Book Series

Research in Science Education

Series Editors
Dennis W. Sunal, *University of Alabama*; Cynthia S Sunal, *University of Alabama*; Emmett L. Wright, *Kansas State University*

The mission of the book series, Research in Science Education, is to provide a comprehensive view of current and emerging knowledge, research strategies, and policy in specific professional fields of science education. This series would present currently unavailable, or difficult to gather, materials from a variety of viewpoints and sources in a usable and organized format.

Each volume in the series would present a juried, scholarly, and accessible review of research, theory, and/or policy in a specific field of science education, K-16. Topics covered in each volume would be determined by present issues and trends, as well as generative themes related to current research and theory. Published volumes will include empirical studies, policy analysis, literature reviews, and positing of theoretical and conceptual bases.

Books in this series:

- Physics Teaching and Learning
- Science and Service Learning
- Research Based Undergraduate Science Teaching
- The Role of Public Policy in K-12 Science Education
- Teaching Science with Hispanic ELLs in K-16 Classrooms
- The Impact of the Laboratory and Technology on Learning and Teaching Science K-16
- The Impact of State and National Standards on K-12 Science Teaching
- Reform in Undergraduate Science Teaching for the 21st Century

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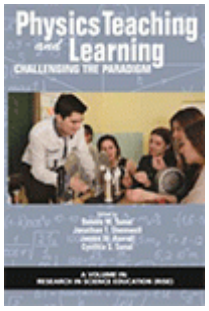


Physics Teaching and Learning
Challenging the Paradigm

Dennis W. Sunal, University of Alabama; Jonathan T. Shemwell, University of Alabama; James W. Harrell, University of Alabama; Cynthia S Sunal, University of Alabama

2019. Paperback 978-1-64113-656-3 $45.99. Hardcover 978-1-64113-657-0 $85.99. eBook 978-1-64113-658-7 $65.

Physics Teaching and Learning: Challenging the Paradigm, RISE Volume 8, focuses on research contributions challenging the basic assumptions, ways of thinking, and practices commonly accepted in physics education. Teaching physics involves multifaceted, research-based, value added strategies designed to improve academic engagement and depth of learning.

In this volume, researchers, teaching and curriculum reformers, and reform implementers discuss a range of important issues. The volume should be considered as a first step in thinking through what physics teaching and physics learning might address in teacher preparation programs, in-service professional development programs, and in classrooms.

To facilitate thinking about research-based physics teaching and learning each chapter in the volume was organized around five common elements:

1. A significant review of research in the issue or problem area.
2. Themes addressed are relevant for the teaching and learning of K-16 science
3. Discussion of original research by the author(s) addressing the major theme of the chapter.
4. Bridge gaps between theory and practice and/or research and practice.
5. Concerns and needs are addressed of school/community context stakeholders including students, teachers, parents, administrators, and community members.

CONTENTS: Preface to the Series. Preface, *Dennis W. Sunal, Jonathan Shemwell, James W. Harrell, and Cynthia S. Sunal.* High School Physics Teaching Reform: Support for Professional Development in the Literature, *Cynthia S. Sunal, Dennis W. Sunal, Justina Ogodo, and Marilyn Stephens.* Effects of Professional Development on Reform in High School Physics Teaching, *Dennis W. Sunal, Marsha E. Simon, Cynthia S. Sunal, Justina Ogodo, James W. Harrell, Marilyn Stephens and Mohan Aggarwal.* Destabilizing the Status Quo in STEM Professional Development with Modeling Instruction, *Kathleen A. Harper, Ted M. Clark, and Lin Ding.* Co-Constructing Models through Whole Class Discussions in High School Physics, *Grant Williams and John Clement.* Extending the Boundaries of High-School Physics: Introducing Computational Modeling of Complex Systems, *Elon Langbeheim, Haim Edri, Nava Schulmann, Samuel Safran, and Edit Yerushalmi.* Personification of Particles in Middle School Students' Explanations of Gas Pressure, *Robert C. Wallon and David E. Brown.* Compromised Physics Teaching: Assessment Driven Teaching, *Isaac Buabeng, Lindsey Conner, and David Winter.* Collaborative Learning with Networked Simulations, *Lisa Hardy and Tobin White.* Design, Implementation and Evaluation of a Research-Informed Teaching Sequence about Energy, *Dora Orfanidou and John Leach.* Biographies.

Science and Service Learning

Jane L. Newman, University of Alabama; Dennis W. Sunal, University of Alabama; Cynthia S Sunal, University of Alabama

2016. Paperback 9781681237367 $45.99. Hardcover 9781681237374 $85.99. eBook 9781681237381 $65.

The goal of Volume VII of Research in Science Education is to examine the relationship between science inquiry and servicelearning. Its primary intent is to bridge the gaps between research and practice. The volume is meant to be useful to science and service-learning researchers and practitioners such as teachers and administrators because it provides information about strategies to integrate service-learning into the science curriculum and instruction.

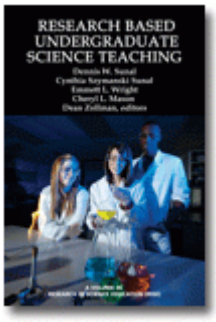
The main themes relate to such topics as:
- Student science academic engagement and academic achievement.
- Teacher instructional strategies in science and service-learning.
- Science curricula adaptation or development.

- Civic responsibility of students and community partners.
- Resiliency of students at-risk.
- Effect of standards based service-learning and science on student outcomes such as academic engagement, civic engagement, and resiliency to adversity.

Specific case studies and strategies focus on how to:
- Make learning more engaging. Encourage collaboration among students, teachers, and community partners.
- Improve academic competence.
- Create social/civic responsibility.
- Stimulate resiliency in students at-risk.
- Improve student interest in STEM subjects and majors.
- Develop STEM career interests.
- Improve the quality of science and service-learning instruction through addressing standards.

Students can learn in teacher-centered classrooms, however, a learner-centered class that focuses on science inquiry, and service-learning is more authentic and engaging to learners. This type of learning may not be the only way to teach, however, many educators believe that it is the best way for students to learn (Jordan, 2005).

CONTENTS: Impact of Science and Service Learning on Middle School Students' Resilience, *Jane L. Newman and Junfei Lu.* A Case Study of Speech Students and a Natural History Museum, *Sally Blomstrom, Barbara Hayford and Lori Mumpower.* Green Works in Service Learning and STEM Workforce Development for Urban Youth, *Alexis Petri and Kate Corwin.* Service Learning Experience Effects on High School Students' Learning of Science Practices, *Angela Chapman and Allan Feldman.* Nurturing Multiple Curiosities: Priorities From a National Survey, *Jennifer Forman.* Connections and Contributions Through Research Service Learning, *Terry M. Tomasek, Lacey D. Huffington, Catherine E. Matthews, and Heidi B. Carlone.* Soils in the City, *Christie Klimas, James Montgomery, Howard Rosing, Marji Hess, Xochyl Perez, and Christian DeKnock.* Academic Service Learning: Community College Prenursing and Elementary Teacher Education Programs, *Anita Cuttita Ferdenzi, Vazgen Shekoyan, and Sharon Ellerton.* Learning and Emotion: The Power of Service Learning in STEM Fields, *Maureen P. Hall and Aminda J. O'Hare.* About the Contributors.



Research Based Undergraduate Science Teaching

Dennis W. Sunal, University of Alabama; Cynthia S Sunal, University of Alabama; Emmett L. Wright, Kansas State University; Cheryl L. Mason, San Diego State University; Dean Zollman, Kansas State University

2014. Paperback 9781623967505 $45.99. Hardcover 9781623967512 $85.99. eBook 9781623967529 $65.

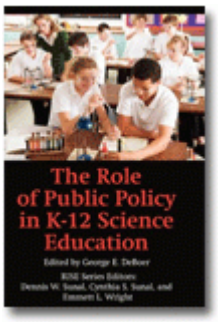
Research in Science Education (RISE) Volume 6, Research Based Undergraduate Science Teaching examines research, theory, and practice concerning issues of teaching science with undergraduates. This RISE volume addresses higher education faculty and all who teach entry level science. The focus is on helping undergraduates develop a basic science literacy leading to scientific expertise. RISE Volume 6 focuses on research-based reforms leading to best practices in teaching undergraduates in science and engineering.

The goal of this volume is to provide a research foundation for the professional development of faculty teaching undergraduate science. Such science instruction should have short- and longterm impacts on student outcomes. The goal was carried out through a series of events over several years. The website at http://nseus.org documents materials from these events. The international call for manuscripts for this volume requested the inclusion of major priorities and critical research areas, methodological concerns, and results of implementation of faculty professional development programs and reform in teaching in undergraduate science classrooms.

In developing research manuscripts to be reviewed for RISE, Volume 6, researchers were asked to consider the status and effectiveness of current and experimental practices for reforming undergraduate science courses involving all undergraduates, including groups of students who are not always well represented in STEM education. To influence practice, it is important to understand how researchbased practice is made and how it is implemented. The volume should be considered as a first step in thinking through what reform in undergraduate science teaching might look like and how we help faculty to implement such reform.

CONTENTS: Preface to the Series. Preface. Acknowledgments. **PART I: NATIONAL STUDY OF EDUCATION IN UNDERGRADUATE SCIENCE.** National Study of Education in Undergraduate Science: Purpose and Baseline Data,

Dennis Sunal, Cynthia Sunal, Erika M. Steele, and Glenda Ogletree. National Study of Education in Undergraduate Science: Research Design, *Dennis Sunal, Cynthia Sunal, Cheryl L. Mason, Dean Zollman, John Dantzler, Donna Turner, Erika M. Steele, Corinne Lardy, Mojgan Matloob-Haghanikar, and Sytil Murphy.* National Study of Education in Undergraduate Science: Lessons Learned, *Dennis Sunal, John Dantzler, Cynthia Sunal, Cheryl L. Mason, Dean Zollman, Donna Turner, and Erika M. Steele.* Investigating the Long-Term Impact of Undergraduate Science Reform Courses on the Pedagogical Practices of Kindergarten through Sixth Grade Elementary Teachers, *Donna Turner and Dennis Sunal.* The Impact of Reformed Undergraduate Science Courses on Elementary Teacher Self-Efficacy and Subsequent Relationships to Science Teaching Practices, *Corinne H. Lardy and Cheryl L. Mason.* **Part II: RESEARCHBASED STRATEGIES.** Constructivism in Context: Factors Affecting Student Learning in Four Different Classrooms, *Emily J. Borda, Kayla Anzalone, Mathew T. Lockett, and Siri Wuotila.* A Contrast of the Science Teaching Practices of Two Preservice Early Childhood Educators, *Deirdre Englehart.* Early Science Teaching Experiences for Undergraduates in an On-Campus, Hands on Laboratory, *Sarah Tanya Heaston and Bev Marcum.* Reframing Non-Science Majors' Fundamental Understandings About Scientific Inquiry and Scientists, *Gayle Buck, Pazit Koren, Xinying Yin, and Varda Bar.* Teaching Undergraduate Introductory Physics With an Innovative Research-based Clicker Methodology, *Lin Ding and Neville W. Reay.* **PART III: STUDENT PROBLEM AND RESEARCH STRATEGIES.** Intrinsic Motivation of Students Utilizing a Project-Based Organic Chemistry Laboratory Curriculum, *Gail Horowitz.* Problem Solving by Developing Guided Research in Introductory University Physics Courses, *Jenaro Guisasola, Mikel Ceberio, and Kristina Zuza.* Integrating Research into Undergraduate Courses: Current Practices and Future Directions, *Iris Alkaher and Erin L. Dolan.* **PART IV: PROFESSIONAL DEVELOPMENT OF LEARNING ASSISTANTS, TEACHING ASSISTANTS, AND INSTRUCTORS.** Development of Biology Graduate Laboratory Assistants' Conceptualizations of Teaching Science as Inquiry, *Kristen R. Miller and J. Steve Oliver.* Lesson Study With Graduate Teaching Assistants: Three Comparative Cases in the Sciences, *Sharon Dotger and Deborah Barry.* Stoichiometry's PCK of University Chemistry Professors, *Kira Padilla and Andoni Garritz.* About the Author.



The Role of Public Policy in K-12 Science Education

George E. DeBoer, AAAS Project 2061

2011. Paperback 978-1-61735-224-9 $85.99. Hardcover 978-1-61735-225-6 $85.99. eBook 9781617352263 $65.

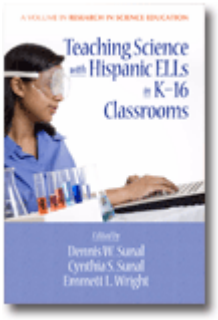
The goal of this volume of Research in Science Education is to examine the relationship between science education policy and practice and the special role that science education researchers play in influencing policy. It has been suggested that the science education research community is isolated from the political process, pays little attention to policy matters, and has little influence on policy. But to influence policy, it is important to understand how policy is made and how it is implemented. This volume sheds light on the intersection between policy and practice through both theoretical discussions and practical examples.

This book was written primarily about science education policy development in the context of the highly decentralized educational system of the United States. But, because policy development is fundamentally a social activity involving knowledge, values, and personal and community interests, there are similarities in how education policy gets enacted and implemented around the world.

This volume is meant to be useful to science education researchers and to practitioners such as teachers and administrators because it provides information about which aspects of the science education enterprise are affected by state, local, and national policies. It also provides helpful information for researchers and practitioners who wonder how they might influence policy. In particular, it points out how the values of people who are affected by policy initiatives are critical to the implementation of those policies.

CONTENTS: Preface to the Series. Preface. Acknowledgements. Introduction to the Policy Terrain in Science Education, *George E. DeBoer*. PART I: MULTIPLE INFLUENCES ON POLICY DEVELOPMENT AND ENACTMENT. Science Education Policy and its Relationship with Research and Practice: Lessons from Europe and the United Kingdom, *Jonathan Osborne*. Science Teacher Education Research and Policy: Are They Connected?, *Jane Butler Kahle & Sarah Beth Woodruff*. How do Foundations Influence Science Education Policy? *Dennis W. Cheek*, and *Margo Quiriconi*. How do Funding Agencies at the Federal Level Inform the Science Education Policy Agenda? The Case of the National Science Foundation, *Janice Earle*. La main à la pâte: Implementing a Plan for Science education reform in France, *Jean-Pierre Sarmant*, *Edith Saltiel*, and *Pierre Léna*. The Role of State Education Departments in Science Education Policy Development, *Dennis W. Cheek*, and *Margo Quiriconi*. Science Education Policy and Student Assessment, *Rodger W. Bybee*. How can Science Educators Influence

Legislation at the State and Federal Levels? The Case of the National Science Teachers Association, *Jodi Peterson*. PART II: IMPACT OF POLICY ON CURRICULUM, INSTRUCTION, AND THE EQUITABLE TREATMENT OF ALL STUDENTS. How State and Federal Policy Affects What is Taught in Science Classes, *George E. DeBoer*. Equity and U.S. Science Education Policy from the GI Bill to NCLB: From Opportunity Denied to Mandated Outcomes, *Sharon J. Lynch*. The Effect of Educational Policy on Curriculum Development: A Perspective from the Lawrence Hall of Science, *Linda De Lucchi* and *Larry Malone*. PART III: POLICY IMPLEMENTATION. School Leadership for Science Education, *Richard Halverson*, *Noah R. Feinstein*, and *David Meshoulam*. About the Authors.



Teaching Science with Hispanic ELLs in K-16 Classrooms

Dennis W. Sunal, University of Alabama; Cynthia S Sunal, University of Alabama; Emmett L. Wright, Kansas State University

2010. Paperback 978-1-61735-047-4 $45.99. Hardcover 978-1-61735-048-1 $85.99. eBook 9781617350498 $65.

The goal of this fourth volume of RISE was to provide a research foundation that demonstrates an agenda to strengthen the preparation and enhancement of teachers of science for regions and states experiencing extensive initial growth of Hispanic ELLs in schools. The goal was carried out through a series of events that led to the planning and subsequent dissemination of research being conducted by various stakeholders throughout the United States. Researchers were first invited from regions of the country that have had a long history of with Hispanic ELLs in classrooms as well as those regions where initial and now extensive growth has occurred only in the past few years. A national conference Science Teacher Education for Hispanic English Language Learners in the Southeast (SHELLS) funded through the National Science Foundation was used as one of the dissemination methods to establish and secure commitments from researchers to a conduct and report research to strengthen teacher preparation for science. The national call for manuscripts requested the inclusion of major priorities and critical research areas, methodological concerns, and concerns and results of implementation of teacher preparation and development programs.

CONTENTS: Preface to the Series. Preface. Acknowledgements. Science Education and Hispanic English Language Learners: The Research Perspective, *Cynthia S. Sunal & Dennis W. Sunal.* Fostering Scientific Reasoning as a Strategy to Support Science Learning for English Language Learners, *Cory A. Buxton & Okhee Lee.* Critical Issues in Teaching Science to Hispanic English Language Learners: An Overview. *Robert D. Leier & Laureen A. Fregeau.* Promoting Science Understanding and Fluency among Hispanic ELLs: Strategies, Explorations, and New Directions, *Ann M.L. Cavallo & Patricia Gomez.* Synergistic Teaching of Science to English Language Learners: Common Components of Model ELL and Science Instruction, *Daniel J. Bergman.* Enhancing Content Instruction for ELLs: Learning about Language in Science, *Luciana C. de Oliveira.* A Framework for the Effective Science Teaching of English Language Learners in Elementary Schools, *Trish Stoddart, Jorge Solis, Sara Tolbert & Marco Bravo.* Pre-service ELL Science Teacher Preparation in the Southeast United States, *Teresa J. Kennedy, Jason T. Abbitt & Michael R.L. Odell.* A Pre-Service Science Education Model with Possibilities for Developing Hispanic English Language Learners' Academic Discourse, *Elsa Villa & Kerrie Kephart.* Transformative Professional Development for In-Service Teachers: Enabling Change in Science Teaching to Meet the Needs of Hispanic ELL Students, *Carla C. Johnson.* Science as Springboard: Promoting Achievement and Aspiration among Latino English Language Learners in the Secondary School, *Bernadette Musetti & Sara Tolbert.* A Framework to Support Hispanic Undergraduate Women in STEM Majors, *Barbara A. Burke & Dennis W. Sunal.* About the Authors.

The Impact of the Laboratory and Technology on Learning and Teaching Science K-16

Dennis W. Sunal, University of Alabama; Emmett L. Wright, Kansas State University; Cheryl Sundberg, University of Alabama

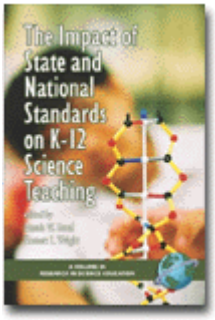
2008. Paperback 978-1-59311-744-3 $45.99. Hardcover 978-1-59311-745-0 $85.99. eBook 9781607526452 $65.

The Impact of the Laboratory and Technology on K-12 Science Learning and Teaching examines the development, use, and influence of active laboratory experiences and the integration of technology in science teaching. This examination involves the viewpoints of policymakers, researchers, and teachers that are expressed through research involving original

documents, interviews, analysis and synthesis of the literature, case studies, narrative studies, observations of teachers and students, and assessment of student learning outcomes. Volume 3 of the series, Research in Science Education, addresses the needs of various constituencies including teachers, administrators, higher education science and science education faculty, policymakers, governmental and professional agencies, and the business community.

The guiding theme of this volume is the role of practical laboratory work and the use of technology in science learning and teaching, K-16. The volume investigates issues and concerns related to this theme through various perspectives addressing design, research, professional practice, and evaluation. Beginning with definitions, the historical evolution and policy guiding these learning experiences are explored from several viewpoints. Effective design and implementation of laboratory work and technology experiences is examined for elementary and high school classrooms as well as for undergraduate science laboratories, informal settings, and science education courses and programs. In general, recent research provides evidence that students do benefit from inquirybased laboratory and technology experiences that are integrated with classroom science curricula. The impact and status of laboratory and technology experiences is addressed by exploring specific strategies in a variety of scientific fields and courses. The chapters outline and describe in detail researchbased best practices for a variety of settings.

CONTENTS: Preface to the Series. Preface. Acknowledgements. The Importance of the Laboratory and Technology in Science Teaching, *Dennis W. Sunal, Cynthia Szymanski Sunal, Cheryl Sundberg, and Emmett L. Wright*. **PART I: DEVELOPMENT AND USE OF THE SCIENCE LABORATORY EXPERIENCE.** Design Principles for Effective Laboratory Instruction, *William A. Sandoval*. The Use of Science Laboratories in Elementary Schools, *Deborah L. Hanuscin*. **PART II: THE STATUS AND IMPACT OF THE LABORATORY IN TEACHING AND LEARNING SCIENCE.** Long-Term Laboratory Inquiry: Promoting Understanding of Ecology, *Billie Eilam*. Students' Perceptions of the Science Laboratory Learning Environment, *Sule Ozkan, Jale Cakiroglu, & Ceren Tekkaya*. Investigating Process-Based Writing in an Organic Chemistry Laboratory Course, *Andrea Gay*. The Effect of the Vee Heuristic on Students' Meaningful Learning in Physics Laboratories, *Tarek Daoud and Saouma BouJaoude*. **PART III: STATUS AND IMPACT OF TECHNOLOGY IN TEACHING AND LEARNING SCIENCE**. Integrating Technology into a Science Classroom: An Evaluation of Inquiry-Based Technology Integration, *Randall S. Davies, Constance R. Sprague, and Colleen M. New*. Impact of Technology on Informal Science Learning, *David A. Ucko and Kirsten M. Ellenbogen*. The Impact of Technology on Science Preservice Preparation and In-service Professional Development, *Craig A. Wilson*. About the Authors.



The Impact of State and National Standards on K-12 Science Teaching

Emmett L. Wright, Kansas State University; Dennis W. Sunal, University of Alabama

2006. Paperback 1-59311-364-1 978-1-59311-364-3 $45.99. Hardcover 1-59311-365-X 978-1-59311-365-0 $85.99. eBook 9781607524885 $65.

This book addresses the expectations toward the science standards of various stakeholders including students, parents, teachers, administrators, higher education science and science education faculty members, politicians, governmental and professional agencies, and the business community.

This book also investigates how the science standards have been translated into practice at the K-12 school district level, addressing issues around professional development, curriculum, assessment/evaluation, and accountability. The fundamental questions to be addressed are: (1) What is the response in terms of trends and patterns, of the educational system to the introduction of the national and state science standards since the late 1980's? and (2) What is the impact of the introduction of the science standards on teachers, classrooms, and students?

CONTENTS: Preface to the Series. Preface. Acknowledgements. Introduction to the Science Standards: Their Impact on K-12 Science Teaching. *Dennis W. Sunal and Emmett L. Wright.* **Part I: Historical, Professional, Political and Economic Influences.** The History of the Science Standards Movement in the United States. *George E. DeBoer.* A Framework for Investigating the Influence of the National Science Standards. *Iris R. Weiss.* **Part II: The Impact of Science Standards on Classrooms and Teachers.** The Status of K–12 Science Teaching in the United States: Results from a National Observation Survey. *Eric R. Banilower, P. Sean Smith, Iris R. Weiss, and Joan D. Pasley.* Teacher Perceptions of Science Standards in K-12 Classrooms: An Alabama Case Study. *Dennis W. Sunal and Emmett L. Wright.* Realizing the National Science Education Standards: Channels of Influence Using a State Level Perspective: A Kansas Case Study. *Stephan Marlette and M. Janice Goldston.* Science Standards: Cause and Object of Influence: A Kansas Case Study. *John R. Staver.* **Part III: Impact of Science Standards on Teaching.** Impact of the Reform Efforts on K-12 Science Inquiry: A Paradigm Shift. *Connie Gabel*. Argumentation and the Science Standards: The Intersection of Scientific and

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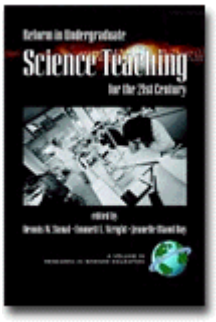

Reform in Undergraduate Science Teaching for the 21st Century

Jeanelle Bland, Eastern Connecticut State University; Emmett L. Wright, Kansas State University; Dennis W. Sunal, University of Alabama

2006. Paperback 1-930608-84-5 978-1-930608-84-9 $45.99. Hardcover 1-930608-85-3 978-1-930608-85-6 $85.99. eBook 9781607525424 $65.

CONTENTS: Introduction and Overview: Improving Undergraduate Science Teaching Through Educational Research. **Part I. Lessons from Research on Reform in Undergraduate Science: Science Education Reform and Higher Education: A Historical Perspective.** Reform in Undergraduate Science Classrooms. Science Education Reform: Factors Affecting Science and Science Education Faculty Collaborations. The Importance of Prior Knowledge in College Science Instruction. Innovative Pedagogy for Meaningful Learning in Undergraduate Science. Interdisciplinary Curriculum Planning in a College Course. Assessment in College Science Courses. Teaching for Diversity in Undergraduate Science. Integrating Information Technology into Undergraduate Science. Teaching Undergraduate Science Online. Professional Development of University Science Faculty Through Action Research. A Case Study of a National Undergraduate Science Reform Effort. **Part II. Perspectives on Reform in Undergraduate Science: A Large University Perspective on Reform in Teaching Undergraduate Science: A Geologist's Personal Practice Theories and Pedagogical Change.** A Small Four-Year College Perspective on Reform in Teaching Undergraduate Science. A Two-Year College Perspective on Linking Policy and Research to Support Science Education Professional Practice. A Science Education Research Organization's Perspective on Reform in Teaching Undergraduate Science. A Science Research Organization Perspective on Reform in Teaching Undergraduate Science. Scientists' Perspective on Reform in Teaching Undergraduate Science: Serving Preservice Science Teachers in the Context of a Heterogeneous Student Population. A University Student's Perspective on Reform in Teaching Undergraduate Science. A University Science Education Researcher's Perspective on Reform in Teaching Undergraduate Science. **Part III. Innovative Models for Reform in Undergraduate Science: A Model for Reform in Teaching in the Biological Sciences: Changing the Culture of an Introductory Biology Course.** A Model for Reform in Teaching in the Biological Sciences: Infrastructure for Inquiry in an Introductory Biology Laboratory. A Model for Reform in Teaching Chemistry: With a Focus on Please recommend our books and journals to your library! Prospective Elementary Teachers. A Model for Reform in Teaching Physics: Large Enrollment Physics Classes. A Model for Reform in Teaching Geological Laboratory Science. A Model for Reform in Teaching Integrated Science: Promoting Scientific Literacy Among Undergraduate Non-Science Majors. A Model for Reform in Teaching in Engineering and Technology: Creating Links Among Disciplines for Increased Scientific Literacy. A Model for Reform in Teaching in Engineering and Technology: With a Focus on Prospective Elementary Teachers. A Model for Reform in Teaching in Engineering and Technology: Artificial Intelligence Systems in Science.

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