

## MATHEMATICAL MODELLING: THE INTERACTION OF CULTURE AND PRACTICE

**ABSTRACT.** Using a sociocultural approach we analyse the results of a Mexican/British project which investigated the ways in which mathematics is used in the practice of school science and the role of spreadsheets as a mathematical modelling tool. After discussing the different school cultures experienced by two groups of pre-university 16–18 year old students we analyse how these different cultures influenced their practice of mathematics, as well as their work with mathematical spreadsheet modelling activities. There were clear differences between the two groups of students in their preference for external representations, in their understanding of the kind of answers they were expected to produce and in the way they conceived the role of mathematics in the practice of science. Although students' preferences for a particular representation were not significantly modified by the use of a spreadsheet as a modelling resource, at the end of the study the students recognised the value of using a more diverse set of representations. The results obtained suggest the possibility of enhancing students' capability to shift between a wider range of representations, including graphical, algebraic and numeric ones, using a modelling approach embedded in a computer environment such as a spreadsheet.

### 1. INTRODUCTION AND BACKGROUND

Mathematics provides one of the most powerful means of modelling and solving problems across a range of subjects in science and technology. Biology, chemistry and physics are all examples of subjects which make use of mathematical techniques to model situations and solve problems. Many of the mathematical techniques involve the use of methods which are considered valuable because of their generalisability. But it is this potential generalisability which is being questioned by the culture and cognition research community (for example Lave, 1988; Rogoff and Lave, 1984). Whereas there have been a number of studies which have investigated the ways in which mathematics is used in everyday practices (for example, Nunes et al., 1993) there has been very little work taking a similar perspective with respect to school practices such as science. Whatever the reasons, many students who study science cannot readily use mathematical methods within science subject areas.



# Mathematical Modelling In Educations And Culture

**Yehudit Judy Dori,Zemira R.  
Mevarech,Dale R. Baker**



## **Mathematical Modelling In Educations And Culture:**

Mathematical Modelling in Education and Culture Q-X Ye,W Blum,S K Houston,Q-Y Jiang,2003-05-01 The mathematical modelling movement in mathematics education at school and university level has been influencing curricula for about 25 years Lecturers will find material to enhance their teaching and extracurricular activities and educators will find innovative ideas to inform their course design and focus their research while students will find interesting problems to explore Helps lecturers enhance their teaching and extracurricular activities Provides educators with innovative ideas to inform their course design and focus their research Students will find interesting problems to explore **Mathematical Modelling in**

**Education Research and Practice** Gloria Ann Stillman,Werner Blum,Maria Salett Biembengut,2015-07-20 In this volume cultural social and cognitive influences on the research and teaching of mathematical modelling are explored from a variety of theoretical and practical perspectives The authors of the current volume are all members of the International Community of Teachers of Mathematical Modelling and Applications the peak research body in this field A distinctive feature of this volume is the high number of authors from South American countries These authors bring quite a different perspective to modelling than has been showcased in previous books in this series in particular from a cultural point of view As well as recent international research there is a strong emphasis on pedagogical issues including those associated with technology and assessment in the teaching and learning of modelling Applications at various levels of education are exemplified The contributions reflect common issues shared globally and represent emergent or on going challenges **Mathematical**

**Modelling Education in East and West** Frederick Koon Shing Leung,Gloria Ann Stillman,Gabriele Kaiser,Ka Lok Wong,2021-04-26 This book documents ongoing research and theorizing in the sub field of mathematics education devoted to the teaching and learning of mathematical modelling and applications Mathematical modelling provides a way of conceiving and resolving problems in people s everyday lives as well as sophisticated new problems for society at large Mathematical tradition in China that emphasizes algorithm and computation has now seen a renaissance in mathematical modelling and applications where China has made significant progress with its economy science and technology In recent decades teaching and learning of mathematical modelling as well as contests in mathematical modelling have been flourishing at different levels of education in China Today teachers and researchers in China become keener to learn from their colleagues from Western countries and other parts of the world in research and teaching of mathematical modelling and applications The book provides a dialogue and communication between colleagues from across the globe with new impetus and resources for mathematical modelling education and its research in both West and East with new ideas on modelling teaching and practices inside and outside classrooms All authors of this book are members of the International Community of Teachers of Mathematical Modelling and Applications ICTMA the peak research body into researching the teaching assessing and learning of mathematical modelling at all levels of education from the early years to tertiary education as well as in the

workplace The book is of interest to researchers mathematics educators teacher educators education administrators policy writers curriculum developers professional developers in service teachers and pre service teachers including those interested in mathematical literacy

**Modelling and Applications in Mathematics Education** Peter L. Galbraith,Hans-Wolfgang Henn,Mogens Niss,2007-12-05 Among the themes that have been central to mathematics education during the last 30 years are those of mathematical modelling and applications of mathematics to extra mathematical fields More generally we refer to these as relations between mathematics and the extra mathematical world some times also called the real world or preferably according to Henry PoUak the rest of the world That applications and modelling have been important themes in mathematics education can be inferred from the wealth of literature on these topics including material generated from a multitude of national and international conferences In particular let us mention firstly the ICMEs the International Congresses on Mathematical Education with their regular working or topic groups and lectures on applications and modelling and secondly the series of ICTMAs the International Conferences on the Teaching of Mathematical Modelling and Applications which have been held biennially since 1983 Their Proceedings and Survey Lectures have addressed the state of the art at the relevant time and contain many examples studies conceptual contributions and resources involving relations between the real world and mathematics for all levels of the educational system In curricula and textbooks we find today many more references to real world phenomena and problems than say twenty years ago

**Researching Mathematical Modelling Education in Disruptive Times** Hans-Stefan Siller,Vince Geiger,Gabriele Kaiser,2024-06-03 This edited volume documents research on mathematical modelling education before during and after the Covid 19 pandemic Mathematical modelling is essential for understanding natural and human generated phenomena and informs decision making about events such as the pandemic climate change and other disruptive events Communication to the public often by the media makes use of mathematical modelling to justify changes to public policy as seen during the COVID 19 crisis Consequently mathematical modelling has assumed an increasingly prominent role in curricula internationally providing opportunities to understand how it is used in current circumstances and to plan for the needs of future societies This book focuses on research on mathematical modelling education and its implementation at school and tertiary level Contributions to the book and point to directions for further innovation in mathematical modelling education Authors of this volume are members of the International Community of Teachers of Mathematical Modelling the peak research body for the teaching and learning of mathematical modelling

**Mathematical Modelling Education and Sense-making** Gloria Ann Stillman,Gabriele Kaiser,Christine Erna Lampen,2020-05-14 This volume documents on going research and theorising in the sub field of mathematics education devoted to the teaching and learning of mathematical modelling and applications Mathematical modelling provides a way of conceiving and resolving problems in people s everyday lives as well as sophisticated new problems for society at large Mathematical modelling and real world applications are considered as having potential for

cultivating sense making in classroom settings This book focuses on the educational perspective researching the complexities encountered in effective teaching and learning of real world modelling and applications for sense making is only beginning All authors of this volume are members of the International Community of Teachers of Mathematical Modelling ICTMA the peak research body into researching the teaching and learning of mathematical modelling at all levels of education from the early years to tertiary education as well as in the workplace International Horizons in Mathematics Modelling Education Toshikazu Ikeda,Akihiko Saeki,Vince Geiger,Gabriele Kaiser,2025-08-09 This edited volume provides an extensive overview of the recent strides in global modelling education It examines the interplay between modelling education and various dimensions of the educational landscape Firstly it delves deeply into the intersection of modelling education with interdisciplinary STEM education teacher education lesson study engineering problem solving and posing and creativity Moreover the book places a strong emphasis on the integration of modelling education with foundational mathematical concepts including algebra geometry functions and statistics demonstrating their integral role across elementary secondary and tertiary levels of mathematics education Furthermore the book delves into the specific issues and considerations that shape modelling education It addresses critical pedagogical aspects the integration of technology and cultural and contextual considerations In essence this book stands as a comprehensive guide that not only surveys the recent advances in global modelling education but also offers invaluable insights and practical guidance **Mathematical Modeling in Cultural Heritage** Gabriella Bretti,Cecilia Cavaterra,Margherita Solci,Michela Spagnuolo,2025-06-20 This book collects contributions presented at the INdAM Workshop Mathematical modeling and Analysis of degradation and restoration in Cultural Heritage MACH2023 held in Rome Italy in September 2023 The book is focused on mathematical modeling and simulation techniques with the aim of improving the current strategies of conservation and restoration in cultural heritage sharing different experiences and approaches The main topics are corrosion and sulphation of materials damage and fractures stress in thermomechanical systems contact and adhesion problems phase transitions and reaction diffusion models restoration techniques additive manufacturing with a particular focus on the effective improvements of the fruition of cultural heritage The final goal is to strengthen the bridge between the experts in different fields of cultural heritage and the mathematical community Mathematical Modelling Programs in Latin America Milton Rosa,Francisco Cordero,Daniel Clark Orey,Pablo Carranza,2022-07-06 This book is about the unique sophisticated and rigorous study of mathematics in Latin America developed over centuries of cultural exchange between Europe North and South America More specifically the book explores the tradition of mathematical modelling introduced a century ago This modelling was adapted to assist members of distinct communities to draw information about their own realities through the elaboration of representations which generate mathematical knowledge that deals with creativity and invention The book provides empirical evidence that a category of mathematical modelling developed in Latin America assesses the horizontal and reciprocal relations between mathematics

school non school contexts and the real world These relations provide an epistemological and ontological change where mathematical knowledge of the others is recognized on a horizontal plane Further they oblige mathematics teachers and students to understand as a community of knowledge that builds their own mathematical categories of their environment governed by the reciprocal relationships between academic knowledge and functional knowledge The dimensions of the relationships make up a frame of reference that guides educational change in mathematics The book presents an inquiry based approach of three Latin American modelling programs ethnomodelling transversality of knowledge and reasoned decision making Each one with its respective theoretical and methodological foundations related to ethnomathematics and mathematical modelling socioepistemology and the attribution of meaning to learning Undoubtedly the three mathematical modelling programs independently provide educational gains each with its levels of specificity and loyal to its philosophical theoretical and methodological principles However the book places them together organized by axes to define a corpus of mathematical knowledge that envisions profound educational change through the development of different approaches of mathematical modelling The authors of the 18 chapters in this book who represent the diversity of Latin America are from eight countries Argentina Brazil Chile Colombia Costa Rica Cuba Ecuador Honduras and Mexico They were invited to share their ideas perspectives and discuss investigations that represent a rich sample of three Latin American perspectives on mathematical modelling

**Lines of Inquiry in Mathematical Modelling Research in Education** Gloria Ann Stillman, Jill P. Brown, 2019-05-16 This open access book is based on selected presentations from Topic Study Group 21 Mathematical Applications and Modelling in the Teaching and Learning of Mathematics at the 13th International Congress on Mathematical Education ICME 13 held in Hamburg Germany on July 24 31 2016 It contributes to the theory research and teaching practice concerning this key topic by taking into account the importance of relations between mathematics and the real world Further the book addresses the balancing act between developing students modelling skills on the one hand and using modelling to help them learn mathematics on the other which arises from the integration of modelling into classrooms The contributions prepared by authors from 9 countries reflect the spectrum of international debates on the topic and the examples presented span schooling from years 1 to 12 teacher education and teaching modelling at the tertiary level In addition the book highlights professional learning and development for in service teachers particularly in systems where the introduction of modelling into curricula means reassessing how mathematics is taught Given its scope the book will appeal to researchers and teacher educators in mathematics education as well as pre service teachers and school and university educators

*Cognition, Metacognition, and Culture in STEM Education* Yehudit Judy Dori, Zemira R. Mevarech, Dale R. Baker, 2017-12-01 This book addresses the point of intersection between cognition metacognition and culture in learning and teaching Science Technology Engineering and Mathematics STEM We explore theoretical background and cutting edge research about how various forms of cognitive and metacognitive instruction may enhance learning and thinking in STEM

classrooms from K 12 to university and in different cultures and countries Over the past several years STEM education research has witnessed rapid growth attracting considerable interest among scholars and educators The book provides an updated collection of studies about cognition metacognition and culture in the four STEM domains The field of research cognition and metacognition in STEM education still suffers from ambiguity in meanings of key concepts that various researchers use This book is organized according to a unique manner Each chapter features one of the four STEM domains and one of the three themes cognition metacognition and culture and defines key concepts This matrix type organization opens a new path to knowledge in STEM education and facilitates its understanding The discussion at the end of the book integrates these definitions for analyzing and mapping the STEM education research Chapter 4 is available open access under a Creative Commons Attribution 4 0 International License via link [springer.com](http://springer.com)     Transforming Mathematics Instruction Yeping Li,Edward A. Silver,Shiqi Li,2014-07-05 This book surveys and examines different approaches and practices that contribute to the changes in mathematics instruction including 1 innovative approaches that bring direct changes in classroom instructional practices 2 curriculum reforms that introduce changes in content and requirements in classroom instruction and 3 approaches in mathematics teacher education that aim to improve teachers expertise and practices It also surveys relevant theory and methodology development in studying and assessing mathematics instruction Classroom instruction is commonly seen as one of the key factors contributing to students learning of mathematics but much remains to be understood about teachers instructional practices that lead to the development and enactment of effective classroom instruction and approaches and practices developed and used to transform classroom instruction in different education systems Transforming Mathematics Instruction is organized to help readers learn not only from reading individual chapters but also from reading across chapters and sections to explore broader themes including Identifying what is important in mathematics for teaching and learning emphasized in different approaches Exploring how students learning is considered and facilitated through different approaches and practices Understanding the nature of various approaches that are valued in different systems and cultural contexts Probing culturally valued approaches in identifying and evaluating effective instructional practices The book brings new research and insights into multiple approaches and practices for transforming mathematics instruction to the international community of mathematics education with 25 chapters and four section prefaces contributed by 56 scholars from 10 different education systems This rich collection is indispensable reading for mathematics educators researchers teacher educators curriculum developers and graduate students interested in learning about different instructional practices approaches for instructional transformation and research in different education systems It will help readers to reflect on approaches and practices that are useful for instructional changes in their own education systems and also inspire them to identify and further explore new areas of research and program development in improving mathematics teaching and learning     **Learning How to Teach Mathematical Modeling in School and**

**Teacher Education** Rita Borromeo Ferri, 2017-11-26 This timely resource fills a gap in existing literature on mathematical modeling by presenting both theory and evidence based ideas for its teaching and learning The book outlines four key professional competencies that must be developed in order to effectively and appropriately teach mathematical modeling and in so doing it seeks to reduce the discrepancies between educational policy and educational research versus everyday teaching practice Among the key competencies covered are Theoretical competency for practical work Task competency for instructional flexibility Instructional competency for effective and quality lessons Diagnostic competency for assessment and grading Learning How to Teach Mathematical Modeling in School and Teacher Education is relevant to practicing and future mathematics teachers at all levels as well as teacher educators mathematics education researchers and undergraduate and graduate mathematics students interested in research based methods for teaching mathematical modeling Exploring Mathematical Modeling with Young Learners Jennifer M. Suh, Megan H. Wickstrom, Lyn D. English, 2021-06-01 This book conceptualizes the nature of mathematical modeling in the early grades from both teaching and learning perspectives Mathematical modeling provides a unique opportunity to engage elementary students in the creative process of mathematizing their world A diverse community of internationally known researchers and practitioners share studies that advance the field with respect to the following themes The Nature of Mathematical Modeling in the Early Grades Content Knowledge and Pedagogy for Mathematical Modeling Student Experiences as Modelers Teacher Education and Professional Development in Modeling Experts in the field provide commentaries that extend and connect ideas presented across chapters This book is an invaluable resource in illustrating what all young children can achieve with mathematical modeling and how we can support teachers and families in this important work *Handbook of Cognitive Mathematics* Marcel Danesi, 2022-10-31 Cognitive mathematics provides insights into how mathematics works inside the brain and how it is interconnected with other faculties through so called blending and other associative processes This handbook is the first large collection of various aspects of cognitive mathematics to be amassed into a single title covering decades of connection between mathematics and other figurative processes as they manifest themselves in language art and even algorithms It will be of use to anyone working in math cognition and education with each section of the handbook edited by an international leader in that field *Advancing and Consolidating Mathematical Modelling* Gilbert Greefrath, Susana Carreira, Gloria Ann Stillman, 2023-04-18 This edited volume presents applications and modelling as a world renowned sub field of research in mathematics education It includes the discussion on students development of modelling competency through the teaching of applications and modelling The teaching of mathematical modelling is considered from different perspectives such as mathematical pedagogical didactical perspectives and critical societal or socio political perspectives Assessment practices local regional or international of modelling activities and difficulties with modelling activities at school and university levels respectively are discussed Use of technology and other resources in modelling activities and their impact on the modelling



processes are included in the considerations Teaching practices teacher education and professional development programs concerning the integration of applications and modelling in school and university mathematics programs are developed in this context

Research in Mathematics Education in Australasia 2020-2023 Carmel Mesiti, Wee Tiong Seah, Berinderjeet Kaur, Cath Pearn, Anthony Jones, Scott Cameron, Emma Every, Kate Copping, 2024-07-02 This book provides a critical review of research in mathematics education published in or about the Australasian region in the four years from 2020 to 2023

Research in Mathematics Education in Australasia 2020 2023 RiMEA 2020 2023 is the eleventh edition of the four yearly review of mathematics education research in Australasia It is compiled by the Mathematics Education Research Group of Australasia MERGA It is primarily focused on research from Australia New Zealand and Singapore but also includes research from other Southeast Asian countries and the South Pacific Although each edition of RiMEA is shaped by the preceding volumes each new edition evolves in response to events coinciding with each new review period Following an introduction by the editors RiMEA 2020 2023 will contain a reflection chapter authored by the editors of the previous edition Research in Mathematics Education in Australasia 2016 2019 on how research in mathematics education in the Australasian region has progressed over the four years since This book provides a comprehensive critical review of research literature in the Australasian region on significant topics published within the review period It serves as a resource for researchers and promotes quality research in the Australasian region Furthermore it provides an introduction to mathematics education research in the Australasian region for Ph D candidates early career researchers and other researchers beginning a new field of research

Mathematical Modelling and Applications Gloria Ann Stillman, Werner Blum, Gabriele Kaiser, 2017-11-05 This volume documents on going research and theorising in the sub field of mathematics education devoted to the teaching and learning of mathematical modelling and applications Mathematical modelling provides a way of conceiving and resolving problems in the life world of people whether these range from the everyday individual numeracy level to sophisticated new problems for society at large Mathematical modelling and real world applications are considered as having potential for multi disciplinary work that involves knowledge from a variety of communities of practice such as those in different workplaces e g those of educators designers construction engineers museum curators and in different fields of academic endeavour e g history archaeology mathematics economics From an educational perspective researching the development of competency in real world modelling involves research situated in crossing the boundaries between being a student engaged in modelling or mathematical application to real word tasks in the classroom being a teacher of mathematical modelling in or outside the classroom or bridging both and being a modeller of the world outside the classroom This is the focus of many of the authors of the chapters in this book All authors of this volume are members of the International Community of Teachers of Mathematical Modelling ICTMA the peak research body into researching the teaching and learning of mathematical modelling at all levels of education from the early years to tertiary education as well as in the workplace

**Third**

**International Handbook of Mathematics Education** M.A. (Ken) Clements, Alan Bishop, Christine Keitel-Kreidt, Jeremy Kilpatrick, Frederick Koon-Shing Leung, 2012-11-15 The four sections in this Third International Handbook are concerned with a social political and cultural dimensions in mathematics education b mathematics education as a field of study c technology in the mathematics curriculum and d international perspectives on mathematics education These themes are taken up by 84 internationally recognized scholars based in 26 different nations Each of section is structured on the basis of past present and future aspects The first chapter in a section provides historical perspectives How did we get to where we are now the middle chapters in a section analyze present day key issues and themes Where are we now and what recent events have been especially significant and the final chapter in a section reflects on policy matters Where are we going and what should we do Readership Teachers mathematics educators ed policy makers mathematicians graduate students undergraduate students Large set of authoritative international authors      *Research in Mathematics Education in Australasia 2012-2015* Katie Makar, Shelley Dole, Jana Visnovska, Merrilyn Goos, Anne Bennison, Kym Fry, 2016-06-02 With the ninth edition of the four yearly review of mathematics education research in Australasia the Mathematics Education Research Group of Australasia MERGA discusses the Australasian research in mathematics education in the four years from 2012 2015 This review aims to critically promote quality research and focus on the building of research capacity in Australasia

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