

JOHN R. FREDERIKSEN

Professor of Education
University of Washington

PROFESSIONAL INTERESTS AND BACKGROUND

Dr. Frederiksen's interests are broadly concerned with the application of the cognitive sciences to learning and instruction within classroom settings. His background in cognitive science encompasses work in experimental cognitive psychology, artificial intelligence, and educational measurement. In his research, he has sought to apply computer and video technologies in developing collaborative learning environments and educational assessment practices that will foster improvements in learning and teaching. His recent work focuses on how elementary and middle school students can develop an understanding of scientific inquiry processes and apply this knowledge in creating models of scientific phenomena. In this context, he is carrying out a longitudinal study of how developing students' inquiry skills may enhance their learning across the middle school curriculum. His research on assessment focuses on both teachers and students. He has studied how teachers' use of video portfolios for assessing teaching may support their inquiry into effective teaching practices, and how students' peer and self assessments of their inquiry processes facilitates their learning. He has also investigated how assessments of scientific inquiry may be incorporated into large-scale science assessments. He has also been interested in students' understanding of physical theories (particularly of electricity) and, within this domain, he has developed intelligent computer-based learning environments for understanding basic circuit theory. His interests in cognitive science and instruction have not been limited to science education. In earlier work, he created computer-based learning environments for developing reading skills of bilingual students and students with reading disabilities. These instructional systems were based on his experimental analyses of the components of reading skill. In all of his research, he applies cognitive theories to educational practice, and uses evaluations of learning and instructional processes to illuminate further development of cognitive theory.

EDUCATION

Ph. D. 1966 (Psychology), Princeton University;

B. A. 1963 (Psychology, magna cum laude), Harvard University.

PROFESSIONAL AFFILIATIONS AND SERVICE

2001-present Professor of Education, University of Washington, Seattle, WA

1990-present: Adjunct Professor, Graduate School of Education, University of California, Berkeley, California (a member of the faculty in Human

Development and in Education in Mathematics, Science, and Technology)

- 2000-present Director of Assessment Development and Research, Teachscape.
- 1990-2000: Principal Scientist and Director, Cognitive Science Research Group, Division of Cognitive and Instructional Sciences, Educational Testing Service, Oakland, California
- 1987-1990: Division Scientist, Education Department, Information Sciences Division, BBN Laboratories, Cambridge, Massachusetts
- 1975-1987: Senior Scientist, Experimental Psychology and Education Departments, BBN Laboratories, Cambridge, Massachusetts
- 1975-1982: Research Associate, Graduate School of Education, Harvard University, Cambridge, Massachusetts
- 1974: Visiting Assistant Professor, Harvard Summer School, Cambridge, Massachusetts
- 1968-1975: Assistant Professor, Department of Psychology, Brandeis University, Waltham, Massachusetts
- 1974: Visiting Assistant Professor, Harvard Summer School, Cambridge, Massachusetts
- 1967-1968: Research Associate, Department of Psychology, Massachusetts Institute of Technology, Cambridge, Massachusetts
- 1966-1967: Postdoctoral Research Fellow, Center for Cognitive Studies, Harvard University, Cambridge, Massachusetts

Fellowships

Psychometric Fellowship, Princeton University; Research Fellow in Cognitive Studies, Harvard University; Research Fellow, Massachusetts Institute of Technology.

Research Grants and Contracts

Air Force Human Resources Laboratory, Army Research Institute, Carnegie Corporation, Defense Advanced Research Projects Agency, James S. McDonnell Foundation, National Board for Professional Teaching Standards, National Institute of Education, Office of Naval Research, National Science Foundation, and U. S. Department of Education, U. S. Office of Educational Research and Improvement. Total of awards: ~\$7.5 M.

Professional Organizations

American Association for the Advancement of Science, American Educational Research Association, Cognitive Science Society, National Association for Research in Science Teaching, Psychonomic Society, and Sigma Xi.

Other Professional Activities

Member of Planning/Working Group, Center for Performance Assessment, ETS; Chair, Lindquist Award Committee, American Educational Research Association, 1997-1998; Advisor, Science Assessment, New Standards Project; Member, Lindquist Award Committee, American Educational Research Association, 1996-1997; National Design Experiment Collaborative, 1992-1997; Technical Advisory Committee, Career and Technical Assessment Program, California Dept. of Education; 1990-1995; National Center for Research in Mathematical Sciences Education, Authentic Assessment Working Group, 1990-1995; Technical Advisory Committee, California Learning Assessment System, California Dept. of Education, 1990-1995; National Academy of Education Focus Group on Testing Research, 1989; Congressional Task Force on School Evaluation, 1987-1989; National Committee on Reading, College Entrance Examination Board, 1979-1988; National Advisory Panel on Reading Effectiveness Measures and Standards, New York State Board of Regents, 1977-1979.

Editorial board, *Journal of the Learning Sciences*. Formerly Consulting Editor, *Journal Consulting and Clinical Psychology*. Editorial consultant for *American Educational Research Journal*, *Cognition and Instruction*, *Cognitive Psychology*, *Cognitive Science*, *Educational Researcher*, *Journal of Experimental Psychology*, *Memory and Cognition*, *Psychological Bulletin*, *Psychological Review*.

TEACHING EXPERIENCE

School of Education, University of California, Berkeley

Graduate Courses: Cognition, Learning, and Instruction (a School of Education Core Course); Assessment as a Resource for Learning and Understanding (pro seminar in measurement and data analysis); Seminar on the Nature of Scientific Inquiry and Modeling; Seminar on Mental Models in Science Education; Research Seminar on Video Portfolios in the Assessment of Teaching; Video Analysis Research Seminar; Methods for Classroom-based Research. Supervised doctoral research. Supervised students in the MACSME program (a two-year teacher education program leading to a Masters and Credential in Science or Mathematics Education).

Harvard Graduate School of Education

Supervised doctoral research.

Harvard Summer School

Elementary Statistics; Cognition and Personality.

Brandeis University

Undergraduate Courses: Introduction to Psychology - Cognitive Processes; Elementary Probability and Statistics (including a computer-based laboratory developed for the course); Upper Division Seminar on Cognitive Processes; Psychology of Motivation.

Graduate Courses: Pro-seminar; Advanced Psychological Statistics and Experimental Design; Multivariate Statistical Methods; Psychological Scaling and Test Theory; Supervised doctoral research.

PROFESSIONAL RESPONSIBILITIES AND PROJECTS

Teachscape

2001-present. Dr. Frederiksen is a Professor in the College of Education, University of Washington in Seattle, WA.

2000 - 2001. Dr. Frederiksen joined a start-up company, Teachscape, that is dedicated to creating video case-based professional development courses for use in school districts and by individual teachers. Case materials include videos of classroom teaching, lessons plans and curriculum, as well as reflections of teachers and education leaders on case materials. The case materials are integrated with on-line threaded discussions and on-site group activities for teachers. Dr. Frederiksen's responsibilities include applying educational theory to the system design, linking video case studies to national and state standards for student learning and teaching, and directing the development of professional development activities and assessments. Work so far has concentrated on elementary school science teaching and early literacy. He is based at SRI International in Menlo Park, CA.

Educational Testing Service

1990 - 2000. Dr. Frederiksen established the Cognitive Science Research Group at the Educational Testing Service in Oakland, California. This group, which falls within the Research Division of Cognitive and Instructional Sciences, was organized by ETS in 1990 to expand its capability for cognitive research by working closely with investigators in universities and other research institutions in the Bay Area, particularly, the School of Education, UC Berkeley. The group conducts basic research concerned with the nature of scientific and mathematical understanding and inquiry, the development of learning environments to facilitate such understanding, and the design of performance assessments that serve as a tool for promoting learning. The group is particularly interested in applications of computer and video technologies in performance assessment and in instruction.

1997 - present. Dr. Frederiksen is co-Principal Investigator (with Prof. Barbara White) of a project entitled *Improving students' learning and achievement through developing generalizable skills for inquiry and self-reflection*, supported by the U. S. Department of

Education's Office of Educational Research and Improvement. In prior research they have shown that students who learn scientific inquiry skills and develop an ability to reflect critically on their work become skillful learners within a classroom research community. Their evidence shows that academically disadvantaged students are particularly well served by a computer-enhanced inquiry curriculum, showing dramatic improvements in their performance as a result of the metacognitive instruction. This project seeks to explore how and under what conditions students learn to generalize their inquiry and reflective skills beyond a single curricular domain, and to what extent these effects on learning are lasting. The theoretical goal is to develop a more complete account of the learning and transfer of inquiry and reflective skills across curricular domains. (Amount of award: \$660,000.)

1995 - 1999. Dr. Frederiksen was co-Principal Investigator (with Prof. Barbara White) of a project entitled *Developing teachers' and students' scientific inquiry skills using a computer-based, classroom learning environment*, supported by the James S. McDonnell Foundation. The project represents a collaboration between researchers at UC Berkeley and ETS, and teachers in the Berkeley and Oakland Public Schools. The goal of the project was to create curricular, video, and computer-based materials to enable teachers to successfully implement an inquiry-based science curriculum within their classrooms. The research sought to evaluate an approach to reforming science education that focuses on teachers as change agents. The approach is to develop teachers' skills in science and inquiry through their experience in implementing an actual inquiry curriculum within their school. The strategy is to use the process of implementing a particular curriculum (the ThinkerTools Inquiry Curriculum) as a vehicle for teachers to learn how to restructure their science classes as collaborative research communities. The overall goal was to construct an approach to science education that develops in both teachers and students a working understanding of scientific inquiry that is broadly generalizable, and that allows them, as they use it, to develop a deep understanding of a domain of science. (Amount of award: \$430,000.)

1991 - 1996. Dr. Frederiksen was Principal Investigator of an NSF Project entitled *Performance assessment as a tool for enhancing learning in middle and secondary school science*. This project was in collaboration with co-Principle Investigators Professors Ann Brown, Joe Campione, and Barbara White, of UC Berkeley, and with Dr. Jan Hawkins of EDC's Center for Children and Technology. The objective of the project was to develop a principled basis for constructing and scoring conceptually rich performance tasks which serve the joint goals of enhancing the teaching and learning of science and scientific inquiry, while meeting psychometric standards needed to provide accountability information to the public. Classroom-based experimental trials were conducted in schools in California and New York to explore alternative assessment models for middle and secondary school science. Assessment activities explored range from relatively scripted curricular activities to extended, open-ended research projects which were often carried out in collaboration with other students. In addition to creating a variety of assessment activities, alternative methods for scoring the activities were studied with an emphasis on social processes in learning to score and in score moderation. In evaluating alternative assessment systems, the focus was not only on their effectiveness for enhancing students' learning, but also for improving teaching. (Amount of award: \$1,586,000.)

1991 - 1995. Dr. Frederiksen was Principal Investigator of a project entitled *Exploration of video portfolios as a means of documenting current teaching practice*, carried out for the National Board for Professional Teaching Standards. This project involved a collaboration with Dr. Allan Collins of BBN Laboratories and with researchers at the Institute for Research on Learning. The purpose of the project was to explore the use of video portfolios produced by teachers as a means for evaluating highly accomplished teaching. The domain of teaching assessed was high school mathematics. Video portfolios consist of video recordings of classes accompanied by teachers' reflections on the purposes and character of their teaching. The assessment criteria are based upon a direct interpretation of teaching episodes. They include teaching functions such as creating a climate of cooperativeness and helping, and promoting mathematical thinking. The criteria are chosen for their reflective value in helping teachers to view and analyze teaching. The process of preparing a video portfolio is viewed as an opportunity for a community of teachers to develop an understanding of how conceptions of accomplished teaching can be seen in viewing videotapes of teaching. Since this is inherently a social process, teachers who are preparing video portfolios work in reflective practitioner groups or video clubs. The overall goal was to design a video portfolio system that, in practice, could become a vehicle for creating communities of teachers and teacher-assessors who work together to improve classroom teaching and learning. (Amount of award: \$669,000.)

1990 - 2000. The *causal models project* represents a continuation of prior research undertaken with Dr. Barbara White at BBN. This research has sought to establish what are the properties of mental models that enable students to develop a robust understanding of physical systems that supports explanation and problem solving. One result has been the construction of a set of alternative conceptual models that enable students to develop an understanding of the physical mechanisms underlying the behavior of electrical circuits. These models represent three different levels of analysis: a *functional model* of circuit behavior, an *aggregate model* to explain the flow of charge within a circuit, and a *particle model* for understanding the cause of charge flow in terms of interactions among charged particles. In this research, we have found that low-level particle models are an important component both of experts' knowledge of electricity and of a successful instructional program for learning about electrical circuits. We are currently studying why such linked causal models enhance students' learning and understanding. (Internally funded through ETS.)

BBN Laboratories

1986 - 1990. While at BBN Laboratories, Dr. Frederiksen collaborated with Drs. Bruce Roberts, Allan Collins, and Barbara White on the design of an *intelligent computer-based tutoring system for training generic troubleshooting strategies* which are used in troubleshooting complex avionics equipment. The focus of this research, sponsored by the Air Force Human Resources Laboratory, was on modeling troubleshooting knowledge and general problem solving skills in a form that facilitates their transfer within a family of avionics jobs covering a range of electrical troubleshooting occupations. This model of cognitive skill formed the basis of a first-generation Avionics Job-Family Tutor which focuses on troubleshooting a complex Automatic Test

Station. The research has included an evaluation of the Avionics tutor in field tests conducted at an Air Force base. (Amount of award: ~\$1,100,000.)

1986 - 1990. At BBN Laboratories, Dr. Frederiksen was Principal Investigator (with Dr. Barbara White) of an ARI-sponsored research project concerned with *qualitative models for reasoning about physical domains and their use in instruction*. The objective of the project was to advance theoretical work on the design and use of qualitative models for instructional purposes. In that context, they investigated how experts use and coordinate multiple models when reasoning about electrical circuits. The results of the empirical training studies and theoretical work contributed to theories underlying the design of intelligent tutoring systems. (Amount of award: ~\$700,000.)

1982 - 1986. Dr. Frederiksen also served as co-Principal Investigator for an ONR and ARI-sponsored project concerned with the *development of an intelligent tutoring system for developing in students a qualitative understanding of electrical systems and their troubleshooting* (QUEST). In this work (carried out in collaboration with Drs. Barbara White and W. Feurzeig), a tutoring system was built that includes a qualitative causal model for simulating the behavior of electrical systems in faulted and unfaulted conditions, an expert troubleshooter that employs a strategy derived from study of an expert troubleshooter/teacher, and an interactive computer-based graphics system for teaching basic electric circuit concepts. Training follows an apprenticeship model in which the computer demonstrates and articulates the strategies and reasoning involved in solving problems while also provides a simulation environment for acquiring such concepts in the course of problem solving. (Amount of award: ~\$650,000.)

1984 - 1986. Dr. Frederiksen was co-Principal Investigator (with Barbara White) of a DARPA-sponsored project concerned with *investigating learning strategies for use in microprocessor-driven part-task training simulators*. This research was part of a larger project centered at the University of Illinois (Principal Investigator, Prof. Emanuel Donchin) whose purpose was to compare widely diverging training strategies for developing a common, complex skill. In all, seven independent groups of investigators located in laboratories worldwide simultaneously developed and tested their own strategies for developing skill in a complex, multicomponent task which resembles a video game. This criterion task involved perceptual-motor, memory, and strategic components, as well as model-based reasoning founded on a knowledge of physical principles governing the motion of objects. The participating research groups were chosen to represent diverse perspectives within the training community. The learning strategy explored in our project involved hierarchical, part-task training which focused on developing knowledge and skill components and on their integration within the strategic context of the whole task. (Amount of award: ~\$300,000.)

1979 - 1986. Dr. Frederiksen has served as Principal Investigator for two ONR-sponsored research projects (also supported by the NIE Center for the Study of Reading) concerned with the *development of game-like, microcomputer-based instructional environments for improving critical components of reading in young adults, including bilingual students, who have low reading skills*. This work involved a collaboration with Prof. Phyllis Weaver of the Harvard Graduate School of Education. The objective of this research

program was to validate an interactive, componential theory of reading by developing a series of instructional games that focus on critical skill components. These games were then employed in a series of instructional experiments which focused on the interactions between newly acquired skills and other skill components of reading. A more general goal of the research was to understand the ways in which domain-specific cognitive theories constrain the form of effective instruction. This project grew out of an earlier ONR-sponsored project at BBN (1975 - 1979), concerned with the *analysis of perceptual and cognitive abilities that are involved in verbal information processing*. This research supported a view of verbal ability as an emergent outcome of a system of interacting component skills that are linked through sharing data and resources (Total of awards: ~\$1,200,000)

1975 - 1980. While at BBN, Dr. Frederiksen also served as research director for a Carnegie- and NIE-sponsored project centered at Harvard University (Principal Investigator R. Edmonds) entitled *Search for Effective Schools*. He has also participated in *Project Intelligence*, an instructional project sponsored by the government of Venezuela through a subcontract to Harvard University which sought to develop and evaluate a curriculum for raising intellectual competencies of school children in that country.

Brandeis University

1971 - 1973. While at Brandeis University, Dr. Frederiksen was Principal Investigator for an NIE-sponsored project entitled *Perceptual, Judgmental, and Linguistic Factors in the Recognition of Masked Auditory Stimuli*.

PUBLICATIONS

Journal Articles

Frederiksen, J. R., White, B. Y., & Gutwill, J. (1999). Dynamic mental models in learning science: The importance of constructing derivational linkages among models. Journal of Research in Science Teaching, 36(7), 806-836.

Gutwill, J. P., Frederiksen, J. R., and White, B. Y. (1999). Making their own connections: Students' understanding of multiple representations and mechanisms in basic electricity. Cognition and Instruction, 17(3), 249-282.

White, B., Shimoda, T., & Frederiksen, J. R. (1999). Enabling students to construct theories of collaborative inquiry and reflective learning: Computer support for metacognitive development. International Journal of Artificial Intelligence in Education, 10(2), 151-182.

Frederiksen, J. R., Sipusic, M., Sherin, M., and Wolfe, E. (1998). Video portfolio assessment: Creating a framework for viewing the functions of teaching. Educational Assessment, 5(4), 225-297.

- Frederiksen, J. R., & White, B. (1998). Teaching and learning generic modeling and reasoning skills. Journal of Interactive Learning Environments, 5(1), 33-52.
- White, B., & Frederiksen, J. (1998). Inquiry, modeling, and metacognition: Making science accessible to all students. Cognition and Instruction, 16(1), 3-118.
- Gutwill, J., Frederiksen, J. R., & Ranney, M. (1996). Seeking the causal connection in electricity: Reasoning about mechanisms, transients, and steady states. International Journal of Science Education, 18 (2), 143-162.
- Frederiksen, J. R. (1994). Assessment as an agent of educational reform. The Educator, 8(2), 2-7.
- White, B., & Frederiksen, J. R. (1994). Using assessment to foster a classroom research community. The Educator, 8(2), 18-26.
- Collins, A., Hawkins, J., & Frederiksen, J. (1993). Three different views of students: The role of technology in assessing students' performance. Journal of the Learning Sciences, 3(2), 205-217.
- White, B. Y., & Frederiksen, J. R. (1990). Causal model progressions as a foundation for intelligent learning environments. Artificial Intelligence, 42, 99-157. (Also appeared in W. Clancey and E. Soloway (Eds.), Artificial Intelligence and Learning Environments. Cambridge, MA: MIT Press.)
- White, B. Y., & Frederiksen, J. R. (1989). Causal models as intelligent learning environments for science and engineering education. Applied Artificial Intelligence: An International Journal, 3 (2-3), 167-190. (Also appeared in W. Horn (Editor), Causal AI Models: Steps Toward Applications. New York: Hemisphere Publishing Co., pp. 83-106.)
- Frederiksen, J. R., & Collins, A. (1989). A systems approach to educational testing. Educational Researcher, 18 (9), 27-32.
- Frederiksen, J. R., & White, B. Y. (1989). An approach to training based upon principled task decomposition. ACTA Psychologica, 71 (1-3), 89-146.
- Frederiksen, J. R., & White, B. Y. (1988). Implicit testing within an intelligent tutoring system. Machine Mediated Learning, 2, 351-372.
- Frederiksen, J. R., & Warren, B. M. (1987). A cognitive framework for developing expertise in reading. In R. Glaser (Ed.), Advances in Instructional Psychology. Hillsdale, N.J: Lawrence Erlbaum Associates.
- Frederiksen, J. R., Warren, B. M., & Rosebery, A. S. (1986). A componential approach to training reading skills: Part II. Decoding and use of context. Cognition and Instruction, 2 (3&4), 271-338.

- Frederiksen, J. R., Warren, B. M., & Rosebery, A. S. (1985). A componential approach to training reading skills: Part I. Perceptual units training. Cognition and Instruction, 2 (2), 91-130.
- White, B. Y., & Frederiksen, J. R. (1985). QUEST: Qualitative understanding of electrical system troubleshooting. ACM SIGART, 93, 34-37.
- Frederiksen, J. R., Warren, B. M., Gillotte, H. P., & Weaver, P. A. (1982). The name of the game is literacy. Classroom Computer News, 2 (5), 23-27.
- Frederiksen, J. R. (1981). A componential theory of reading skills and their interactions. In R. J. Sternberg (Ed.) Advances in the Psychology of Human Intelligence. Hillsdale, N.J.: Lawrence Erlbaum Associates.
- Frederiksen, J. R. (1981). A Thurstonean's reaction to a componential theory of intelligence. The Behavior and Brain Sciences.
- Frederiksen, J. R. (1981). Understanding anaphora: Rules used by readers in assigning pronominal referents. Discourse Processing, 4, 323-347. (Also ONR Technical Report No. 3 and Center for the Study of Reading Technical Report No. 242, Cambridge, MA: Bolt Beranek and Newman Inc.)
- Frederiksen, J. R. (1979). Component skills in reading: Identifying sources of reading disability in young adults. Naval Research Review, 32, 24-41.
- Frederiksen, J. R. (1977). Paradigm shift in creativity research? (Review of Perspectives in Creativity by I. A. Taylor and J. W. Getzels). Contemporary Psychology.
- Frederiksen, J. R., & Kroll, J. (1976). Spelling and sound: approaches to the internal lexicon. J. Experimental Psychology: Human Perception and Performance, 2, 361-379.
- Frederiksen, J. R. (1975). Two models of psychophysical judgment: Scale invariance with changes in stimulus range. Perception and Psychophysics, 17, 147-157.
- Frederiksen, J. R. (1973). A tachistoscopic software system for use in remote timesharing applications. Behavior Research Methods and Instrumentation, 6, 481-486.
- Frederiksen, J. R. (1972). Review of Science, Psychology, and Communication: Essays Honoring William Stephenson by S. R. Brown and D. J. Brenner. Contemporary Psychology.
- Frederiksen, J. R. (1971). A statistical decision model for auditory word recognition. Psychological Review, 78, 409-419.
- Frederiksen, J. R. (1971). Theory of personality structure: Proteus of Procrustes? (Review of The Structure of Human Personality), 3rd Ed., by H. J. Eysenck). Contemporary Psychology, 16 (6), 374-375.

Frederiksen, J. R. (1970). Searching for the gifted, (Review of *The Discovery of Talent* by D. Wolfle). Contemporary Psychology, 15 (3), 186.

Frederiksen, J. R. (1969). Response perseveration in auditory word recognition. J. of Experimental Psychology, 77, 48-55.

Frederiksen, J. R. (1967). Cognitive factors in the recognition of ambiguous auditory and visual stimuli. Journal of Personality and Social Psychology, 7 (1), whole issue (Monograph supplement, No. 639).

Chapters in Contributed Volumes

Frederiksen, J. R., & White, B. Y. (in press). Conceptualizing and constructing linked models: Creating coherence in complex knowledge systems. To appear in P. Brna, M. Baker, K. Stenning and A. Tiberghien (Eds.), The Role of Communication in Learning to Model. Mahwah, NJ: Erlbaum.

White, B., & Frederiksen, J. (2000). Metacognitive facilitation: An approach to making scientific inquiry accessible to all. In J. Minstrell and E. van Zee (Eds.), Inquiring into Inquiry Learning and Teaching in Science. (pp. 331-370). Washington, DC: American Association for the Advancement of Science.

White, B., Shimoda, T., & Frederiksen, J. (2000). ThinkerTools that support metacognitive and metasocial development: enabling students to construct theories of collaborative inquiry and reflection. In S. Lajoie (Ed.), Computers as Cognitive Tools, Volume Two: No More Walls. (pp. 97-132). Mahwah, NJ: Erlbaum.

White, B., & Frederiksen, J. (2000). Technological tools and instructional approaches for making scientific inquiry accessible to all. In M. Jacobson and R. Kozma (Eds.), Innovations in Science and Mathematics Education: Advanced Designs for Technologies of Learning. (pp. 321-359). Mahwah, NJ: Lawrence Erlbaum Associates.

Frederiksen, J. R., & Collins, A. (1996). Designing an assessment system for the workplace of the future. (pp. 193-221). In L. B. Resnick, J. Wirt, & D. Jenkins (Eds.), Linking School and Work: Roles for Standards and Assessment. Jossey-Bass.

Sheingold, K., & Frederiksen, J. R. (1994). Using technology to support innovative assessment. (pp. 111-132). In B. Means (Ed.), Technology and School Reform: The Reality Behind the Promise. San Francisco: Jossey-Bass.

White, B., Frederiksen, J. R., & Spoehr, K. (1993). Conceptual models for understanding electrical circuits. (pp. 77-95). In M. Caillot (Ed.), Learning Electricity and Electronics with Advanced Educational Technology. New York: Springer Verlag.

Frederiksen, J. R., & White, B. Y. (1992). Mental models and understanding: A problem for science education. (pp. 211-226). In E. Scanlon & T. O'Shea (Eds.), New Directions in Educational Technology. New York, NY: Springer Verlag.

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Frederiksen, J. R., & White, B. Y. (1990). Intelligent tutors as intelligent testers. (pp. 1-25). In N. Frederiksen, R. Glaser, A. Lesgold, & M. Shafto, (Editors), Diagnostic Monitoring of Skill and Knowledge Acquisition. Hillsdale, N.J.: Lawrence Erlbaum Associates.

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Frederiksen, J. R. (1980). Some cautions we might exercise in attributing age deficits in memory to attentional dysfunctions. In L. W. Poon, J. L. Fozard, L., Cermak, D. Arenberg, & L. W. Thompson (Eds.). New Directions in Memory and Aging: Proceedings of the George Talland Memorial Conference. Hillsdale, N.J.: Lawrence Erlbaum Associates.

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Montague, W. E. (Eds.), Aptitude, Learning and Instruction: Cognitive Process Analysis. Hillsdale, N.J.: Lawrence Erlbaum Associates.

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Refereed Conference Proceedings

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Frederiksen, J., & White, B. (1996) Facilitating generic modeling skills. (pp. 47-56). In Proceedings of the Workshop on the Role of Qualitative Reasoning Techniques in Intelligent Tutoring Systems. Montreal, Canada: ITS'96, University of Montreal.

Frederiksen, J. R., & White, B. Y. (1993). The Avionics Job-Family Tutor: An approach to developing generic cognitive skills within a job-situated context. (pp. 513-520). In P. Brna, S. Ohlsson, & H. Pain (Eds.), Artificial Intelligence in Education, 1993: The World Conference on AI in Education. Charlottesville, VA: Association for the Advancement of Computing in Education.

White, B., Frederiksen, J. R., & Spoehr, K. (1993). Reductionistic models and the acquisition of electrical expertise. (pp. 1071-1076). In Proceedings of the Fifteenth Annual Meeting of the Cognitive Science Society. Hillsdale, NJ: Lawrence Erlbaum Associates.

White, B. Y., & Frederiksen, J. R. (1988). Explorations in understanding how physical systems work. (pp. 325-331). In Proceedings of the Tenth Annual Meeting of the Cognitive Science Society. Hillsdale, NJ: Lawrence Erlbaum Associates.

Frederiksen, J. R., & White, B. Y. (1988). Intelligent learning environments for science education. (pp. 250-257). In Proceedings of Intelligent Tutoring Systems 88. Montreal, Canada: University of Montreal.

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Frederiksen, J. R., & White, B. Y. (1985). A system for teaching a qualitative understanding of electrical circuit behavior and troubleshooting. In Proceedings of the Second International Conference on Artificial Intelligence and Education. Exeter, Devon, UK.

White, B. Y., & Frederiksen, J. R. (1984). Modeling expertise in troubleshooting and reasoning about simple electric circuits. (pp. 337-343). In Proceedings of the Sixth Annual Meeting of the Cognitive Science Society. Lawrence Erlbaum Associates, Hillsdale, New Jersey.

Feurzeig, W., Frederiksen, J. R., White, B. Y., & Horwitz, P. (1983). Designing an expert system for training automotive electrical troubleshooting. In Proceedings of the Joint Services Workshop on Artificial Intelligence in Maintenance. Boulder, Colorado, October. (Also appeared in J. Richardson (Ed.), Artificial Intelligence in Maintenance. Noyes Publications, Park Ridge, NJ.)

Frederiksen, J. R. (1973). Response latencies and memory access in auditory word recognition. Proceedings of the 81st Annual Convention of the American Psychological Association, Vol. 8.

Refereed Technical Reports

White, B., & Frederiksen, J. (1997). The ThinkerTools Inquiry Project: Making scientific inquiry accessible to students and teachers. Princeton, NJ: ETS Center for Performance Assessment. (Also appeared in Cognition and Instruction, in revised form.)

Anderson, T. H., Wardrop, J. L., Hirely, W., Anderson, R. I., Hastings, N. C., & Frederiksen, J. R. (1977). Plans and procedures for developing and using domain referenced tests. Center of the Study of Reading, Technical Report, Champaign, IL: University of Illinois.

Technical Reports

Frederiksen, J. R., & White, B. (1996) Reflective assessment: assessing students' research within an inquiry-based middle-school science curriculum. Technical Report CM-96-02, UC Berkeley, School of Education.

White, B. Y., & Frederiksen, J. R. (1995). An overview of the ThinkerTools inquiry project. School of Education, University of California, Berkeley: Causal Models Research Group Report 95-04.

Frederiksen, J. R., Sipusic, M., Gamoran, M., and Wolfe, E. (1992). Video portfolio assessment: A study for the National Board for Professional Teaching Standards. Project final report. Emeryville, CA: Educational Testing Service.

Roschelle, J., & Frederiksen, J. (1992). Technology choices, feasibility, and use for video portfolio assessment. Palo Alto, CA: Institute for Research on Learning, Project Report, 1992.

Frederiksen, J. R. (1987). Final report on the development of computer-based instructional systems for training essential components of reading. Report No, 6465. BBN Laboratories, Cambridge, Massachusetts.

- White, B. Y., & Frederiksen, J. R. (1986). Progressions of qualitative models as a foundation for intelligent learning environments. BBN Technical Report No. 6277. Cambridge, MA: Bolt Beranek and Newman. (Also appeared in Artificial Intelligence, in revised form)
- Frederiksen, J. R., Weaver, P. A., Warren, B. M., Gillotte, H. P., Rosebery, A. S., Freeman, B., & Goodman, L. (1983) A componential approach to training reading skills.. Report No. 5295. ONR, Cambridge, MA: Bolt Beranek and Newman, Inc.
- Weaver, P. A., Frederiksen, J. R., Warren, B. M., Gillotte, H. P., Freeman, B., & Goodman, L. (1982). Perceptual units training for improving word analysis skills. ONR Technical Report No. 1, Harvard University Graduate School of Education, Cambridge, MA.
- Frederiksen, J. R. (1981). Sources of process interactions in reading. ONR Technical Report No. 4, and BBN Report No. 4459, Cambridge, MA: Bolt Beranek and Newman Inc. (Also appeared in Discourse Processing.)
- Frederiksen, J. R. (1981). Understanding anaphora: Rules used by readers in assigning pronominal referents. ONR Technical Report No. 3 and Center for the Study of Reading Technical Report No. 242, Cambridge, MA: Bolt Beranek and Newman Inc.
- Frederiksen, J. R. (1978). A chronometric study of component skills in reading. ONR Technical Report and BBN Report No. 3757, Cambridge, Mass: Bolt Beranek and Newman Inc.
- Frederiksen, J. R. (1978). Assessment of perceptual, decoding and lexical skills and their relation to reading proficiency. ONR Technical Report and BBN Report No. 3756, Cambridge, Mass: Bolt Beranek and Newman Inc. (Also appeared in A. M. Lesgold, J. W. Pellegrino, S. Fokkema, and R. Glaser (Eds.), Cognitive Psychology and Instruction. N.Y.: Plenum Press, 1978.)
- Frederiksen, J. R. (1975). School effectiveness and equality of educational opportunity. Report submitted to the Carnegie Corporation of New York, Cambridge, MA: Harvard University Graduate School of Education.
- Frederiksen, J. R. (1975). Survey of the state-of-the-art in human factors in computers. Report SAI-75-533-WA, Science Applications, Inc.
- Frederiksen, J. R. (1972). A system for memory access and perceptual decision-making in auditory word recognition. Technical Report, Waltham, MA: Brandeis University.
- Frederiksen, J. R. (1966). A study of perceptual recognition in two sense modalities. Ph.D. Thesis, Princeton University, Princeton, N.J.

Frederiksen, J. R. (1965). The role of cognitive factors in the recognition of ambiguous visual stimuli. ETS Research Bulletin, 65-23, Princeton, N.J.: Educational Testing Service.

Frederiksen, J. R. (1963). The effect of retinal area stimulated on interocular transfer. Senior Honors Thesis, Harvard University, Cambridge, MA.

SELECTED ORAL PRESENTATIONS

“Creating Coherent Understanding of Complex Systems of Models.” (with B. White). Paper presented at the Annual Meeting of the American Educational Research Association, Seattle, April 11, 2001.

“Learning and teaching science through inquiry and reflective collaboration.” Invited lecture presented at the University of Washington, Seattle, March 14, 2001.

"Source of difficulty in students' understanding causal models of physics systems." (with B. White). Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, April 26, 2000.

"Using item analyses for testing imputations about science students' epistemological beliefs." Paper presented at the Annual Meeting of the American Educational Research Association, Montreal, Quebec, Canada, April 20, 1999.

"Improving classroom practices through video analysis and reflective conversations." Invited lecture presented at the Harvard Graduate School of Education, Cambridge, MA, March, 1999.

"Improving classroom practices through video analysis and reflective conversations." Featured presentation at the Annual Meeting of the National Science Teachers' Association, Seattle, WA, October 29, 1998.

"Assessing students' scientific inquiry: enhancing validity by creating multiple warrants for performance standards." (with B. White). Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, April 15, 1998.

"Creating a "working model" of science teaching through video analysis." (with N. Chaney-Aiello and B. White). Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, CA, April 16, 1998.

"Reflective assessment of students' research within an inquiry-based middle school science curriculum." (with B. White). Paper presented at the Annual Meeting of the American Educational Research Association, Chicago, IL, March 25, 1997.

"Computer microworlds and scientific inquiry: Enabling students to construct conceptual models." (with C. Schwarz and B. White). Paper presented at the annual meeting of the National Association for Research in Science Teaching, Chicago, IL, March, 1997.

"Assessing students' research within an inquiry-based science curriculum." Presented at the National Academy of Sciences/ National Research Council Conference on Science Education Standards: The Assessment of Science Meets the Science of Assessment, February 22, 1997.

"Facilitating Generic Modeling Skills." Invited talk presented at the Workshop on the Role of Qualitative Reasoning Techniques in Intelligent Tutoring Systems held at ITS'96 at the University of Montreal, Montreal, Canada, June 11, 1996.

"Linking topics in physics education: Multiple representations and mechanisms in basic electricity." (with J. Gutwill and B. White). Paper presented at the Annual Meeting of the American Educational Research Association, New York, April, 12, 1996.

"Dynamic mental models in learning science: The importance of constructing derivational linkages among models." (with B. White). Paper presented at the Annual Meeting of the American Educational Research Association, New York, April 11, 1996.

"ThinkerTools: A curriculum for teaching scientific inquiry and modeling." (with B. White and C. Schwarz). Paper presented at the Annual Meeting of the American Educational Research Association, New York, April 9, 1996.

"A theory of learning and instruction based upon derivational linkages among alternative models of domain phenomena." Invited talk presented at the University of Victoria, Victoria, BC, Canada, February 9, 1996.

"Inquiry, Modeling, and Metacognition: Making science accessible to all students." (with B. White). Invited talk presented at the University of Victoria, Canada, February 8, 1996.

"The ThinkerTools Inquiry Project: Making scientific inquiry accessible to students and teachers." (with B. White). Paper presented at the James S. McDonnell Foundation meeting at Vanderbilt University, September, 1995.

"A theory of learning and instruction based upon derivational linkages among multiple models." Presented at Educational Testing Service, Princeton, NJ, June 14, 1995.

"The ThinkerTools Inquiry Project: Making scientific inquiry accessible to students and teachers." (with B. White). Presented at Educational Testing Service, Princeton, NJ, May 25, 1995.

"Causal models of electric circuits: Overcoming students difficulties." (with B. White and J. Gutwill). Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, April, 1995.

"The ThinkerTools II Project: A computer-based curriculum for scientific inquiry and modeling." (with B. White). Invited address presented at the Annual Meeting of the National Association for Research in Science Teaching, San Francisco, April, 1995.

"ThinkerTools II: Scientific inquiry and modeling." (with B. White). Paper presented at the James S. McDonnell Foundation meeting at the University of California at Berkeley, October, 1994.

"Using assessment to foster a classroom research community." National Conference on Large-scale Assessment, Standards and Assessment to Support Learning, Conference of the Chief State School Officers, Albuquerque, NM, June 14, 1994.

"ThinkerTools II: Scientific inquiry and modeling." Invited talk presented at NSF Conference on Cognitive Science Research and Education, Philadelphia, May 7, 1994.

"Learning to interpret teaching: the video portfolio project." Paper presented at the annual meetings of the American Educational Research Association, New Orleans, 1994.

"Video clubs: Building professional development into an assessment of accomplished teaching." (with M. Sipusic). Paper presented at the annual meetings of the American Educational Research Association, New Orleans, 1994.

"Video portfolios for the assessment of accomplished teaching." Invited talk presented at the School of Education, Northwestern University, April, 1994.

"Video portfolios for the assessment of accomplished teaching." Invited talk presented at the Center for Technology and Learning, SRI International, March, 1994.

"Reductionistic models and the acquisition of electrical expertise." (with B. White). Paper presented at the Fifteenth Annual Meeting of the Cognitive Science Society, Boulder, Colorado, June 20, 1993.

"Performance assessment as a tool for enhancing learning in middle school science." Paper presented at the National Association for Research in Science Teaching, Atlanta, GA, April 18, 1993.

"Interactive engagement: Video Portfolios for teachers." Invited colloquium presented at the University of California, Santa Cruz, January 28, 1993.

"Learning to interpret teaching: The Video Portfolio Project." Invited colloquium presented at the University of California, Berkeley, December 7, 1992.

"The video portfolio assessment as a tool for encouraging reflective practice." Invited paper presented at the National Board for Professional Teaching Standards, National Forum, Las Vegas, Nevada, June 22, 1992.

"Linking assessment with reform: Technologies that support conversations about student work" (with K. Sheingold). Paper presented at an SRI Conference on Technology and Education, June, 1992.

"New research on the assessment of student learning: The NSF Assessment of Science Inquiry Project." Paper presented at the Education Commission of the States Assessment Conference, Boulder, Colorado, June 5, 1992.

"Learning to 'See:' Scoring Video Portfolios." Paper presented at the annual meetings of the American Educational Research Association, San Francisco, April 21, 1992.

"Understanding performance assessment and student motivation." Invited paper presented at the Annual Meetings of the American Psychological Association, Symposium on Contributions of Psychology to Learning and Education, San Francisco, CA, August 16, 1992.

"Conceptual models for understanding electrical circuits" (with B. White). Invited paper presented at a NATO Advanced Research Workshop on "Learning electricity or electronics with advanced educational technology," at the Laboratoire Interuniversitaire de Recherche sur l'Education Scientifique et Technologique, Paris, France, June, 1991.

"NCME task force report: A research agenda for policy and issues in performance assessment." Paper presented in an NCME symposium at the Annual Meeting of the American Educational Research Association, April 4, 1991.

"Assessment can truly serve the needs of all children" (with Mari-luci Jaramillo). Paper presented at the National Integration Conference, San Diego, CA, December 4, 1990.

"Perspectives on the design of future assessment systems." Invited paper presented at a symposium on "New approaches to psychological assessment in education," at the annual Science Weekend meeting of the APA, Boston, MA, August 10-12, 1990.

"Systemically valid approaches to educational assessment." Invited paper presented at a Conference on Alternative Assessment for At-risk Students, sponsored by the Educational Testing Service and Stanford University, in Emeryville, CA, June 28-29, 1990.

"Representing mental models: some design concepts" (with B. White). Paper presented in a symposium on Dynamic Diagrams in Science Education, at the Annual Meeting of the American Educational Research Association, Boston, MA, April, 1990.

"Conceptual models for understanding electrical circuits" (with B. White). Paper presented in a symposium on Using Conceptual Models to Facilitate Learning in Science, at the Annual Meeting of the American Educational Research Association, Boston, MA, April, 1990.

"Developing generic cognitive skills within a job-situated task context" (with B. Roberts, B. White, & S. Gott). Paper presented at the AAI Spring Symposium on Knowledge-based Environments for Learning and Teaching, Stanford University, March 27-29, 1990.

"Mental models and understanding: A role for intelligent tutoring systems in science education" (with B. White). Paper presented in a special session on Mental Models and

the Design of Intelligent Tutoring Systems, at the National Educational Computing Conference, Boston, MA, June 22, 1989.

"Creating mental models for understanding science." Colloquium presented at the University of Michigan, Ann Arbor, MI, June 15, 1989.

"Creating mental models for understanding science." Colloquium presented at the Ontario Institute for Studies in Education, May 30, 1989.

"Implicit testing within an intelligent tutoring system" (with B. White). Paper presented in a symposium on Improving Educational Assessment through Artificial Intelligence and Cognitive Science, at the Annual Meeting of the American Educational Research Association, San Francisco, CA, April, 1989.

"Creating a cognitive apprenticeship within an intelligent, computer-based learning environment." Paper presented at the Cognition and Education Workshop, Institute for Research on Learning, Palo Alto, CA, February 13-15,, 1989.

"Mental models and understanding: A problem for science education" (with B. White). Invited paper presented at the NATO Advanced Research Workshop on New Directions in Educational Technology, Milton Keynes, UK, November 10-13, 1988.

"Explorations in understanding how physical systems work" (presented by co-author Barbara White). Paper presented at the Tenth Annual Meeting of the Cognitive Science Society, Montreal, Canada, August, 1988.

"Five traits of good teaching: Learning, thinking, listening, involving, and helping" (with Allan Collins). Paper presented at a conference of the New Interstate Teacher Assessment and Support Consortium, Boulder, Colorado, June, 1988.

"Intelligent learning environments for science education" (with Barbara White). Paper presented at the International Conference on Intelligent Tutoring Systems, University of Montreal, Montreal, Quebec, Canada, 1988.

"Implicit testing within a tutoring system." Paper presented at the Educational Testing Service, Princeton, NJ, April, 1988.

"Intelligent learning environments for science education: the need for multiple mental models" (with Barbara White). Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, April, 1988.

"Restoring lost apprenticeships: An approach based upon intelligent tutoring" (with Barbara White). Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, April, 1988.

"Implicit testing within a tutoring system." Paper presented at the First Annual Wechsler Conference on New Ways of Assessing Intelligence, University of Texas, Austin, TX, March, 1988.

"Explorations in understanding how physical systems work" (with Barbara White). Paper presented at the Cognition and Education Workshop, BBN Laboratories, Cambridge, MA, March, 1988.

"Intelligent learning environments for science education." Presented at the EMST Seminar, School of Education, University of California at Berkeley, December, 1987.

"A problem-centered tutoring environment based upon cognitive modeling," (with B. White). Paper presented at the Annual Meeting of the Cognitive Science Society, University of Washington, Seattle, Washington, July, 1987.

"Tutoring based upon multiple mental models," (with B. White). Paper presented at the Third International Conference on AI and Education, University of Pittsburgh, Pittsburgh, PA., May, 1987.

"Cognitive models and skill acquisition," (with B. White). Paper presented at the Second Workshop on Workload and Training: Individual Differences. Carmel, California, January, 1987.

"Qualitative models and learning environments for troubleshooting." Paper presented at the Conference on Intelligent Tutoring Systems: Lessons Learned, Smuggler Notch, Vermont, October, 1986.

"A system for teaching a qualitative understanding of electrical circuit behavior and troubleshooting," (with B. White). Paper presented at the annual meeting of the American Education Research Association, San Francisco, California, April, 1986.

"Development of a training strategy based upon principled decomposition," (with B. White). Paper presented at the annual meeting of the American Educational Research Association, San Francisco, California, April, 1986.

"Cognitive science models for reading and reading instruction," (with B. Warren). Paper presented at the annual meeting of the American Educational Research Association, April, 1984.

"The impact of cognitive research on reading instruction: A role for the degrees of reading power program." Paper presented at the Forty-Second Annual Superintendents Work Conference, Teachers College, Columbia University, July, 1983.

"Computer games for training critical reading skills." Paper presented in a symposium on Trainability of Information-processing Skills at the annual meetings of the American Educational Research Association, April, 1983.

"Process interactions in understanding discourse." Paper presented in a symposium on Executive Control of Reading at the annual meetings of the American Educational Research Association, April, 1983.

"Reader differences in contextual primary of semantic categories," (with B. M. Warren and P. Weaver). Paper presented at the annual meeting of the Psychometric Society, November, 1982.

"Psychological considerations in designing micro-computer based games for reading instruction." Invited paper presented at the Annual Meetings of the American Psychological Association, August, 1982.

"Testing models of reading components." Paper presented at the annual meeting of the American Educational Research Association in Boston, April, 1980.

"Models for determining school effectiveness." Paper presented at the annual meeting of the American Educational Research Association, Boston, 1980.

"Understanding anaphora: Rules used by readers in assigning pronominal referents." Paper presented at the annual meeting of the Psychonomic Society, Phoenix, Arizona, November, 1979.

"Knowledge derived from text: Applications in decoding and comprehension." Paper delivered at a symposium, Understanding Discourse: Interactions Between Knowledge and Process," at the annual meetings of the American Psychological Association in New York on September, 1979.

"Components skills in readers of varying ability." Invited address presented at the annual meeting of the American Educational Research Association in San Francisco, April, 1979.

"Word recognition in presence of semantically constraining context." Paper delivered at the Annual Meeting of the Psychonomic Society, San Antonio, Texas, November, 1978.

"The search for effective city schools." Address presented at an Educational Staff Seminar, Institute for Educational Leadership, The George Washington University, Washington, D.C. April, 1978.

"Discussion of: Predicting reading performance; the validation of an effectiveness measure." delivered at the Annual Meeting of the American Educational Research Association, Toronto, Canada, March, 1978.

"Text comprehension and the effective visual field." Paper delivered at the annual meeting of the Psychonomic Society, Washington, DC, November, 1977.

"Decoding skills and lexical retrieval." Paper delivered at the annual meeting of the Psychonomic Society, November, 1976.

"Phonemic recoding and lexical search in the perception of letter arrays." Paper delivered at the annual meeting of the Psychonomic Society, November, 1974.

"The invariance properties of psychophysical scales based upon quantitative and categorical judgment." Paper delivered at the annual meeting of the Eastern Psychological Association, April, 1972.

"A statistical decision model for auditory word recognition." Paper delivered at annual meeting of the Eastern Psychological Association, April, 1972.

"A stochastic model for response dependencies in auditory word recognition." Paper presented at Conference on Mathematical Theories of Memory held at Massachusetts Institute of Technology, July, 1969.

"Response perseveration in auditory word recognition." Paper presented at the fall meeting of the Eastern Association for Verbal Learning, October, 1967; a shorter version presented at the annual meeting of the Eastern Psychological Association, April, 1968.

"Cognitive processes in the recognition of ambiguous auditory and visual stimuli" Paper delivered at the annual meeting of the Eastern Psychological Association, April, 1967.