Book Series

Science & Engineering Education Sources

Series Editors
Calvin S. Kalman, *Concordia University*

This book series provides volumes that are of general significance to theory development and research in Science & Engineering education. The series provides an opportunity to publish monographs, reviews, and collections of papers, which are at the forefront of the field. It publishes work from leading practitioners in the field, and cutting edge researchers.

Call for Monographs

This series is looking for monographs, reviews, and collections of papers that would be the basis for future research on the development of student understanding in science education.

Sample issues include:
What is the stage of the students' intellectual development?

How can the instructor enable the student to resolve cognitive dissonance in the difficulties students have in transcending their misconceptions toward target ideas?

Students can have great difficulty reading scientific texts and trying to cope with the professor in the classroom. Part of the reason for student's difficulties is that for a student taking a science gateway course the language and epistemology of science are akin to a foreign culture. For many students in the introductory gateway course, although individual words are understandable, the sentences appear to take the form of an unknown language.

What is the students' world view; knowledge-in-pieces as described by diSessa, a coherent theory as described for example by Posner, Strike, Hewson, and Gertzog or and an ontological view as described by Chi.

What instructional supports are necessary for students to examine their own ideas and compare them to the ideas presented by peers, the textbook, and the instructor? Feyerabend (1993, p.33) has pointed out that evaluation of a theoretical framework doesn't occur until there is an alternative (principle of counter induction.)

Relating epistemic change to conceptual change in students.

All inquiries and papers may be directed to Series Editor Calvin S. Kalman: Calvin.Kalman@concordia.ca

Books in this series:

- Using and Developing Measurement Instruments in Science Education
- Developing Science Literacy in the 21st Century
- Successful Science and Engineering Teaching in Colleges and Universities, 2nd Edition
- Deep Learning in Introductory Physics
- Rethinking Science Education
- Using and Developing Measurement Instruments in Science Education
- College Teaching and the Development of Reasoning

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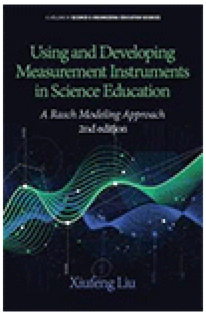


Using and Developing Measurement Instruments in Science Education

A Rasch Modeling Approach 2nd Edition

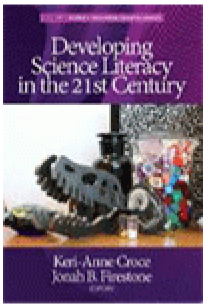
Xiufeng Liu, State University of New York, Buffalo

2020. Paperback 978-1-64113-934-2 $45.99. Hardcover 978-1-64113-935-9 $85.99. eBook 978-1-64113-936-6 $65.

This book meets a demand in the science education community for a comprehensive and introductory measurement book in science education. It describes measurement instruments reported in refereed science education research journals, and introduces the Rasch modeling approach to developing measurement instruments in common science assessment domains, i.e. conceptual understanding, affective variables, science inquiry, learning progression, and learning environments. This book can help readers develop a sound understanding of measurement theories and approaches, particularly Rasch modeling, to using and developing measurement instruments for science education research.

This book is for anyone who is interested in knowing what measurement instruments are available and how to develop measurement instruments for science education research. For example, this book can be a textbook for a graduate course in science education research methods; it helps graduate students develop competence in using and developing standardized measurement instruments for science education research. Science education researchers, both beginning and experienced, may use this book as a reference for locating available and developing new measurement instruments when conducting a research study.

CONTENTS: List of Tables. List of Figures. Preface. Preface to the Second Edition. CHAPTER 1: Essential Concepts and Skills for Using and Developing Measurement Instruments. CHAPTER 2: Approaches to Developing Measurement Instruments. CHAPTER 3: Using and Developing Instruments for Measuring Conceptual Understanding. CHAPTER 4: Using and Developing Instruments for Measuring Affective Variables. CHAPTER 5: Using and Developing Instruments for Measuring Science Inquiry and Practices. CHAPTER 6: Using and Developing Instruments for Measuring Learning Progression. CHAPTER 7: Using and Developing Instruments for Measuring Science Learning Environments.



Developing Science Literacy in the 21st Century

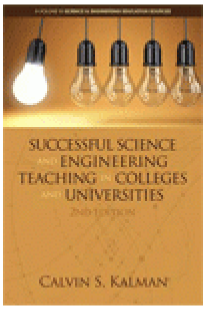
Keri-Anne Croce, Towson University; Jonah Firestone, Washington State University

2020. Paperback 978-1-64113-981-6 $45.99. Hardcover 978-1-64113-982-3 $85.99. eBook 978-1-64113-983-0 $65.

The development of science literacy has the potential to have an enormous impact on real world outcomes. Specifically, developing science literacy may persuade individuals to act. We hope that this book will influence scientists, science journalists, sociologists, anthropologists, communication specialists, political leaders, media outlets, educational institutions, and individual science content consumers.

The chapters in this book describe a definition of science literacy that draws on the emotional, cognitive, and social. The authors strive to help prepare individuals to read, write, and speak science in a continuously evolving information landscape. In order to meet these objectives, the chapters examine both qualitative and quantitative research. It is within these frameworks that we can begin to address science literacy in the 21st century.

CONTENTS: Defining what it means to develop science literacy, *Keri-Anne Croce and Jonah B. Firestone.* Understanding science and decision-making: What does science literacy have to do with it? *Keri-Anne Croce and Marcia J. Watson-Vandiver.* Science literacy as a social interactional inquiry process, *Huili Hong, Karin Keith, and Renee Rice Moran.* Assessment and science literacy: Approaches for educators, *Keri-Anne Croce and Debra Goodman.* Utilizing project-based learning to enhance science literacy, *Bridget Miller, Christie Martin, and Lucy Spence.* Realism, immersion, and interactivity: The effects of virtual reality on students' science scientific writing, *Richard Lamb, Elisabeth Etopio, Jonah B. Firestone, Jacqueline Zeder, and Brian Hand.* Lead in the water, Blood on the leaves: A systematic overview of scientific misuse and malpractice in African communities and social justice call to action, *Marcia J. Watson-Vandiver.* Developing science literacy in schools and colleges in Mumbai, *Sonali Raje, Ankush Gupta, Savita Ladage and Lakshmy Ravishankar.* What is the future for science literacy? *Keri-Anne Croce and Jonah B. Firestone.*



Successful Science and Engineering Teaching in Colleges and Universities, 2nd Edition

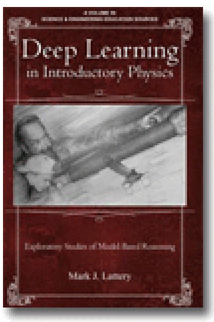
Calvin S. Kalman, Concordia University

2017. Paperback 9781681239576 $45.99. Hardcover 9781681239583 $85.99. eBook 9781681239590 $65.

Based on the author's work in science and engineering educational research, this book offers broad, practical strategies for teaching science and engineering courses and describes how faculty can provide a learning environment that helps students comprehend the nature of science, understand science concepts, and solve problems in science courses.

This book's student-centered approach focuses on two main themes: writing to learn (especially Reflective Writing) and interactive activities (collaborative groups and labatorials). When faculty incorporate these methods into their courses, students gain a better understanding of science as a connected structure of concepts rather than as a toolkit of assorted practices.

CONTENTS: PART I: INTRODUCTION, ROAD MAP OF THE BOOK. Writing to Learn. Two Goals for Any Science and Engineering Course. Questions by Students. What Students Get Out of Class. In-Class and Out-of-Class Activities. Solving Problems. Computer Aids. **PART II: REFLECTIVE WRITING.** Freewriting. Getting Students to Read Material in the Textbook Before Coming to Class. Gadamer's Hermeneutical Approach. Instructions on Doing Reflective Writing. Samples of Student Use of Reflective Writing. Marking Reflective Writing. Student Response to Reflective Writing. Reflective Writing Rubric. **PART III: WRITING TO LEARN.** Reflective Write–Pair–Share. Scenario for a Class. The Course Dossier Method. Transforming Each Lecture Into a Mini Research Paper. End of Semester. Hosting an End of Semester Conference. **PART IV: CONSTRUCTING STUDENT KNOWLEDGE.** Cognitive Dissonance Students' Intellectual Development. Student Misconceptions. Debate in the Science Education Community. Critical Thinking. **PART V: COLLABORATIVE GROUPS.** Team Work and Group Projects Benefits to Having Students Work in Groups. Team Formation. Team Size. Team Management. Team Evaluation. Group Development. Classroom Warmups. Roles for Group Member. Dysfunctional Groups. **PART VI: UTILIZING COLLABORATIVE GROUPS TO PROMOTE CONCEPTUAL CONFLICT.** Conceptual Conflict. Peer Instruction. Collaborative Group Conceptual Conflict Activity. Comparison of Peer Instruction With the Conceptual Conflict Group Activity. Incommensurabilty in Conceptual Change. Task Sheets for Warm-Up and the Four Concept Exercises. **CHAPTER VII: SELECTED METHODS OF UTILIZING COLLABORATIVE GROUPS.** Labatorials. Jigsaw. The Learning Cell. Concept Mapping. Collaborative Concept Mapping. Appendix. Sample Labatorial Worksheet. **PART VIII: CHANGING STUDENTS' EPISTEMOLOGIES.** Developing a Scientific Mindset. Stages in Epistemic Development in Students. Critique Exercise. Model Course: Presenting Students With Alternative Frameworks: Pre-Galilean Physics and Newtonian Physics. The Calgary Study: Reflective Writing and Labatorials. Epistemology. Critique Exercise. Students' Epistemic Thinking. Appendix: Critique #1. Critique #2. Critique #3. **PART VIII: PROBLEM SOLVING.** Solving Problems Using Templates Versus Solutions. Using Paradigms. Five-Step Method for Solving Problems. **PART X: METHODS FOR TRAINING STUDENTS TO SOLVE PROBLEMS.** Writing Their Way Into the Solution. Collaborative Problem-Solving Groups. How Many People Should Be in the Group? Who Should Be Placed in the Group? Individual Accountability. Appendix. A Student's Advice for Studying Physics. **PART XI: USING THE COMPUTER TO AID TEACHING.** Computer-Assisted Instruction (CAI). Using the Computer to Manage Laboratories. References.



Deep Learning in Introductory Physics
Exploratory Studies of Model-Based Reasoning

Mark J. Lattery, University of Wisconsin Oshkosh

2016. Paperback 9781681236285 $45.99. Hardcover 9781681236292 $85.99. eBook 9781681236308 $65.

Deep Learning in Introductory Physics: Exploratory Studies of Model-Based Reasoning is concerned with the broad question of how students learn physics in a model-centered classroom. The diverse, creative, and sometimes unexpected ways students construct models, and deal with intellectual conflict, provide valuable insights into student learning and cast a new vision for physics teaching. This book is the first publication in several years to thoroughly address the "coherence versus fragmentation" debate in science education, and the first to advance and explore the hypothesis that deep science learning is regressive and revolutionary. Deep Learning in Introductory Physics also contributes to a growing literature on the use of history and philosophy of science to confront difficult theoretical and practical issues in science teaching, and addresses current international concern over the state of science education and appropriate standards for science teaching and learning.

The book is divided into three parts. Part I introduces the framework, agenda, and educational context of the book. An initial study of student modeling raises a number of questions about the nature and goals of physics education. Part II presents the results of four exploratory case studies. These studies reproduce the results of Part I with a more diverse sample of students; under new conditions (a public debate, peer discussions, and group interviews); and with new research prompts (model-building software, bridging tasks, and elicitation strategies). Part III significantly advances the emergent themes of Parts I and II through historical analysis and a review of physics education research.

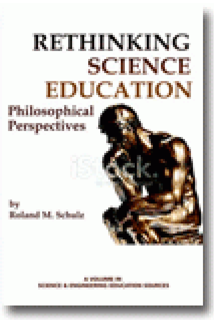
ENDORSEMENTS:
"In *Deep Learning in Introductory Physics*, Lattery describes his extremely innovative course in which students' ideas about motion are elicited, evaluated with peers, and revised through experiment and discussion. The reader can see the students' deep engagement in constructive scientific modeling, while students deal with counter-intuitive ideas about motion that challenged Galileo in many of the same ways. Lattery captures students engaging in scientific thinking skills, and building difficult conceptual understandings at the same time. This is the 'double outcome' that many science educators have been searching for. The case studies provide inspiring examples of innovative course design, student sensemaking and reasoning, and deep conceptual change."

~ **John Clement**, *University of Massachusetts—Amherst, Scientific Reasoning Research Institute*

"*Deep Learning in Introductory Physics* is an extraordinary book and an important intellectual achievement in many senses. It offers new perspectives on science education that will be of interest to practitioners, to education researchers, as well as to philosophers and historians of science. Lattery combines insights into model-based thinking with instructive examples from the history of science, such as Galileo's struggles with understanding accelerated motion, to introduce new ways of teaching science. The book is based on first-hand experiences with innovative teaching methods, reporting student's ideas and discussions about motion as an illustration of how modeling and model-building can help understanding science. Its lively descriptions of these experiences and its concise presentations of insights backed by a rich literature on education, cognitive science, and the history and philosophy of science make it a great read for everybody interested in how models shape thinking processes."

~ **Dr. Jürgen Renn**, *Director, Max Planck Institute for the History of Science*

CONTENTS:



Rethinking Science Education

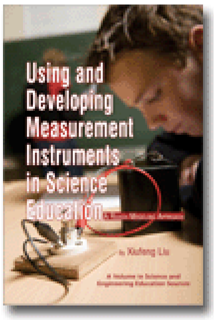
Philosophical Perspectives

Roland M. Schulz

2014. Paperback 9781623967147 $45.99. Hardcover 9781623967154 $85.99. eBook 9781623967161 $65.

This book presents a "philosophy of science education" as a research field as well as its value for curriculum, instruction and teacher pedagogy. It seeks to re-think science education as an educational endeavour by examining why past reform efforts have been only partially successful, including why the fundamental goal of achieving scientific literacy after several "reform waves" has proven to be so elusive. The identity of such a philosophy is first defined in relation to the fields of philosophy, philosophy of science, and philosophy of education. It argues that educational theory can support teacher's pedagogical content knowledge and that history, philosophy and sociology of science should inform and influence pedagogy. Some case studies are provided which examine the nature of science and the nature of language to illustrate why and how a philosophy of science education contributes to science education reform. It seeks to contribute in general to the improvement of curriculum design and science teacher education. The perspective to be taken on board is that to teach science is to have a philosophical frame of mind—about the subject, about education, about one's personal teacher identity.

CONTENTS: Abstract. Preface. Acknowledgments. Introduction: Philosophical Perspectives on Science Education. Chapter 1: Defining the Identity of the Philosophy of Science Education: Surveying the Terrain. Chapter 2: Science Education Reform and the Need for Philosophy of Science: Education and Educational Theory. Chapter 3: Philosophy of Science Education and Kieran Egan's Educational Metatheory. Chapter 4: Philosophy of Science Education, Epistemology, and Nature of Science (NoS). Chapter 5: Philosophy of Science Education and Nature of Language. Chapter 6: Conclusion. References. About the Author.



Using and Developing Measurement Instruments in Science Education

A Rasch Modeling Approach

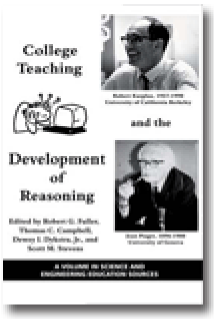
Xiufeng Liu, State University of New York, Buffalo

2010. Paperback 978-1-61735-003-0 $45.99. Hardcover 978-1-61735-004-7 $85.99. eBook 9781617350054 $65.

This book meets a demand in the science education community for a comprehensive and introductory measurement book in science education. It describes measurement instruments reported in refereed science education research journals, and introduces the Rasch modeling approach to developing measurement instruments in common science assessment domains, i.e. conceptual understanding, affective variables, science inquiry, learning progression, and learning environments. This book can help readers develop a sound understanding of measurement theories and approaches, particularly Rasch modeling, to using and developing measurement instruments for science education research.

This book is for anyone who is interested in knowing what measurement instruments are available and how to develop measurement instruments for science education research. For example, this book can be a textbook for a graduate course in science education research methods; it helps graduate students develop competence in using and developing standardized measurement instruments for science education research. For use as a textbook there are summaries and exercises at the end of each chapter. Science education researchers, both beginning and experienced, may use this book as a reference for locating available and developing new measurement instruments when conducting a research study.

CONTENTS: 1. Essential Concepts and Skills for Using and Developing Measurement Instruments. 2. Approaches to Developing Measurement Instruments. 3. Using and Developing Instruments for Measuring Conceptual Understanding. 4. Using and Developing Instruments for Measuring Affective Variables. 5. Using and Developing Instruments for Measuring Science Inquiry. 6. Using and Developing Instruments for Measuring Learning Progression. 7. Using and Developing Instruments for Measuring Science Learning Environments. Exercises. References. Subject Index. Author Index. About the Authors.



College Teaching and the Development of Reasoning

Robert G. Fuller, University of Nebraska Lincoln; Thomas C. Campbell, Illinois Central College; Dewey I. Dykstra, Boise State University; Scott M. Stevens, Carnegie Mellon University

2009. Paperback 978-1607522362 $45.99. Hardcover 978-1607522379 $85.99. eBook 9781617352461 $65.

This book is intended to offer college faculty members the insights of the development of reasoning movement that enlighten physics educators in the late 1970s and led to a variety of college programs directed at improving the reasoning patterns used by college students. While the original materials were directed at physics concepts, they quickly expanded to include other sciences and the humanities and social sciences. On-going developments in the field will be included.

The editors have introduced new topics, including discussions of Vygotsky's ideas in relation to those of Piaget, of science education research progress since 1978, of constructivist learning theory applied to educational computer games and of applications from anthropology to zoology. These materials are especially relevant for consideration by current university faculty in all subjects.

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