A.E. and J.M. Bealer, "The Acquisition of Basic Quantitative Reasoning Skills during Adolescence: Learning or Development?," J. Res. Sci. Tching. 21:417-424 (1984).

*Lawson, A.E., "A Review of Research on Formal Reasoning and Science Teaching," J. Res. Sci. Tching. 22:569-617 (1985).

Linn, M.C., C. Clement, and S. Pulos, "Is It Formal if It's Not Physics: (The Influence of Content on Formal Reasoning)," J. Res. Sci. Tching. 20:763-770 (1983).

Martorano, S.C., "A Developmental Analysis of Performance on Piaget's Formal Operation Tasks," Dev. Psych. 13:666 (1977).

McKinnon, J. and J. Renner, "Are Colleges Concerned with Intellectual Development?," Amer. J. Phy. 39:1047 (1971).

*Neimark, E.D., "Current Status of Formal Operations Research," Hum. Dev. 22:60-67 (1979).

Renner, J.W., "Significant Physics Content and Intellectual Development - Cognitive Development as a Result of Interacting with Physics Content," Amer. J. Phy. 44:218-222 (1976).

Renner, J.W. and W.C. Paske, "Comparing Two Forms of Instruction in College Physics," Amer. J. Phy. 45:851-860 (1977).

Renner, J.W., M.R. Abraham, and H.H. Birnie, "The Importance of the FORM of Student Acquisition of Data in Physics Learning Cycles," J. Res. Sci. Tching. 22:303-325 (1985).

Renner, J.W., M.R. Abraham, and H.H. Birnie, "The Necessity of Each Phase of the Learning Cycle in Teaching High School Physics," J. Res. Sci. Tching. 25:39-58 (1988).

Rowell, J.A. and C.J. Dawson, "Laboratory Counterexamples and the Growth of Understanding in Science," Eur. J. Sci. Educ.:203-215 (1980).

Selman, R.L., M.P. Krupa, C.R. Stone, and D.S. Jaquette, "Concrete Operational Thought and the Emergence of the Concept of Unseen Force in Children's Theories of Electromagnetism and Gravity," Sci. Educ. (1982).

Staver, J.R. and E.T. Pascarells, "The Effect of Method and Format on the Responses of Subjects to a Piagetian Reasoning Problem," J. Res. Sci. Tching. 21:305 (1984).

Strauss, S., J. Canziger, and T. Ramati, "University Students' Understanding of Nonconservation: Implications for Structural Reversion," Dev. Psych. 13:359 (1977).

B) Neo-Piagetian Theory

This theoretical perspective seems to be a combination of Piagetian and Information-Processing frameworks. Pascual-Leone and Case are two of the more prominent workers in this area. (Comments on this category are definitely the personal view of the individual compiling this bibliography, and any misrepresentation is definitely unintentional.)

*Case, R., "A Developmentally Based Theory and Technology of Instruction," Review of Educ. Res. 48:439-463 (1978).

*Chapman, M., "Pascual-Leone's Theory of Constructive Operators: An Introduction," Human Dev. 24:145-155 (1981).

*Gould, C.F., "Physics Teaching and Cognitive Functioning: A Neo-Piagetian Perspective," The Phy. Tcher. 17:513-518 (1979).

Karplus, R., "Education and Formal Thought - A Modest Proposal," in New Directions in Piagetian Theory and Practice Siegel, Brodzinsky and Colinkoff (Eds.), Lawrence Erlbaum Associates, Hillsdale, NJ (1981).

Pascual-Leone, J. and D. Goodman, "Intelligence and Experience: A Neo-Piagetian Approach," Instr. Sci. 8:301-367 (1979).

Renner, J.W., M.R. Abraham, E.B. Grzybowski, and E.A. Marek, "Understanding and Misunderstanding of Eighth Graders of Four Physics Concepts Found in Textbooks," J. Res. Sci. Tching. 27:35-54 (1990).

Roth, W.-M., "The Development of Reasoning on the Balance Beam," J. Res. Sci. Tching. 27:631-645 (1991).

Roth, W.-M., "Neo-Piagetian Predictors of Achievement in Physical Science," J. Res. Sci. Tching. 27:509-521 (1990).

Wollman, W.T., "Form versus Content in Piagetian Testing," Sci. Educ. (1982).

C) Reception (Ausubelain) Theory

Ausubel, D., J.D. Novak, and H. Hanesian, "Educational Psychology: A Cognitive View," 2nd ed., Holt, Rhinehart, and Winston, NY (1978).

Bascones, J. and J.D. Novack, "Alternative Instructional Systems and the Development of Problem-Solving Skills in Physics," Eur. J. Sci. Educ. 7:253-261 (1985).

Healy, V.C., "The Effect of Advanced Organizer and Prerequisite Knowledge Passages on the Learning and Retention of Science Concepts," J. Res. Sci. Tching. 26:627-642 (1989).

*Novak, J.D., "Implications for Teaching of Research on Learning," in What Research Says to the Science Teacher, Vol. 2, Mary Budd Rowe (Ed.), National Science Teachers Association, Washington, DC (1979).

Pankratius, W.J., "Building an Organized Knowledge-Base: Concept Mapping and Achievement in Secondary School Physics," J. Res. Sci. Tching.

Thorsland, M.N. and J.D. Novak, "The Identification and Significance of Intuitive and Analytic Problem Solving Approaches Among College Physics Students," Sci. Educ. 58:245-265 (1974).

D) Information Processing Theory

This is probably the most active theoretical group in cognitive psychology currently. Two strong themes in this research paradigm are comparisons between expert and novice performance, and computer modeling of reasoning processes. Several studies on the expert-novice comparison are included in the earlier section on problem solving.

de Kleer, J. and J.S. Brown, "Mental Models of Physical Mechanisms and Their Acquisition," in Cognitive Skills and Their Acquisition, J.R. Anderson (Ed.), Lawrence Erlbaum and Associates, Hillsdale, NJ (1981).

Halford, G.S., C.A. Brown, and R. McL. Thompson, "Children's Concepts of Volume and Flotation," Dev. Psych. 22:208-222 (1986).

Hardiman, P.T., A. Pollatsek, and A.D. Well, "Learning to Understand the Balance Beam," Cog. and Instr. 3:63-96 (1986).

Klahr, D. and K. Dunbar, "Dual Space Search During Scientific Reasoning," Cog. Sci. 12:1-48 (1988).

Larkin, J.H., "Studying How People Think: An Application to the Science Classroom," in What Research Says to the Science Teacher, Robert E. Yager (Ed.), NSTA, Washington, DC (1982).

Larkin, J., "Cognition of Learning Physics," Amer. J. Phy. 49:534-541 (1981).

Larkin, J.H. and B. Rainard, "A Research Methodology for Studying How People Think," J. Res. Sci. Tching. 21:235-254 (1984).

Larkin, J.H. and H.A. Simon, "Why a Diagram is (Sometimes) Worth Ten Thousand Words," Cog. Sci. 11:65-99 (1987).

Larkin, J.H., F. Reif, J. Carbonell, and A. Gugliotta, "FERMI: A Flexible Expert Reasoner with Multi-Domain Inferencing," Cog. Sci. 12:101-128 (1988).

Luger, G.F., "Mathematical Model Building in the Solution of Mechanics Problems: Human Protocols and the MECHO Trace," Cog. Sci. 5:55-77 (1981).

Mullet, E. and A. Montcouquiol, "Archimedes' Effect, Information Integration and Individual Differences," Int. J. Sci. Educ. 10:285-301 (1988).

Neches, R. and J.R. Hayes, "Progress Towards a Taxonomy of Strategy Transformation," in Cognitive Psychology and Instruction, A.M. Lesgold, J.W. Pellegrino, S.D. Fokkema, and R. Glaser (Eds.), Plenum Press, NY (1978).

Rumelhart, D.E. and D.A. Norman, "Analogical Processes in Learning," in Cognitive Skills and Their Acquisition, J.R. Anderson (Ed.), Lawrence Erlbaum Associates, Hillsdale, NJ (1981).

Siegler, R.S., "Three Aspects of Cognitive Development," Cog. Psych. 8:481-520 (1976).

Siegler, R.S., "The Origin of Scientific Reasoning," in Children's Thinking: What Develops, R.S. Siegler (Ed.), Lawrence Erlbaum Associates, Hillsdale, NJ (1978).

Siegler, R.S. and D.D. Richards, "Development of Time, Speed, and Distance Concepts," Dev. Psych. 15:288 (1979).

Siegler, R.S., "Recent Trends in the Study of Cognitive Development: Variations on a Task-Analytic Theme," Human Dev. 23:278-285 (1980).

*Simon, H.A., "Studying Human Intelligence by Creating Artificial Intelligence," Amer. Scientist.

*Stewart, J.H. and J.A. Atkin, "Information Processing Psychology: A Promising Paradigm for Research in Science Teaching," J. Res. Sci. Tching. 19:321 (1982).

Wilkening, F., "Integrating Velocity, Time, and Distance Information: A Developmental Study," Cog. Psych. 13:231 (1981).

4) Reasoning Abilities, Skills, and/or Intelligence

Rather obviously this is something of a catch-all category. There are a number of abilities, skills, and aptitudes (or whatever you wish to call them) that have been associated with success in physics. Research on these characteristics and how they affect performance in physics continues within one theoretical paradigm.

Arons, A., "Thinking, Reasoning, and Understanding in Introductory Physics Courses," The Phy. Tcher. 19:166-172 (1981).

Arons, A.B., "Student Patterns of Thinking and Reasoning," Phy. Tcher., Part 1 21:576 (1983); Part 2, 22:21 (1984); Part 3, 22:88 (1984).

Champagne, A.B. and L.E. Klopfer, "A Causal Model of Students' Achievement in a College Physics Course," J. Res. Sci. Tching. 19:299 (1982).

Enyeart, M.A., D. Baker, and D. Vanharlingen, "Correlation of Inductive and Deductive Logical Reasoning to College Physics Achievement," J. Res. Sci. Tching. 17:263 (1980).

Friedler, Y., R. Nachmias, and M.C. Linn, "Learning Scientific Reasoning Skills in Microcomputer-Based Laboratories," J. Res. Sci. Tching. 27:173-192 (1980).

Hudson, H.T. and W.R. McIntire, "Correlation Between Mathematical Skills and Success in Physics," Amer. J. Phy. 45:470-471 (1977).

Hudson, H.T. and D. Liberman, "The Combined Effect of Mathematics Skills and Formal Operational Reasoning on Student Performance in the General Physics Course," Amer. J. Phy. 50:1117-1119 (1982).

Hudson, H.T., "A Comparison of Cognitive Skills Between Completes and Dropouts in a College Physics Course," J. Res. Sci. Tching. 22:41-50 (1985).

Karplus, R., "Continuous Functions: Students' Viewpoints," Eur. J. Sci. Educ. 1:397 (1979).

Liberman, D. and H.T. Hudson, "Correlation Between Logical Abilities and Success in Physics," Amer. J. Phy. 48:784-786 (1979).

Linn, M.C., "When Do Adolescents Reason?," Eur. J. Sci. Educ. 2:429 (1980).

Pallrand, C.J. and F. Seeber, "Spatial Ability and Achievement in Introductory Physics," J. Res. Sci. Tching. 21:507-516 (1984).

White, R.T. and R.E. Mayer, "Understanding Intellectual Skills," Instr. Sci. 9:101-127 (1980).

Wollman, W. and F. Lawrenz, "Identifying Potential 'Dropouts' from College Physics Classes," J. Res. Sci. Tching. 21:385-390 (1984).

5) Studies/Theories of Conceptual Change and/or Learning

The articles in this category are concerned with specific studies and theories about how people alter their conceptual knowledge in a particular area. The various specific theories of conceptual change can be found within all of the wider theoretical frameworks identified in section 3.

Brown, D., "Using Examples and Analogies to Remediate Misconceptions in Physics: Factors Influencing Conceptual Change," J. Res. Sci. Tching. 29:17-34 (1992).

Chi, M.T.H., "Conceptual Change Within and Across Ontological Categories: Examples From Learning and Discovery in Science," Minnesota Studies in the Philosophy of Science, Ronald

N. Giere (Ed.), Univ. of Minnesota Press, Minn. (1992).

Chinn, C.A. and W.F. Brewer, "The Role of Anomalous Data in Knowledge Acquisition: A Theoretical Framework and Implications for Science Instruction," Review Educ. Rsch. 63(1):1-49 (1993).

Driver, R., "Students' Conceptions and the Learning of Science," Int. J. Sci. Educ. 11:481-490 (1989).

Duschl, R.A., and D.H. Gitomer, "Epistemological Perspectives on Conceptual Change: Implications for Educational Practice," J. Res. Sci. Tching. 28:839-858 (1991).

Dykstra, Jr., D.I., C.F. Boyle, and I.A. Monarch, "Studying Conceptual Change in Learning Physics," Sci. Educ. 76:625-652 (1992).

Fischer, H.E., "Framework for Conducting Empirical Observations of Learning Processes," Sci. Educ. 77:131-151 (1993).

Fischer, H.E., and S. Von Aufschnaiter, "Development of Meaning During Physics Instruction: Case Studies in View of the Paradigm of Constructivism," Sci. Educ. 77:153-168 (1993).

Gilbert, J.K., R.J. Osborne, and P.J. Fensham, "Children's Science and its Consequences for Teaching," Sci. Educ. 66:623 (1982).

Gilbert, J.K. and A. Zylbersztajn, "A Conceptual Framework for Science Education: The Case Study of Force and Movement," Eur. J. Sci. Educ. 7:107-120 (1985).

Guidoni, P., "On Natural Thinking," Eur. J. Sci. Educ. 7:133-140 (1985).

Hashweh, M.Z., "Toward an Explanation of Conceptual Change," Eur. J. Sci. Educ. 8:229-249 (1986).

Hewson, P.W., "Learning and Teaching Science," South African J. of Sci. 76:397-403 (1980).

Hewson, P.W., "A Conceptual Change Approach to Learning Science," Eur. J. Sci. Educ. 3:383-396 (1981).

Hewson, P.W., "A Case Study of Conceptual Change in Special Relativity: The Influence of Prior Knowledge in Learning," Eur. J. Sci. Educ. 4:61-78 (1982).

Hewson, M.G. and P.W. Hewson, "Effect of Instruction Using Students' Prior Knowledge and Conceptual Change Strategies on Science Learning," J. Res. Sci. Tching. 20:731-743 (1983).

Hewson, P.W. and G.J. Posner, "The Use of Schema Theory in the Design of Instructional Materials: A Physics Example," Instr. Sci. 13:119-139 (1984).

Hewson, P.W., "Diagnosis and Remediation of an Alternative Conception of Velocity Using a Microcomputer Program," Amer. J. Phy. 53:680-684 (1985).

Linder, C.J., "A Challenge to Conceptual Change," Sci. Educ. 77:293-300 (1993).

Nussbaum, J. and S. Novick, "Alternative Frameworks, Conceptual Conflict and Accommodation: Toward a Principled Teaching Strategy," Instr. Sci. 11:183-200 (1982).

Nussbaum, J., "Classroom Conceptual Change: Philosophical Perspectives," Int. J. Sci. Educ. 11:530-540 (1989).

Ogborn, J., "Understanding Students' Understandings: An Example from Dynamics," Eur. J. Sci. Educ. 7:141-150 (1985).

Osborne, R.J. and M.C. Wittrock, "Learning Science: A Generative Process," Sci. Educ. 67:489-508 (1983).

Perez, D.G. and J.C. Alis, "Science Learning as a Conceptual and Methodological Change," Eur. J. Sci. Educ. 7:231-236 (1985).

Pope, M. and J. Gilbert, "Personal Experience and the Construction of Knowledge in Science," Sci. Educ. 67:193-203 (1983).

Pope, M.L. and J.K. Gilbert, "Explanation and Metaphor: Some Empirical Questions in Science Education," Eur. J. Sci. Educ. 5:249-261 (1983).

Posner, G.J., K.A. Strike, P.W. Hewson, and W.A. Gertzog, "Accommodation of a Scientific Conception: Toward a Theory of Conceptual Change," Sci. Educ. 66:211-227 (1982).

Sebastia, J.M., "Cognitive Constraints and Spontaneous Interpretations in Physics," Int. J. Sci. Educ. 11:363-369 (1989).

White, R. and R. Gunstone, "Metalearning and Conceptual Change," Int. J. Sci. Educ. 11:577-586 (1989).

Zietsman, A.I. and P.W. Hewson, "Effects of Instruction Using Microcomputer Simulations and Cognitive Change Strategies on Science Learning," J. Res. Sci. Tching. 23:27-39 (1986).

6) Instructional Investigations and Curriculum Ideas

Arnold, M., "Being Constructive: An Alternative Approach to the Teaching of Introductory Ideas in Electricity," Int. J. Sci. Educ. 9:553-563 (1987).

Arons, A.B., "Guiding Insight and Inquiry in the Introductory Physics Laboratory," The Phy. Tcher. 31:278-282 (1993).

Bar, V., "Introducing Mechanics at the Elementary School," Phy. Educ. 24:348-352 (1989).

Beichner, R.J., "The Effect of Simultaneous Motion Presentation and Graph Generation in a Kinematics Lab," J. Res. Sci. Tching. 27:803-815 (1990).

Brasell, H., "The Effect of Real-Time Laboratory Graphing on Learning Graphic Representations of Distance and Velocity," J. Res. Sci. Tching. 24:385-395 (1987).

Brna, P., "Confronting Misconceptions in the Domain of Simple Electrical Circuits," Instr. Sci. 17:29-55 (1988).

Brouwer, W., "Problem-Posing Physics: A Conceptual Approach," Amer. J. Phy. 52:602-607 (1984).

Bullock, B., "The Use of Models to Teach Elementary Physics," Phy. Educ. 14:312-317 (1979).

Carr, M. and V. Kirkwood, "Teaching and Learning About Energy in New Zealand Secondary School Junior Science Classrooms," Phy. Educ. 23:86-92 (1988).

Clement, J., D. Brown, and A. Zietsman, "Not All Preconceptions are Misconceptions: Finding 'Anchoring Conceptions' for Grounding Instruction on Students' Intuitions," Int. J. Sci. Educ. 11:554-565 (1989).

Finegold, M. and D. Raphael, "Physics in Canadian Secondary Schools: Intentions, Perceptions, and Achievement," J. Res. Sci. Tching. 25:293-315 (1988).

Flick, L.B., "Interaction of Intuitive Physics with Computer-Simulated Physics," J. Res. Sci. Tching. 27:219-231 (1990).

Gilbert, J.K. and R.J. Osborne, "The Use of Models in Science and Science Teaching," Eur. J. Sci. Educ. 2:3 (1980).

Hake, R.R., "Promoting Student Crossover to the Newtonian World," Amer. J. Phy. 55:878-884 (1987).

Hake, R.R., "Socratic Pedagogy in the Introductory Physics Laboratory," The Phy. Tcher.

30:546-552 (1992).

Heller, P., R. Keith, and S. Anderson, "Teaching Problem Solving Through Cooperative Grouping. Part 1: Group Versus Individual Problem Solving," Amer. J. Phy. 60:627-636 (1992).

Heller, P., and M. Hollabaugh, "Teaching Problem Solving Through Cooperative Grouping. Part 2: Designing Problems and Structuring Groups," Amer. J. Phy. 60:637-644 (1992).

Hestenes, D., "Toward a Modeling Theory of Physics Instruction," Amer. J. Phy. 55:440-454 (1987).

Hestenes, D., "Modeling Games in the Newtonian World," Amer. J. Phy. 60:732-748 (1992).

Hewson, P. and R. Thornley, "The Conditions of Conceptual Change in the Classroom," Int. J. Sci. Educ. 11:541-553 (1989).

Hicks, R.B. and H. Laue, "A Computer-Assisted Approach to Learning Physics Concepts," Amer. J. Phy. 57:807-811 (1989).

Kirkwood, V. and M. Carr, "A Valuable Teaching Approach: Some Insights from LISP (Energy)," Phy. Educ. 24:332-334 (1989).

Klopfer, L.E., A.B. Champagne, and S.D. Chaikelin, "The Ubiquitous Quantities: Explorations That Inform the Design of Instruction on the Physical Properties of Matter," Sci. Educ. 76:597-614 (1992).

Larkin, J.H. and F. Reif, "Better Instruction with Lower Costs: Some Practical Suggestions," Amer. J. Phy. 45:138-142 (1977).

Larkin, J.H., "Teaching Problem Solving in Physics: The Psychological Laboratory and the Practical Classroom," in Problem Solving and Education: Issues in Teaching and Research, D.T. Tuma and F. Reif (Eds.), Lawrence Erlbaum Associates, Hillsdale, NJ (1980).

Linn, M.C. and N.B. Songer, "Teaching Thermodynamics to Middle School Students: What Are Appropriate Cognitive Demands?" J. Res. Sci. Tching. 28:885-918 (1991).

Lochhead, J. and J. Collura, "A Cure for Cookbook Laboratories," The Phy. Tcher. 19:46-50 (1981).

McDermott, L.C., L.K. Piternick, and M.L. Rosenquist, "Helping Minority Students Succeed in Science," Part 1 - January; Part 2 - March; and Part 3 - May; J. Coll. Sci. Tching. 9 (1980).

McDermott, L.C., and P.S. Shaffer, "Research As A Guide for Curriculum Development: An Example from Introductory Electricity. Part 1: Investigation of Student Understanding." Amer. J. Phy. 60:994-1003 (1992).

Mokros, J.R. and R.F. Tinker, "The Impact of Microcomputer-Based Labs on Children's Ability

to Interpret Graphs," J. Res. Sci. Tching. 24:369-383 (1987).

Omasta, E. and V.N. Lunetta, "Exploring Functions: A Strategy for Teaching Physics Concepts and Problem Solving," Sci. Educ. 72:625-636 (1988).

Osborne, R., "Children's Dynamics," The Phy. Tcher. 22:504-508 (1984).

Psillos, D., P. Koumaras, and A. Tiberghien, "Voltage Presented as a Primary Concept in an Introductory Teaching Sequence on DC Circuits," Int. J. Sci. Educ. 10:29-43 (1988).

Renner, J.W., M.R.A. Abraham, and H.H. Birnie, "Secondary School Students' Beliefs about the Physics Laboratory," Sci. Educ. 69:649-664 (1985).

Rosenquist, Mark L. and L.C. McDermott, "A Conceptual Approach to Teaching Kinematics," Amer. J. Phy. 55:407-415 (1987).

Roth, W.-M. and A. Roychaudhury, "The Concept Map As A Tool for the Collaborative Construction of Knowledge: A Microanalysis of High School Physics Students," J. Res. Sci. Tching. 30:503-534 (1993).

Saxena, A.B., "An Attempt to Remove Misconceptions Related to Electricity," Int. J. Sci. Educ. 14:157-162 (1992).

Shaffer, P.S. and L.C. McDermott, "Research as a Guide for Curriculum Development: An Example from Introductory Electricity. Part II: Design of Instructional Strategies," Amer. J. Phy. 60:1003-1013 (1992).

St. John, M., "Thinking like a Physicist in the Laboratory," The Phy. Tcher. 18:436-443 (1980).

Thorley, N.R. and D.F. Treagust, "Conflict within Dyadic Interactions as a Stimulant for Conceptual Change in Physics," Int. J. Sci. Educ. 9:203-216 (1987).

Thornton, R.K., and D.R. Sokoloff, "Learning Motion Concepts Using Real-Time Microcomputer-based Laboratory Tools," Amer. J. Phy. 58:858-867 (1990).

Trumper, R., "Being Constructive: An Alternative Approach to Teaching of the Energy Concept - Part 1, Int. J. Sci. Educ. 12:343-354 (1990).

Trumper, R., "Being Constructive: An Alternative Approach to Teaching of the Energy Concept - Part 2, Int. J. Sci. Educ. 13: 1-10 (1991).

Webb, P., "Primary Science Teachers' Understandings of Electric Current," Int. J. Sci. Educ. 14: 423-429 (1992).

Wollman, W., "Models and Procedures: A Classroom Study of Teaching for Transfer," School Sci. & Math. 83:122 (1983).

7) Miscellaneous

Abimbola, I.O., "The Problem of Terminology in the Study of Student Conceptions in Science," Sci. Educ. 72:175-184 (1988).

Adey, P. and M. Shayer, "Strategies for Meta-Learning in Physics," Phy. Educ. 23:97-105 (1988).

Altes, A.S. and M.M. Merce, "The Scientific Method Used in Physics," Int. J. Sci. Educ. 10:111-120 (1988).

Bar, V., "Comparison of the Development of Ratio Concepts in Two Domains," Sci. Educ. 71:599-613 (1987).

Boyes, E., "Catastrophic Misconceptions in Science Education," Phy. Educ. 23:105-110 (1988).

Breitenberger, E., "The Mathematical Knowledge of Physics Graduates: Primary Data and Conclusions," Amer. J. Phy. 60:318-323 (1992).

Burbales, N.C. and M.C. Linn, "Response to Contradiction: Scientific Reasoning During Adolescence," J. Educ. Psych. 80:67-75 (1988).

Cachapuz, A.F.C. and R. Maskill, "Detecting Changes with Learning in the Organization of Knowledge: Use of Word Association Tests to Follow the Learning of Collision Theory," Int. J. Sci. Educ. 9:491-504 (1987).

Dee-Lucas, D. and J.H. Larkin, "Equations in Scientific Proofs: Effects on Comprehension," Amer. Educ. Res. J. 28(3):661-682 (1991).

Dee-Lucas, D. and J.H. Larkin, "Organization and Comprehensiblity in Scientific Proofs," or "Consider a particle p . . . ," J. Educ. Psych. 82:701-714 (1990).

Dee-Lucas, D. and J.H. Larkin, "Attentional Strategies for Studying Scientific Texts," Mem. Cog. 16:469-479 (1988a).

Dee-Lucas, D. and J.H. Larkin, "Novice Rules for Assessing Importance in Scientific Texts," J. Mem. Lang. 27:288-308 (1988b).

Dee-Lucas, D. and J.H. Larkin, "Novice strategies for Processing Scientific Texts," Discourse Processes 9:329-354 (1986).

Di Sessa, A.A., "The Third Revolution in Computers and Education," J. Res. Sci. Tching. 24, 343-367 (1987).

Dobson, K., "The Experience of Physics," Phy. Educ. 20:188-191 (1985).

Eckstein, S.G., and M. Shemesh, "Stage Theory of the Development of Alternative

Conceptions," J. Res. Sci. Tching. 30:45-64 (1993).

Eylon, B-S., R. Ben-Zvi, and J. Silberstein, "Hierarchical Task Analysis: An Approach for Diagnosing Students' Conceptual Difficulties," Int. J. Sci. Educ. 9:187-196 (1987).

Eylon, R. and M.C. Linn, "Learning and Instruction: An Examination of Four Research Perspectives in Science Education," Rev. Educ. Res. 58:251-301 (1989).

Feher, E., "Interactive Museum Exhibits as Tools for Learning: Explorations with Light," Int. J. Sci. Educ. 12(1):35-50 (1990).

Ferguson-Hessler, M.C.M. and T. DeJong, "Studying Physics Texts: Differences in Study Processes Between Good and Poor Performers," Cog. and Instruc. 7:41-54 (1990).

Finegold, M. and P. Gorsky, "Learning about Forces: Simulating the Outcomes of Pupils; Misconceptions," Instruc. Sci. 17:251-261 (1988).

Finley, F.N., "Students' Recall from Science Text," J. Res. Sci. tching. (1983).

Flick, L.B., "Interaction of Intuitive Physics With Computer-Simulated Physics," J. Res. Sci. Tching. 27: 219-231 (1990).

Gamble, R., "Force," Phy. Educ. 24:79-82 (1989).

Griffiths, A.K., K. Thomey, B. Cooke, and G. Normore, "Remediation of Student-Specific Misconceptions Relating to Three Science Concepts," J. Res. Sci. Tching. 25:709-719 (1988).

Gilbert, J.K. and D.J. Swift, "Towards a Lakatosian Analysis of the Piagetian and Alternative Conceptions Research Programs," Sci. Educ. 69:681-696 (1985).

Gunstone, R.F. and R.T. White, "Assessing Understanding by Means of Venn Diagrams," Sci. Educ. 70:151-158 (1986).

Harsch, G., "The Efficiency of Simulation Games in Science Education: An Empirical Study," Int. J. Sci. Educ. 9:23-36 (1987).

Hegarty, M., "Mental Animation: Inferring Motion From Static Displays of Mechanical Systems," J. of Exp. Psych:L,M, & C. 18:1084-1102 (1992).

Helm, H. and J. Gilbert, "Thought Experiments and Physics Education - Part 1," Phy. Educ. 20:124-131 (1985).

Helm, H., J. Gilbert, and D.M. Watts, "Thought Experiments and Physics Education - Part 2," Phy. Educ. 20:211-217 (1985).

Hestenes, D., "Wherefore a Science of Teaching?," The Phy. Tcher. 17:235-241 (1979).

Jorg, T. and T. Wubbles, "Physics a Problem for Girls, or Girls a Problem for Physics," Int. J. Sci. Educ. 9:297-307 (1987).

Kariotogloy, P., D. Psillos, and O. Vallassiades, "Understanding Pressure: Didactical Transpositions and Pupils' Conceptions," Phy. Educ. 25:92-96 (1990).

Karplus, R., "Educational Aspects of the Structure of Physics," Amer. J. Phy. 49:238-241 (1981).

Keating, D.P., "Thinking Processes in Adolescence," in Handbook of Adolescent Psychology, Joseph Adelson (Ed.), Wiley, NY (1980).

Koch, A., and S.G. Eckstein, "Improvement of Reading Comprehension of Physics Texts by Students' Question Formulation," Int. J. Sci. Educ. 13:473-485 (1991).

Labudde, P., R. Reif, and L. Quinn, "Facilitation of Scientific Concept Learning by Interpretation Procedures and Diagnosis," Int. J. Sci. Educ. 10:81-98 (1988).

Lawson, A.E., "Predicting Science Achievement: The Role of Developmental Level, Disembedding Ability, Mental Capacity, Prior Knowledge, and Beliefs," J. Res. Sci. Tching. (1983).

Lemke, J.L., "Talking Physics," Phy. Educ. 17:263-267 (1982).

Lin, H., "Learning Physics vs. Passing Courses," The Phy. Tcher. 20:151-157 (1982).

Linder, C., "Is Teacher-reflected Epistemology a Source of Conceptual Difficulty in Physics?" Int. J. Sci. Educ. 14:111-122 (1992).

Lythcott, J., "'Aristotelian' Was Given as the Answer, But What Was the Question?," Amer. J. Phy. 53:428-432 (1985).

MacGuire, P.R.P. and A.H. Johnstone, "Techniques for Investigating the Understanding of Concepts in Science," Int. J. Sci. Educ. 9:565-577 (1987).

Maloney, D.P., "Forces as Interactions," The Phy. Tcher. 28:386-390 (1990).

Mayer, R.E., "What Have We Learned About Increasing the Meaningfulness of Science Prose?," Sci. Educ. (1983).

McDermott, L.C., "Research and Computer-Based Instruction: Opportunity for Interaction," Amer. J. Phy. 58:452-462 (1990).

McDermott, L.C., "Millikan Lecture 1990: What We Teach and What is Learned-Closing the Gap," Amer. J. Phy. 59:301-315 (1991).

Mestre, J. and J. Touuger, "Cognitive Research: What's in It for Physics Teachers?," The Phy.

Tcher. 27:447-456 (1989).

Ogborn, J., "PROLOG and Models of Reasoning in Science," Phy. Educ. 22:225-229 (1987).

Osborne, J., "New Technology and Newtonian Physics," Phy. Educ. 22:360-364 (1987).

Pankratius, W.J., "Building An Organized Knowledge Base: Concept Mapping and Achievement in Secondary School Physics," J. Res. Sci. Tching. 27:315-333 (1990).

Perkins, D.N. and R. Simmons, "Patterns of Misunderstanding: An Integrative Model for Science, Math, and Programming," Rev. Educ. Res. 58:303-326 (1988).

Raat, J.H. and M. de Vries, "Technology in Education: Research and Development in the Project 'Physics and Technology'," Int. J. Sci. Educ. 9:159-168 (1987).

Reed, S.K. and N.C. Saavedra, "A Comparison of Computation, Discovery, and Graph Procedures for Improving Students' Conception of Average Speed," Cog. & Instr. 3:31-62 (1986).

Reif, F., "Instructional Design, Cognition, and Technology: Application to the Teaching of Scientific Concepts," J. Res. Sci. Tching. 24:209-224 (1987).

Reif, F., and J. Larkin, "Cognition in Scientific and Everyday Domains: Comparison and Learning Implications," J. Res. Sci. Tching. 28:733-760 (1991).

Roth, W.-M., and A. Roychoudhury, "The Nature of Scientific Knowledge, Knowing and Learning: The Perspectives of Four Physics Students," Int. J. Sci. Educ. 15:27-44 (1993).

Schauble, L., L.E. Klopfer, and K. Raghavan, "Students' Transition from an Engineering Model to a Science Model of Experimentation," J. Res. Sci. Tching. 28:859-882 (1991).

Shadmi, Y., "Teaching 'Control of Variables' to Primary School Teachers," Phy. Educ. 16:93-98 (1981).

Stenhouse, D., "Conceptual Change in Science Education: Paradigms and Language Games," Sci. Educ. 70:413-425 (1986).

Strnad, J., "On Some New Trends in Physics Teaching," Eur. J. Phy. 7:11-16 (1986).

Thornton, R.K., "Tools for Scientific Thinking: Microcomputer Based Laboratories for Physics Teaching," Phy. Educ. 22:280-238 (1987).

Tobias, S., "Peer Perspectives on Physics," The Phy. Tcher. 26:77-80 (1988).

Tobias, S. and R.R. Hake, "Professors as Physics Students: What Can They Teach Us?," Amer. J. Phy. 56:786-794 (1988).

Veiga, M.L.F.C.S., D.J.V.C. Pereira, and R. Maskill, "Teachers' Language and Pupils' Ideas in Science Lessons: Can Teachers Avoid Reinforcing Wrong Ideas?," Int. J. Sci. Educ. 11:465-479 (1989).

Watts, M. and M. Pope, "Thinking about Thinking, Learning about Learning: Constructivism in Physics Education," Phy. Educ. 22:326-331 (1987).

White, B.Y., "Designing Computer Games to Help Students Understand Newton's Laws of Motion," Cog. & Instr. 1:69-108 (1984).

Winn, B., "Recall of the Pattern, Sequence, and Names of Concepts Presented in Instructional Diagrams," J. Res. Sci. Tching. 25:373-386 (1988).

8) Books

The books listed contain many articles that range over most of the topics in this bibliography. They are not listed in any specific order.

The Psychology of Teaching for Thinking and Creativity, Lawson, A.E. (Ed.), 1980 AETS Yearbook ERIC, Columbus, OH (1979). This book contains a number of articles describing several of the theoretical paradigms and the research involved. A good reference for someone getting started.

Proceedings of the International Seminar on Misconceptions in Science and Mathematics, Helm, H. and J.D. Novak (Eds.), Cornell University Press, Ithaca, NY (1983). This volume contains a wealth of material about current research on conceptual understanding.

Cognitive Process Instruction, Lochhead, J. and J. Clement (Eds.), The Franklin Institute Press, Philadelphia, PA (1979). An excellent volume with several very good overview articles and specific examples of the application of research findings to classroom instruction.

Mechanisms of Cognitive Development, Sternberg, R.J. (Ed.), W.H. Freeman & Co., San Francisco, CA (1984). A recent collection of articles, by various researchers, on their research on cognitive development.

Human Abilities: An Information Processing Approach, Sternberg, R.J. (Ed.), W.H. Freeman & Co., San Francisco, CA (1994). A collection of articles by researchers, all operating from an information processing theory of cognition, based on their recent work. Includes a chapter on problem solving ability.

Developmental Implications of Science Teaching: Early Adolescence, Wollman, W.T. ERIC/SMEAC (1978). This is a useful critique of the Piagetian theory with an introduction to other, primarily information processing, approaches to science education research.

Proceedings of the International Workshop on Problems concerning Students' Representation of Physics and Chemistry Knowledge, Jung, W., H. Pfundt, and D.V. Rhoneck (Eds.), Paeagogische Hochschule Ludwigsburg, Ludwigsburg, West Germany (1981). Another volume containing a large variety of articles on current research on conceptual understanding. This volume is especially rich in articles on electrical circuit investigations.

Mental Models, Gentner, D. and A.L. Stevens (Eds.), Lawrence Erlbaum Associates, Hillsdale, NJ (1983). Most of the systems considered in this volume are physical systems. Several of the articles can be read without any background in contemporary psychology, for example, the ones by di Sessa, Larkin, McCloskey, and Clement. However, a number of the other articles really require knowledge of information processing theory to be fully understood. The character of the presentations in this volume is quite variable since some of the authors are physics education researchers, while others are psychologists.

Aspects of Understanding Electricity: Proceedings of an International Workshop, Duit, R., W. Jung, and C. von Rhoneck (Eds.), IPN-Arbeitsberichte (1985). The papers in this volume are organized into three areas: students' conceptions and problem solving processes, methods of investigations, and teaching electricity.

Cognitive Structure and Conceptual Change, West, L.H.T. and A.L. Pines (Eds.), 1985 Academic Press, Inc., NY (1985). Three chapters in this volume are directly concerned with physics. Two of the three are by Champagne, Gunstone, and Klopfer, and the third is by Fred Reif. The other chapters all essentially fit into the "constructivist" paradigm of learning.

Thinking and Learning Skills: Volume 2 Research and Open Questions, Chipman, S.F., J.W. Segal, and R. Glaser (Eds.), Lawrence Erlbaum Associates, Hillsdale, NJ (1985). A survey volume about cognitive research, including a section on problem solving with a chapter by Jill Larkin. Other sections deal with research on such matters as knowledge acquisition, intelligence and reasoning, and approaches to the teaching of cognitive skills.

Learning in Science: The Implications of Children's Science, Osborne, R. and P. Freyberg, Heinemann, Portsmouth, NH, written by staff members of the Learning in Science Project at the University of Waikato, New Zealand (1985). The children's science of the title is that of subjects from about 10 to 17 years of age.

Children's Ideas in Science, Driver, R., E. Guesne, and A. Tiberghien (Eds.), Open University Press, Milton Keynes, Philadelphia, PA (1985). The chapters in this volume are written by individuals who have carried out investigations on alternative conceptions, alternative

frameworks and children's science. All but one chapter deal with topic areas from physics.

Qualitative Reasoning about Physical Systems, Bobrow, D.C. (Ed.), MIT Press, Cambridge, MA (1985). This volume is more directly associated with the artificial intelligence framework than the cognitive science perspective.

Proceedings of the Second International Seminar on Misconceptions and Educational Strategies in Science and Mathematics, Novak, J.D. (Ed.), Cornell University, Ithaca, NY (1987). These proceedings were published in three volumes; most of the physics related articles are in volume 3, but there are physics articles in the other two volumes also.

Research in Physics Learning: Theoretical Issues and Empirical Studies, Duit, R., F. Goldberg, and H. Niedderer (Eds.), IPN, University of Kiel (1992). The articles in this volume were presented at an international workshop held at the University of Bremen in March, 1991.

J) Journals

We list here the journals mentioned in the bibliography with their sponsoring organizations and/or publishers, where known.

American Journal of Physics -- American Association of Physics Teachers
Cognition -- Elsevier Sequoia S.A.
Cognition and Instruction -- Lawrence Erlbaum Associates Publishers, Hillsdale, NJ
Cognitive Psychology -- Academic Press
Cognitive Science -- Cognitive Science Society, Ablex Publishing Corp.
Develpmental Psychology -- American Psychological Association
Educational Psychologist -- American Psychological Association
European Journal of Science Education -- Institute for Science Education (Now: International Journal of Science Education) Kiel, FR Germany, Taylor & Francis
Instructional Science -- Kluwer Academic Publishers, Boston
Journal of College Science Teaching -- National Science Teachers Association
Journal of Educational Psychology -- American Psychological Association
Journal of Experimental Psychology: Learning, Memory, and Cognitive -- American Psychological Association
Journal of Research in Science Teaching -- National Association for Research in Science Teaching, John Wiley & Sons
Physics Education -- Institute of Physics, London
Problem Solving -- Lawrence Erlbaum Associates Publishers, Hillsdale, NJ
School Science and Mathematics -- School Science and Mathematics Association
Science Education -- Association for the Education of Teachers in Science, John Wiley & Sons
Studies in Science Education
The Physics Teacher -- American Association of Physics Teachers