

**THE NATIONAL ACADEMIES
NATIONAL RESEARCH COUNCIL
BOARD ON SCIENCE EDUCATION**

Evidence on Promising Practices in Undergraduate Science, Technology,
Engineering, and Mathematics (STEM) Education

Presenters' Biosketches

Robert Beichner is a member of NC State's Physics Education R & D Group. His research focuses on increasing our understanding of student learning and the improvement of physics education. His largest current project is the creation and study of a learning environment supporting a new way to teach called SCALE-UP: Student-Centered Active Learning Environment for Undergraduate Programs. This approach has been adopted at more than 50 institutions. The SCALE-UP project is part of Dr. Beichner's efforts to reform physics instruction at a national level. He co-authored, with Raymond Serway, the 5th edition of *Physics for Scientists and Engineers*, a top-selling introductory calculus-based physics book. Dr. Beichner and his students have written a series of tests aimed at diagnosing students' misconceptions about a variety of introductory physics topics. His kinematics graphing test is being used in high schools and colleges around the world and has been translated into six languages. He is also the founding editor of the APS journal *Physical Review Special Topics: Physics Education Research*. Dr. Beichner earned his Ph.D. in Science Education from SUNY: Buffalo.

Karen Cummings is a tenured Associate Professor of Physics at Southern Connecticut State University. Before moving to Southern Connecticut State, she spent five years as the Edward Hamilton Clinical Assistant Professor of Physics at Rensselaer Polytechnic Institute where she helped to develop and run their Studio Physics program. Dr. Cummings' research focuses on the learning and teaching of physics including assessment of learning outcomes, the effective use of technology, development of problem solving ability in introductory students and development of curricular materials for use in modern learning environments. She has served as the Physics Education Research editor for the *American Journal of Physics*, a member of the Executive Board for the national American Physical Society Forum on Education and a member of the American Association of Physics Teachers National committees on Undergraduate Education and Research in Physics Education. Dr. Cummings earned her Ph.D. in Physics from the University of Albany.

Melissa Dancy is an assistant professor in the Department of Natural Science and Math at Johnson S. Smith University. Prior to this, Dr. Dancy was an assistant professor of physics and optical science at the University of North Carolina, Charlotte. Dr. Dancy was an elected member of the Physics Education Research Organizing Council (PERLOC), the Physics Education Research Section of the American Association of Physics Teachers. She is a member of the Committee on Research in Physics Education from 2002-2005. She earned her Ph.D. in Physics, with a research focus on physics education from North Carolina State University.

Diane Ebert-May is a Professor in the Department of Plant Biology at Michigan State University. She provides national leadership for promoting professional development, evaluation and improvement of faculty, postdoctoral scholars, and graduate students who actively participate in creative research about teaching and learning in the context of their discipline. Ebert-May's research team is developing and testing a model for faculty change in teaching undergraduate biology, and is investigating the impact of students' design and use of models to build conceptual connections. She is PI of project FIRST III (Faculty Institutes for Reforming Science Teaching), an NSF-funded project that is developing an assessment database that will store assessment data from undergraduate science courses. Her most recent NSF-funded project is FIRST IV, a

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professional development program to help postdoctoral scholars create their first introductory biology course in preparation for their academic position. Her recent book, *Pathways to Scientific Teaching*, is based on active learning, inquiry-based instructional strategies, assessment and research. She teaches plant biology and introductory biology to majors, and environmental science to non-majors in large enrollment courses, and a graduate-level seminar on scientific teaching. Her plant ecology research continues on Niwot Ridge, Colorado, where she has conducted long-term ecological research on alpine tundra plant communities since 1971.

James Fairweather is the Dr. Mildred B. Erickson Distinguished Chair in Higher, Adult and Lifelong Education at Michigan State University (MSU) where he directs the Center for Higher and Adult Education. Dr. Fairweather is widely known for his work on faculty roles and rewards, reform in undergraduate STEM education, the globalization of higher education policy, and the role of higher education in economic development. Among his most cited works are *Faculty Work and Public Trust: Restoring the Value of Teaching and Public Service in American Academic Life* and *Entrepreneurship and Higher Education: Lessons for Colleges, Universities, and Industry*. Dr. Fairweather has been head of the editorial board of the most prestigious journal in the field, the *Journal of Higher Education*. He has published in the top journals in the field, including the *Journal of Higher Education*, *Review of Higher Education*, *Research in Higher Education*, *Economics of Education Review*, *Educational Evaluation and Policy Analysis*, *Journal of College Student Development*, *Journal of Engineering Education*, and *International Journal of Engineering Education*. Dr. Fairweather's research has been funded by the National Science Foundation, U.S. Department of Education, Ford Foundation, General Electric Fund, IBM, and the Dutch and Omani governments. Most recently he has been co-PI of the NSF-funded Center for the Integration of Research, Teaching and Learning. Dr. Fairweather received the Exemplary Research career award from the American Educational Research Association Division J. He also has been a Fulbright Scholar and held an Erasmus Mundus Professorship granted by the European Union. Dr. Fairweather received the Ph.D. in Higher Education from Stanford University in 1980.

Tom Foster has been interested in problem solving since he was a child as evidenced by all the playpens he escaped from and small appliances he dissected. Since then, he has focused this curiosity onto physics problem solving, specifically how to improve student physics problem solving skills and how to assess those skills. He did his dissertation research under the mentoring and guidance of Patrica Heller at the University of Minnesota followed by a brief stint at Carnegie Mellon working for Ruth Chabay and Bruce Sherwood on the evolutionary *Matter & Interactions* project. Since 2000, he has been teaching Physics, Astronomy, and Physics Education courses at Southern Illinois University Edwardsville and continues to explore how to help students become better problem-solvers.

Sandra Gregerman directs the university-wide Undergraduate Research Opportunity Program at the University of Michigan. The program, which serves 900 students and 500 faculty researchers, is designed to improve retention of students of color and women in the sciences. Responsibilities include admission, student and faculty recruitment, fundraising, academic and curricular program development, outreach, and development of multicultural activities, and program assessment and evaluation. Gregerman has spent over 25 years working in various roles at the University of Michigan, including director of academic services and admissions officer. Gregerman has

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received the National Science Foundation Recognition Award for the Integration of Teaching and Research and the White House Presidential Award for Excellence in Science and Mathematics Mentoring. Gregerman was the Chair of the Board of Governors for the National Conferences on Undergraduate Research, from 2005-2007. She currently is a on the Executive Board for the Council on Undergraduate Research. Gregerman earned her M.S. in Environmental Policy Education, from the University of Michigan.

David Gijbels is an Assistant Professor of Learning and Instruction in the Institute of Education and Information Sciences, at the University of Antwerp. There, Dr. Gijbels is the chair of the Educational Committee of the ‘Training and Educational Sciences’ Masters. He is the leader of the research group Professional Learning (Pro-L), which focuses its research on learning in a professional context (corporate training or training programs for professions). A key theme in the research is the mapping of the effectiveness of corporate training programs and factors influencing this effectiveness at various levels including, the trainee (approaches to study, perceptions, etc), the training program (goals, learning activities, assessment, etc), and the organisation (learning climate, possibilities for on-the-job-learning). Other current research projects include the Research in Education and Professional Development (REPRO). This research unit mainly focuses on research in education within compulsory, higher and adult education as well as workplace learning. He is a co-principal investigator on the TALIS project in Flanders, which focuses on 1) recognition, feedback, reward and evaluation of teachers; 2) school leadership; 3) teacher practices, beliefs and attitudes; 4) mentorship; and 5) professional development. He is the assistant editor of the EARLI-journal and an editorial board member of *Active learning in Higher Education*. Dr. Gijbels earned his Ph.D. from the University of Maastricht.

Donald Gillian-Daniel is an Associate Director of the Delta Program in Research, Teaching and Learning (www.delta.wisc.edu) at the University of Wisconsin-Madison. Dr. Gillian-Daniel has been with Delta since its original National Science Foundation funding in 2003. He has been involved as a participant in a number of professional development activities in teaching for a number of years; through the Delta Program, he now provides those opportunities for others. Before becoming involved in professional development programming in teaching for future faculty, Dr. Gillian-Daniel was an Assistant Scientist (2002-2003) and a Post-doctoral researcher in the Department of Biochemistry (1997-2002). He is also a Lecturer in the School of Veterinary Medicine each spring semester (2003-2008). Dr. Gillian-Daniel’s current research interests involve the following: (a) understanding how STEM graduate students come to develop a personally meaningful definition of diversity that they then apply in their teaching, and (b) defining elements of professional development programs that are key to successfully preparing future faculty to teach. As a former Biochemist, Dr. Gillian-Daniel’s research interests focused on understanding how the body fine-tunes cholesterol levels. His research, along with the contributions of others in the laboratory, led to a paradigm shift in the field; he published several scholarly papers on the topic. More recently Dr. Gillian-Daniel co-authored a chapter about Preparing Science, Technology, Engineering and Math (STEM) Doctoral Students for Faculty Careers in the New Directions in Teaching and Learning Monograph series. He graduated from Bucknell University (PA) in 1989 with a BS in Biology. He earned a PhD from the Program in Cell and Molecular Biology at the University of Wisconsin-Madison in 2007.

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Charles Henderson is an Associate Professor in the Physics Department and the Mallinson Institute for Science Education of Western Michigan University. His current work is focused on the development of theories and strategies for promoting change in the teaching of STEM subjects. This includes issues related to the diffusion and adoption of research-based instructional strategies. Two current projects include ‘Facilitating Change in Undergraduate STEM’ and ‘Understanding Instructor Practices and Attitudes Toward the Use of Research-Based Instructional Strategies (RBIS) in Introductory College Physics’. Both projects are funded by NSF. The goal of the former project is to articulate models for promoting changes in STEM instructional practices in higher education. In the latter, Dr. Henderson and Dr. Melissa Dancy seek to understand the level of knowledge about, attitudes towards and use of RBIS by introductory physics instructors. He is the editor of *Physics Education Research Section of the American Journal of Physics*. He is a member of the American Association of Physics Teachers (AAPT) Governance Review Committee and the current President of the Michigan chapter of the AAPT. He is a member of the Dr. Henderson earned his Ph.D. in Physics Education Research from the University of Minnesota, Twin Cities Campus.

Paula Heron is a Professor in the Physics Department at the University of Washington. Her current research focuses on student ability to apply concepts and principles from introductory mechanics courses to more advanced topics, including thermal physics. Her work has appeared in peer-reviewed publications, notably the *American Journal of Physics*. Dr. Heron collaborates with other members of the University of Washington Physics Education Group on two NSF-funded curriculum development projects: *Tutorials in Introductory Physics* (Prentice Hall 2002) and *Physics by Inquiry* (1996). The *Tutorials*, which have been translated into Spanish, German and Greek, are intended to supplement instruction in large enrollment introductory physics courses. *Physics by Inquiry* is intended for courses and institutes for K-12 teachers. Dr. Heron serves on many national committees and advisory boards and was elected twice to the Forum on Education Executive Committee of the American Physical Society (APS). She is a co-founder of the bi-annual conference series *Foundations and Frontiers in Physics Education Research*. Dr. Heron is a Fellow of the American Physical Society. She shared the 2008 APS Excellence in Physics Education Award with other members of the UW Physics Education Group. Dr. Heron earned her Ph.D. in Physics from the University of Western Ontario.

Kenneth S. Krane is Professor of Physics (Emeritus) at Oregon State University, where he has served on the faculty since 1974, including 14 years as Department Chair. Dr. Krane held postdoctoral research positions at the Los Alamos National Laboratory and the Lawrence Berkeley National Laboratory before joining the faculty at Oregon State. His research involves nuclear structure and nuclear spectroscopy, and has led to more than 100 papers in refereed journals and 30 years of funding in experimental nuclear physics from NSF and DOE. He was selected to be a Fellow of the American Physical Society by the Division of Nuclear Physics. He is also involved in education research and curriculum development and has held numerous NSF grants supporting those activities. He has served as chair of the APS Committee on Education, the APS Forum on Education, and the AIP Advisory Committee on Physics Education. From 1993-1994 he served as Physics Program Officer in the Division of Undergraduate Education at NSF. He was a member of the National Task Force on Undergraduate Physics and was the co-director of the Task Force’s Project SPIN-UP, which studied the characteristics of successful undergraduate physics programs. From 1995-2006, Dr. Krane was the director of the Workshop

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for New Faculty in Physics and Astronomy, a national mentoring program for college and university faculty. He is the author of three textbooks: *Physics*, 5th edition (with David Halliday and Robert Resnick), *Modern Physics*, 2nd edition, and *Introductory Nuclear Physics*. In 2004 he was awarded the Millikan Medal of the American Association of Physics Teachers in recognition of his contributions to physics teaching. He received the Ph.D. in nuclear physics from Purdue University in 1970.

Julie Libarkin is an Assistant Professor in the Department of Geological Science and Division of Science and Mathematics Education at Michigan State University, with scholarly affiliations in the Center for Research on College Science Teaching and Learning (CRCSTL) as well as the interdisciplinary Cognitive Science Program. Dr. Libarkin is PI on NSF-funded efforts to develop the Geoscience Concept Inventory, including an on-going initiative to engage the geosciences community in item development and review. She is also a PI on a multidisciplinary, collaborative project, recently funded through NSF's REESE program, to understand expert-novice cognitive processes as they relate to geological phenomena, particularly in the field. Dr. Libarkin is trained in both tectonics and geocognition, with emphasis on tectonic development of high elevation plateaus and conceptual change. As director of MSU's Geocognition Research Lab, Dr. Libarkin facilitates geocognitive research undertaken by postdoctoral research associates, PhD students, and undergraduate scholars. Current research includes investigation of working memory function in expert and novice geoscientists, conceptual understanding of climate change in high school and college populations, and expert-novice perceptions of plate tectonics. Dr. Libarkin is recipient of the 2007 Shea Award from the National Association of Geoscience Teachers and MSU's Lorena V. Blinn Endowed Teaching Award, and is the incoming Co-Editor of the *Journal of Geoscience Education*.

Mary A. Lundeberg is a Professor in the Department of Teacher Education and Department of Educational Psychology, College of Education at Michigan State University. Dr. Lundeberg's research interests, funded by over \$5 million in grant awards, include case-based pedagogy in teacher education and science, multimedia learning environments, and cultural and gender influences in confidence. She is currently exploring the effects of case-based learning on student motivation, confidence, and understanding of complex subject matter in science, teacher education and engineering. The author of more than 50 articles and book chapters and three books, including *Who Learns What From Cases and How* (Lawrence Erlbaum Publishers 1999), Lundeberg has extensive research experience in learning and cognition, with a particular focus on what and how students learn from technology projects. Formerly Associate Editor of the *Journal of Educational Psychology*, Lundeberg has won awards from the International Reading Association, the Wisconsin Department of Public Instruction, The University of Minnesota, the College of Education at the University of Wisconsin-River Falls, and the American Association of Colleges of Teacher Education. Lundeberg received her Ph.D. in Educational Psychology from the University of Minnesota.

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Cathryn A. Manduca is director of the Science Education Resource Center (SERC) at Carleton College and Executive Director of the National Association of Geoscience Teachers. SERC engages in projects that support effective science education nation-wide with a special focus on undergraduate earth-science education. Current projects include the “On the Cutting Edge” professional development program for geoscience faculty which combines workshops and websites to bring new research results (in education and geoscience) into mainstream geoscience teaching; development of digital library collections that link together teaching materials with information on their effective use; and a research study of spatial thinking in geoscience faculty and students. Dr. Manduca served as coordinator for the Keck Geology Consortium undergraduate research program from 1994-2000. She was an editor of “Earth and Mind: How Geologists Think and Learn About the Earth” and has co-authored several reports mobilizing action in the geoscience and digital library communities: *Bringing Research on Learning to the Geosciences*; *Using Data in Undergraduate Science Courses*; *Shaping the Future of Undergraduate Earth Science Education*; *The Digital Library for Earth System Education—A Community Plan*; and *Pathways To Progress—Vision and Plans for the National STEM Education Digital Library*. Dr. Manduca received her Ph.D. in Geology from the California Institute of Technology.

David McConnell is a professor in the Department of Marine, Earth, and Atmospheric Sciences at North Carolina State University. Dr. McConnell’s research focuses on science education, with specific attention to assessment of learning in large general education geoscience classes. He works with colleagues in other sciences and in the College of Education to provide instructors with teaching strategies designed to fit their course and classroom setting, and to provide students with a range of learning opportunities that will capture their interest and increase their understanding of key concepts. Their current work examines the affective domain that involves the attitudes, feelings and emotions that may hinder or promote learning. They seek to uniquely identify factors affecting student motivation in order to better inform geoscience and other science disciplines in terms of the importance of affective constructs (e.g., goal orientation, task value, self efficacy) in introductory classes. The ultimate outcome of this and future research will be to develop better university introductory science classes aimed at increasing the number of majors, improving student learning and increasing student retention rates. Ongoing research examines the cognitive domain that involves all kinds of thinking, from rote memorization to critical analysis. Dr. McConnell’s current teaching interests are Introductory Physical Geology, Earth Science, and graduate courses focusing on research in science education. Dr. McConnell received his Ph.D. in Geology from Texas A&M University.

Marcy Osgood is an Associate Professor and Vice Chair of Education in the Department of Biochemistry and Molecular Biology in the School of Medicine, University of New Mexico. Prior to her move to New Mexico in July 2002, she was at the University of Michigan in Ann Arbor, where she coordinated a Personalized System of Instruction (PSI) program in Biochemistry and taught majors and non-majors Biology for nine years. Dr. Osgood’s recent research activities have focused on educational methodology in biochemistry and biology, particularly cooperative and peer-assisted learning strategies, and remedial strategies for medical students. She is the coauthor of a biochemistry study guide. Dr. Osgood received her Ph.D. in Biology from Rensselaer Polytechnic Institute.

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Terry Reed-Rhoads is the Assistant Dean of Engineering for Undergraduate Education, Associate Professor of Engineering Education at Purdue University. Dr. Reed-Rhoads' research focuses on Assessment and evaluation of learning and programs; research statistics education; concept inventory development and P-12 engineering education outreach. She received the Brandon H. Griffith Teaching Award, 2002. She was the Frontiers in Education new faculty fellow in 2001. Dr. Reed-Rhoads earned her M.B.A. from University of Texas, Permian Basin and her Ph.D. in Industrial Engineering from Arizona State University.

Gabriela Weaver is a professor of chemistry and now serves as Associate Head in the Department of Chemistry, at Purdue University. In 2004 she became Director of the Center for Authentic Science Practice in Education, funded by the Undergraduate Research Centers initiative of the Chemistry Division at NSF. Dr. Weaver received her B.S. degree in Chemistry in 1989 from the California Institute of Technology and her Ph.D. in Chemical Physics in 1994 from the University of Colorado at Boulder. She served as an Assistant Professor in the Department of Chemistry at the University of Colorado at Denver from 1994 to 2001. During that time she shifted the focus of her research work from physical chemistry to educational research and the development of instructional technologies. As of September 1, 2008, Dr. Weaver agreed to also serve as Interim Director of the Discovery Learning Center in Purdue's Discovery Park. Dr. Weaver has been a coauthor on two different first-year chemistry textbooks, and continues to be a contributing author to *Chemistry in Context*, a textbook produced by the American Chemical Society. She has also been the leader in several projects to develop instructional technologies including DVDs, websites and videogames for teaching chemistry.

Donald Wink is a professor in the Department of Chemistry and program faculty and Director of Graduate Studies in the Learning Sciences Research Institute at the University of Illinois, Chicago. Dr. Wink is developing innovations in the teaching of undergraduate chemistry. His research in chemical education is focused on the use of interdisciplinary teams to improve student understanding of chemistry. One program has developed a new curriculum for chemistry and mathematics. Another works on the introduction of perspectives from other university research and teaching programs that use chemistry. This is called the Chemical Professional Laboratory Program. The methods of chemical education research are used in Dr. Wink's programs to help design and evaluate the work. Quantitative questionnaires are used to track changes in student attitudes and performance. Qualitative measures, including focus groups and classroom observation, provide summary information about what happens in the teaching environment. Finally, literature studies of the impact of educational psychology are a new area of research. Dr. Wink earned his Ph.D. in Inorganic Chemistry, from Harvard University, 1985.