

# Modeling Theory in Science Education

Ibrahim A. Halloun

Kluwer Academic Publishers, 2004

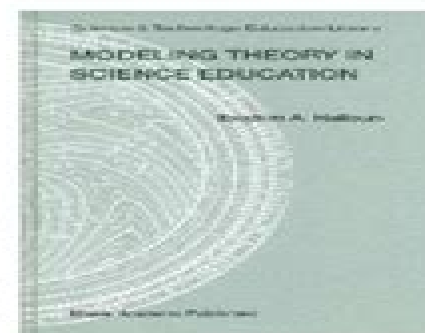
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This book is the culmination of over twenty years of work toward a pedagogical theory that promotes experiential learning of model-laden theory and inquiry in science. It is primarily intended for researchers and graduate students in science education, and it may serve as a major reference for in-service and pre-service science teachers. The book focuses as much on course content as on instruction and learning methodology, and presents practical aspects that have repeatedly demonstrated their value in fostering meaningful and equitable learning of physics and other science courses at the secondary school and college levels.

The author shows how a scientific theory that is the object of a given science course can be organized around a limited set of basic models. Special tools are introduced, including modeling schemata, for students to meaningfully construct models and required conceptions, and for teachers to efficiently plan instruction and assess and regulate student learning and teaching practice. A scientific model is conceived to represent a particular pattern in the structure or behavior of physical realities and to explore and reify the pattern in specific ways.

The author further shows how to engage students in modeling activities through structured learning cycles. Throughout a given cycle, students construct a specific model and deploy it so as to develop generic tools and systematic rules and schemes of scientific inquiry. The target model is constructed by successive refinements of related subsidiary models that individual students would have developed by correspondence to familiar situations. The entire process is teacher-mediated in a way to bring to the surface various student ideas, especially those that are at odds with science, and to help students mutually ascertain their ideas and regulate them in an insightful manner.



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# Modeling Theory In Science Education

**Myint Swe Khine, Issa M. Saleh**



## **Modeling Theory In Science Education:**

*Modeling Theory in Science Education* Ibrahim A. Halloun, 2007-01-25 The book focuses as much on course content as on instruction and learning methodology and presents practical aspects that have repeatedly demonstrated their value in fostering meaningful and equitable learning of physics and other science courses at the secondary school and college levels The author shows how a scientific theory that is the object of a given science course can be organized around a limited set of basic models Special tools are introduced including modeling schemata for students to meaningfully construct models and required conceptions and for teachers to efficiently plan instruction and assess and regulate student learning and teaching practice A scientific model is conceived to represent a particular pattern in the structure or behavior of physical realities and to explore and reify the pattern in specific ways The author further shows how to engage students in modeling activities through structured learning cycles

Modeling Theory in Science Education Ibrahim A. Halloun, 2004-07-20 This book is the culmination of over twenty years of work toward a pedagogical theory that promotes experiential learning of model laden theory and inquiry in science The book focuses as much on course content as on instruction and learning methodology presenting practical aspects that have repeatedly demonstrated their value in fostering meaningful and equitable learning of physics and other science courses at the secondary school and college levels

*Models and Modeling* Myint Swe Khine, Issa M. Saleh, 2011-03-01 The process of developing models known as modeling allows scientists to visualize difficult concepts explain complex phenomena and clarify intricate theories In recent years science educators have greatly increased their use of modeling in teaching especially real time dynamic modeling which is central to a scientific investigation Modeling in science teaching is being used in an array of fields everything from primary sciences to tertiary chemistry to college physics and it is sure to play an increasing role in the future of education Models and Modeling Cognitive Tools for Scientific Enquiry is a comprehensive introduction to the use of models and modeling in science education It identifies and describes many different modeling tools and presents recent applications of modeling as a cognitive tool for scientific enquiry

*Philosophy, Science, Education and Culture* Robert Nola, Gürol Irzik, 2006-02-22 Currents such as epistemological and social constructivism postmodernism and certain forms of multiculturalism that had become fashionable within science education circles in the last decades lost sight of critical inquiry as the core aim of education In this book we develop an account of education that places critical inquiry at the core of education in general and science education in particular Since science constitutes the paradigm example of critical inquiry we explain the nature of science paying particular attention to scientific methodology and scientific modeling and at the same time showing their relevance in the science classroom We defend a universalist rationalist and objectivist account of science against epistemological and social constructivist views postmodernist approaches and epistemic multiculturalist accounts

**K-12 Education: Concepts, Methodologies, Tools, and Applications** Management Association, Information Resources, 2013-09-30 Primary and Secondary education is a

formative time for young students Lessons learned before the rigors of higher education help to inform learners future successes and the increasing prevalence of learning tools and technologies can both help and hinder students in their endeavors K 12 Education Concepts Methodologies Tools and Applications investigates the latest advances in online and mobile learning as well as pedagogies and ontologies influenced by current developments in information and communication technologies enabling teachers students and administrators to make the most of their educational experience This multivolume work presents all stakeholders in K 12 education with the tools necessary to facilitate the next generation of student teacher interaction

International Handbook of Research in History, Philosophy and Science Teaching Michael R. Matthews, 2014-07-03 This inaugural handbook documents the distinctive research field that utilizes history and philosophy in investigation of theoretical curricular and pedagogical issues in the teaching of science and mathematics It is contributed to by 130 researchers from 30 countries it provides a logically structured fully referenced guide to the ways in which science and mathematics education is informed by the history and philosophy of these disciplines as well as by the philosophy of education more generally The first handbook to cover the field it lays down a much needed marker of progress to date and provides a platform for informed and coherent future analysis and research of the subject The publication comes at a time of heightened worldwide concern over the standard of science and mathematics education attended by fierce debate over how best to reform curricula and enliven student engagement in the subjects There is a growing recognition among educators and policy makers that the learning of science must dovetail with learning about science this handbook is uniquely positioned as a locus for the discussion The handbook features sections on pedagogical theoretical national and biographical research setting the literature of each tradition in its historical context It reminds readers at a crucial juncture that there has been a long and rich tradition of historical and philosophical engagements with science and mathematics teaching and that lessons can be learnt from these engagements for the resolution of current theoretical curricular and pedagogical questions that face teachers and administrators Science educators will be grateful for this unique encyclopaedic handbook Gerald Holton Physics Department Harvard University This handbook gathers the fruits of over thirty years research by a growing international and cosmopolitan community Fabio Bevilacqua Physics Department University of Pavia

Systemic Cognition and Education Ibrahim A. Halloun, 2023-05-18 This book offers pedagogic and governance foundations and guidelines for systemic education It provides an overall systems based picture of what formal education should be about and of how things should be carried out in practice in order to empower students and teachers for success in life It transcends traditional disciplinary education showing how systemic praxis immersive convergence education SPICE produces graduates who know how to think outside the box and excel in practical real life situations Drawing on philosophy cognition and the latest developments in neuroscience the book calls for systemic pedagogical frameworks that allow for different curricula to be coherently and efficiently designed and consistently and systematically deployed across different disciplines and various

grade levels in the context of mind and brain based experiential learning ecologies This volume is a major design and practice reference for school teachers university professors graduate students along with interested educators educationists and stakeholders in various sectors of society

**Handbook of Metacognition in Education** Douglas J. Hacker, John Dunlosky, Arthur C. Graesser, 2009-06-15 Providing comprehensive coverage of the theoretical bases of metacognition and its applications to educational practice this compendium of focused and in depth discussions from leading scholars in the field represents an intersection of education cognitive science and technology serves as a gateway to the literature for researchers and practitioners interested in one or more of the wide array of topics included and sets the standard for scholarship for theoretical research and practical applications in this field The Handbook of Metacognition in Education covering Comprehension Strategies Metacognitive Strategies Metacomprehension Writing Science and Mathematics Individual Differences Self Regulated Learning Technology Tutoring and Measurement is an essential resource for researchers faculty students curriculum developers teachers and others interested in using research and theory on metacognition to guide and inform educational practice

*Modeling Students' Mathematical Modeling Competencies* Richard Lesh, Peter L. Galbraith, Christopher R. Haines, Andrew Hurford, 2013-03-17 Modeling Students Mathematical Modeling Competencies offers welcome clarity and focus to the international research and professional community in mathematics science and engineering education as well as those involved in the sciences of teaching and learning these subjects

**Towards a Competence-Based View on Models and Modeling in Science Education** Annette Upmeyer zu Belzen, Dirk Krüger, Jan van Driel, 2020-01-01 The book takes a closer look at the theoretical and empirical basis for a competence based view of models and modeling in science learning and science education research Current thinking about models and modeling is reflected The focus lies on the development of modeling competence in science education and on philosophical aspects including perspectives on nature of science The book explores interprets and discusses models and modeling from the perspective of different theoretical frameworks and empirical results The extent to which these frameworks can be integrated into a competence based approach for science education is discussed In addition the book provides practical guidance by outlining evidence based approaches to diagnosing and promoting modeling competence The aim is to convey a strong understanding of models and modeling for professions such as teacher educators science education researchers teachers and scientists Different methods for the diagnosis and assessment of modeling competence are presented and discussed with regard to their potential and limitations The book provides evidence based ideas about how teachers can be supported in teaching with models and modeling implementing a competence based approach and thus how students can develop their modeling competence Based on the findings research challenges for the future are identified

*Modelling-based Teaching in Science Education* John K. Gilbert, Rosária Justi, 2016-05-30 This book argues that modelling should be a component of all school curricula that aspire to provide authentic science education for all The literature on

modelling is reviewed and a model of modelling is proposed The conditions for the successful implementation of the model of modelling in classrooms are explored and illustrated from practical experience The roles of argumentation visualisation and analogical reasoning in successful modelling based teaching are reviewed The contribution of such teaching to both the learning of key scientific concepts and an understanding of the nature of science are established Approaches to the design of curricula that facilitate the progressive grasp of the knowledge and skills entailed in modelling are outlined Recognising that the approach will both represent a substantial change from the content transmission approach to science teaching and be in accordance with current best practice in science education the design of suitable approaches to teacher education are discussed Finally the challenges that modelling based education pose to science education researchers advanced students of science education and curriculum design teacher educators public examiners and textbook designers are all outlined

*Technology-Enhanced Learning* Nicolas Balacheff, Sten Ludvigsen, Ton de Jong, Ard Lazonder, Sally Barnes, 2009-03-24 Technology enhanced learning is a timely topic the importance of which is recognized by educational researchers practitioners software designers and policy makers This volume presents and discusses current trends and issues in technology enhanced learning from a European research and development perspective This multifaceted and multidisciplinary topic is considered from four different viewpoints each of which constitutes a separate section in the book The sections include general as well as domain specific principles of learning that have been found to play a significant role in technology enhanced environments ways to shape the environment to optimize learners interactions and learning and specific technologies used by the environment to empower learners An additional section discusses the work presented in the preceding sections from a computer science perspective and an implementation perspective This book comes out of the work in Kaleidoscope a European Network of Excellence in which over 1 000 people from more than 90 institutes across Europe participate Kaleidoscope brings together researchers from diverse disciplines and cultures through their collaboration and sharing of scientific outcomes they are helping move the field of technology enhanced learning forward Progress in Robotics Jong-Hwan Kim, Shuzhi Sam Ge, Prahlaad Vadakkepat, Norbert Jesse, Abdullah Al Mamun, Sadasivan Puthusserypady, Ulrich Rückert, Joaquin Sitte, Ulf Witkowski, Ryohei Nakatsu, Thomas Braunl, Jacky Baltes, John Anderson, Ching-Chang Wong, David Ahlgren, 2009-08-19 This volume is an edition of the papers selected from the 12 FIRA RoboWorld Congress held in Incheon Korea August 16 18 2009 The Federation of International Robosoccer Association FIRA www.fira-net is a non profit organization which organizes robotic competitions and meetings around the globe annually The RoboSoccer competitions started in 1996 and FIRA was established on June 5 1997 The Robot Soccer competitions are aimed at promoting the spirit of science and technology to the younger generation The congress is a forum in which to share ideas and future directions of technologies and to enlarge the human networks in robotics area The objectives of the FIRA Cup and Congress are to explore the technical development and achievement in the field of robotics and provide participants with a

robot festival including technical presentations robot soccer competitions and exhibits der the theme Where Theory and Practice Meet th Under the umbrella of the 12 FIRA RoboWorld Incheon Congress 2009 six int national conferences were held for greater impact and scientific exchange th 6 International Conference on Computational Intelligence Robotics and Autonomous Systems CIRAS th 5 International Symposium on Autonomous Minirobots for Research and Edutainment AMiRE International Conference on Social Robotics ICSR International Conference on Advanced Humanoid Robotics Research ICAHRR International Conference on Entertainment Robotics ICER International Robotics Education Forum IREF This volume consists of selected quality papers from the six conferences

### **Multiple Representations in Chemical Education**

John K. Gilbert, David Treagust, 2009-02-28 Chemistry seeks to provide qualitative and quantitative explanations for the observed behaviour of elements and their compounds Doing so involves making use of three types of representation the macro the empirical properties of substances the sub micro the natures of the entities giving rise to those properties and the symbolic the number of entities involved in any changes that take place Although understanding this triplet relationship is a key aspect of chemical education there is considerable evidence that students find great difficulty in achieving mastery of the ideas involved In bringing together the work of leading chemistry educators who are researching the triplet relationship at the secondary and university levels the book discusses the learning involved the problems that students encounter and successful approaches to teaching Based on the reported research the editors argue for a coherent model for understanding the triplet relationship in chemical education

*History, Philosophy and Science Teaching* Michael R. Matthews, 2017-08-30 This anthology opens new perspectives in the domain of history philosophy and science teaching research Its four sections are first science culture and education second the teaching and learning of science third curriculum development and justification and fourth indoctrination The first group of essays deal with the neglected topic of science education and the Enlightenment tradition These essays show that many core commitments of modern science education have their roots in this tradition and consequently all can benefit from a more informed awareness of its strengths and weaknesses Other essays address research on leaning and teaching from the perspectives of social epistemology and educational psychology Included here is the first ever English translation of Ernst Mach s most influential 1890 paper on The Psychological and Logical Moment in Natural Science Teaching This paper launched the influential Machian tradition in education Other essays address concrete cases of the utilisation of history and philosophy in the development and justification of school science curricula These are instances of the supportive relation of HPS a subject long discussed in philosophy of education but inadequately in science education This book is a timely reminder of why history and philosophy of science are urgently needed to support understanding of science From major traditions such as the Enlightenment to the tensions around cultural studies of science the book provides a comprehensive context for the scientific endeavour drawing on curriculum and instructional examples Sibel Erduran University of Oxford UK The scholarship that each of the authors in this volume offers

deepens our understanding of what we teach in science and why that understanding matters This is an important book exploring a wide set of issues and should be read by anyone with an interest in science or science education Jonathan Osborne Stanford University USA This volume presents new and updated perspectives in the field such as the Enlightenment Tradition Cultural Studies Indoctrination in Science Education and Nature of Science Highly recommended Mansoor Niaz Universidad de Oriente Venezuela This volume provides an extremely valuable set of insights into educational issues related to the history and philosophy of science Michael J Reiss University College London UK

**The Routledge Handbook of Philosophy of Scientific Modeling** Tarja Knuuttila, Natalia Carrillo, Rami Koskinen, 2024-09-05 Models and modeling have played an increasingly important role in philosophy going back to the nineteenth century While philosophical interest in models has been remarkably lively over the last two decades there are still many underexplored questions The Routledge Handbook of Philosophy of Scientific Modeling is an outstanding reference source and guide to this fast growing area and is the first volume of its kind Comprised of 40 specially commissioned chapters by an international team of contributors the Handbook is organized into five clear parts Historical and General Perspectives Philosophical Accounts of Modeling Methodological Aspects Model Construction Evaluation and Calibration Related Topics Modeling in the Wild Within these parts the Handbook covers a diverse range of topics including historical perspectives on modeling the relationship between models theories representation idealization and understanding and related topics like big data simulation and statistical and computational modeling Different kinds of models are discussed for example network models financial models and climate and synthetic models The Routledge Handbook of Philosophy of Scientific Modeling is essential reading for students and scholars of philosophy of science formal epistemology and philosophy of social sciences It is also a valuable resource for those in related fields such as computer science and information technology

*Active Learning: Theoretical Perspectives, Empirical Studies and Design Profiles* Robert Cassidy, Elizabeth S. Charles, James D. Slotta, Nathaniel Lasry, 2019-07-11 This book represents the emerging efforts of a growing international network of researchers and practitioners to promote the development and uptake of evidence based pedagogies in higher education at something a level approaching large scale impact By offering a communication venue that attracts and enhances much needed partnerships among practitioners and researchers in pedagogical innovation we aim to change the conversation and focus on how we work and learn together i e extending the implementation and knowledge of co design methods In this first edition of our Research Topic on Active Learning we highlight two of the three types of publications we wish to promote First are studies aimed at understanding the pedagogical designs developed by practitioners in their own practices by bringing to bear the theoretical lenses developed and tested in the education research community These types of studies constitute the practice pull that we see as a necessary counterbalance to knowledge push in a more productive pedagogical innovation ecosystem based on research practitioner partnerships Second are studies empirically examining the implementations of evidence based designs in naturalistic settings

and under naturalistic conditions Interestingly the teams conducting these studies are already exemplars of partnerships between researchers and practitioners who are uniquely positioned as in between straddling the two worlds As a result these publications represent both the rigours of research and the pragmatism of reflective practice In forthcoming editions we will add to this collection a third type of publication design profiles These will present practitioner developed pedagogical designs at varying levels of abstraction to be held to scrutiny amongst practitioners instructional designers and researchers alike We hope by bringing these types of studies together in an open access format that we may contribute to the development of new forms of practitioner researcher interactions that promote co design in pedagogical innovation

*Understanding Online Instructional Modeling: Theories and Practices* Zheng, Robert Z., Ferris, Sharmila Pixy, 2007-10-31 Higher education is currently undergoing significant changes and conditions in higher education reflect changing financial social and political conditions which affect both faculty and students Both the rising costs of education and changes from brick and mortar to technologically driven programs often lead to a change from the traditional space and time bound institution to ones that offer cost effective technologically enhanced programs Online learning has become an integral and expansive factor in higher education both in distance learning and as an adjunct to the traditional classroom *Understanding Online Instructional Modeling Theories and Practices* focuses on both theoretical and practical aspects of online learning by introducing a variety of online instructional models as well as best practices that help educators and professional trainers to better understand the dynamics of online learning

Natural Language Processing and Information Systems Gosse Bouma, Ashwin Ittoo, Elisabeth Métais, Hans Wortmann, 2012-06-22 This book constitutes the refereed proceedings of the 17th International Conference on Applications of Natural Language to Information Systems held in Groningen The Netherlands in June 2012 The 12 full papers 24 short papers and 16 poster papers presented in this volume together with a full paper length invited talks were carefully reviewed and selected from 90 submissions The rapidly evolving state of the art in NLP and the shifting interest to applications targeting document and data collections available on the Web including an increasing amount of user generated content is reflected in the contributions to this book Topics covered are information retrieval text classification and clustering summarization normalization of user generated content forensic NLP ontologies and natural language sentiment analysis question answering and information extraction terminology and named entity recognition and NLP tools development

**Scientific Knowledge as a Culture** Igal Galili, 2022-02-01 This book in its first part contains units of conceptual history of several topics of physics based on the research in physics education and research based articles with regard to several topics involved in teaching science in general and physics in particular The second part of the book includes the framework used the approach considering science knowledge as a special type of culture discipline culture Within this approach scientific knowledge is considered as comprised of a few inclusive fundamental theories each hierarchically structured in a triadic pattern nucleus body periphery While nucleus incorporates the basic principles and

body comprises their implementations in the variety of laws models and experiments periphery includes concepts at odds to the nucleus This structure introduces knowledge in its conceptual variation thus converting disciplinary knowledge to cultural disciplinary one The approach draws on history and philosophy of science HPS necessary for meaningful learning of science It is exemplified in several aspects regarding teaching physics presenting history in classes considering the special nature of science and using artistic images in regular teaching The revealed conceptual debate around the chosen topics clarifies the subject matter for school students and teachers encouraging construction of Cultural Content Knowledge Often missed in teachers preparation and common curriculum it helps genuine understanding of science thus providing remedy of students misconceptions reported in educational research

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