

A brief survey of the state of mathematical modeling around the world

Bharath Sriraman (USA)
Gabriele Kaiser (Germany)
Morten Blomhøj (Denmark)

Abstract

We briefly survey and discuss the issues and perspectives presented in the two special issues of the Zentralblatt für Didaktik der Mathematik on mathematical modeling and pose open questions to the community of researchers interested in this domain of inquiry.

ZDM Classification: M10

Overview

These two issues of the Zentralblatt fuer Didaktik der Mathematik (vol. 38, no. 2 and vol. 38, no. 3) show that mathematics education research in the field of mathematical modeling has been both active and evolving in many parts of the world. In addition they show the variety of approaches, which even has lead to a different spelling of the word modeling either with one or two 'l'. The current issue complements the state of modeling research presented in the previous issue. The articles in the previous issue gave an overall perspective on a theory for teaching and learning modeling with the commonly accepted idea about a general mathematical modeling process. In particular, we presented papers in which a general modeling cycle could be used as an analytic tool.

In contrast to the previous issue, many of the papers in this issue show research based perspectives that have evolved out of the problem solving genre in the 1970's onto what is known today as models and modeling perspectives (MMP). This issue contains for the first time a paper coming out of a Romance language speaking country, namely Spain, which takes an epistemological approach to modeling (Garcia et al). In addition a paper from Brazil presents a socio-critical perspective (Barbosa). Given the wide variety of modeling perspectives used by the modeling community as presented in these two ZDM issues, the final paper by Kaiser & Sriraman provides a classification system based on their relation to previous approaches found in the literature and the general disciplinary background within which these approaches fit. This

classification provides the research community an opportunity to discuss similarities and differences between approaches and the possibility of accumulating and consolidating ongoing research in the years to come.

Issues for Discussion

The paper by Garcia et al. contends that existing approaches to modelling research concerned with pragmatic and utilitarian goals only presents a part of the spectrum of what the research community understands by modelling. Their paper proposes a general epistemological framework of mathematics grounded in Chevallard's Anthropological Theory of didactics (ATD), and a reformulation of the modelling processes within ATD. Garcia et al. "transpose" the modelling cycle into epistemological terms and argue that what we term *modelling* is not just one aspect of mathematics, but that all mathematical activity is essentially a *modelling activity*.

Sriraman & Lesh take a critical stance on what constitutes mathematical modelling for today's students. Their focus is on the dismal state of affairs in the North American scene particularly the barriers to the implementation of mathematical modeling in school curricula. Sriraman & Lesh also stress the urgent need to initiate a new research agenda based on the fact that today's students are living in a fundamentally different world in which their reality is characterized by complex systems. These authors also take critical, reflective and retrospective stance on what went wrong with problem solving research grounded in archaic information processing metaphors. The evolution from archaic information processing perspectives onto a system-based perspective is outlined in the discussion of contextual modeling approached in the paper by Kaiser & Sriraman.

Pierce & Stacey discuss ways in which teachers enhance the image of mathematics by using sensory stimuli typically peripheral to the situation being modeled. They point to inherent dangers in such a strategy where mathematical learning goals may end up being compromised in the process of creating "enjoyable and memorable" lessons for middle school students.

Doerr presents the results of a case study in which she observed the classroom practices of four experienced secondary school teachers while they engaged their students in the initial development of

mathematical models for exponential growth. Doerr's research focuses on two particular aspects of teachers' classroom practice, namely (1) when, how and to what extent teachers' saw and interpreted students' ways of thinking about exponential functions and (2) how teachers responded to their students' thinking.

Michelsen takes an interdisciplinary stance to mathematical modeling and emphasizes the value of using well known didactical strategies from science to initiate mathematical modeling. Michelsen argues that modeling activities lie at the intersection of science and mathematics and demonstrates a modeling based approach to the notion of concept of function in a Danish upper secondary school.

Iversen & Larson adapt a well known model eliciting activity (MEA) into a Danish context to research the shortcomings of traditional mathematics assessments. They employ a multi-tier design-based research methodology to adapt a MEA to measure student performance on a complex real-world task. These researchers use student solutions to the MEA to develop tools for capturing and assessing the strengths and weaknesses of the mathematical models present in these solutions.

The paper by Barbosa takes a socio-critical stance on the role of mathematical modeling in school curricula under the perspective of discursive psychology. This contribution stresses the need to cultivate critical pedagogy via mathematical modeling.

Concluding thoughts

These two ZDM issues reveal the difficult balance between trying to build a coherent theoretical understanding of mathematical modeling while maintaining the very large variation in approaches to modeling represented in the world. The classification offered by Kaiser & Sriraman offers one good possibility for systematizing the myriad approaches in this domain of research. Another possibility for the community is to form special interest topics groups with representatives of numerous approaches interested in analyzing a mutually agreed upon data set from different analytic perspectives. Such an enterprise would be able to clarify the underlying positions of the various approaches in the world today.

Authors

Bharath Sriraman, Prof.
Editor, The Montana Mathematics Enthusiast
<http://www.montanamath.org/TMME>
Dept. of Mathematical Sciences
The University of Montana
Missoula, MT 59812
USA
sriramanb@mso.umt.edu

Gabriele Kaiser, Prof.
Chief Editor, Zentralblatt für Didaktik der
Mathematik
University of Hamburg
Faculty of Education
Von-Melle-Park 8
20146 Hamburg, Germany
E-mail: gabriele.kaiser@uni-hamburg.de

Morten Blomhøj, Prof.
Editor, Nordic Studies in Mathematics Education
IMFUFA, Roskilde University
Postbox 260, Dk-4000 Roskilde
Denmark
E-mail: Blomhoej@ruc.dk