

Kaye Stacey · Ross Turner *Editors*

Assessing Mathematical Literacy

The PISA Experience

 Springer

Assessing Mathematical Literacy

Kaye Stacey • Ross Turner
Editors

Assessing Mathematical Literacy

The PISA Experience

 Springer

Editors

Kaye Stacey
Melbourne Graduate School
of Education
The University of Melbourne
Melbourne, VIC, Australia

Ross Turner
International Surveys,
Educational Monitoring and Research
Australian Council
for Educational Research (ACER)
Camberwell, VIC, Australia

ISBN 978-3-319-10120-0 ISBN 978-3-319-10121-7 (eBook)
DOI 10.1007/978-3-319-10121-7
Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014954104

© Springer International Publishing Switzerland 2015

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

The initiative for this book came from the PISA 2012 Mathematics Expert Group, which had worked together with a team from the Australian Council for Educational Research (ACER) for nearly 4 years in the preparation of the OECD's 2012 PISA survey. The mathematics assessment for the 2012 survey underwent substantial changes, building on and further developing the structures and conceptualisation of the 2003 survey (when Mathematics had last been the major domain) and responding to the wide-ranging international feedback that had arisen in those 9 years. The Framework has grown steadily since its inception for the 2000 survey, and its impact has expanded dramatically over this time. The item design has also been substantially refined. The expert group came to realise that the work that goes into an international survey such as PISA should be better known: hence this book. We hope it is a contribution both to thinking about the most fundamental goals and activities of mathematics education and toward better understanding the results of the PISA surveys.

It has been a pleasure to work with a team of such talented, engaged, and well-informed authors in the preparation of this book. Many chapter authors were also members of the Mathematics Expert Group for the PISA 2012 survey and the mathematics teams of international contractors for PISA 2012 led by ACER. We thank them for contributions to the book as well as for their contribution to the Mathematics Framework and items for the 2012 survey. Other authors have played important roles in using PISA to improve mathematics education in their own countries. The editors have also enjoyed bringing their own two different perspectives together as they worked on this book: Ross's experience as the leader of the ACER team responsible for delivering the mathematics framework, items, and coding since the first PISA survey and Kaye's view from research, teaching, and national policy and as chair of the Mathematics Expert Group for PISA 2012.

It is essential to acknowledge that many of the ideas in the book are the outcome of the joint work of the members of all the Mathematics Expert Groups from PISA 2000 to PISA 2012. Their names are listed at the end of this Preface along with

other key mathematics staff members of agencies contracted to develop and implement PISA mathematics over its first several survey administrations.

We also acknowledge the valuable input of the Springer editors and especially of the anonymous reviewers whose useful comments helped sharpen the text. It is a special pleasure to acknowledge the work of Pam Firth from the University of Melbourne for her able editorial and administrative assistance.

Opinions expressed in this book are those of the authors and do not imply any endorsement by the Organisation for Economic Co-operation and Development (OECD) or any other organization.

Melbourne, VIC, Australia
Camberwell, VIC, Australia
3 Dec 2013

Kaye Stacey
Ross Turner

Membership of Mathematics Expert Groups and Other Contributors

2000

Jan de Lange (Chair, Netherlands), Raimondo Bolletta (Italy), Sean Close (Ireland), Maria Luisa Moreno (Spain), Mogens Niss (Denmark), Kyungmee Park (Korea), Thomas Romberg (United States), Peter Schüller (Austria)
Margaret Wu and Ross Turner (ACER, Executive Officers)

2003

Jan de Lange (Chair, Netherlands), Werner Blum (Germany), Vladimir Burjan (Slovak Republic), Sean Close (Ireland), John Dossey (United States), Mary Lindquist (United States), Zbigniew Marciniak (Poland), Mogens Niss (Denmark), Kyungmee Park (Korea), Luis Rico (Spain), Yoshinori Shimizu (Japan)
Ross Turner (Executive Officer)

2006

Jan de Lange (Chair, Netherlands), Werner Blum (Germany), John Dossey (United States), Zbigniew Marciniak (Poland), Mogens Niss (Denmark), Yoshinori Shimizu (Japan)
Ross Turner (Executive Officer)

2009

Jan de Lange (Chair, Netherlands), Werner Blum (Germany), John Dossey (United States), Zbigniew Marciniak (Poland), Mogens Niss (Denmark), Yoshinori Shimizu (Japan)

Ross Turner (Executive Officer)

2012

Kaye Stacey (Chair, Australia), Caroline Bardini (France, Australia), Werner Blum (Germany), Solomon Garfunkel (USA), Joan Ferrini-Mundy (USA), Toshikazu Ikeda (Japan), Zbigniew Marciniak (Poland), Mogens Niss (Denmark), Martin Ripley (England), William Schmidt (USA)

Ross Turner (Executive Officer)

Other Contributors

We acknowledge the contribution of other ACER staff members, consultants and staff of organisations working closely with ACER to develop PISA mathematics over its first several administrations, but who did not contribute directly to writing this book.

Kees Lagerwaard, Gerben van Lent (both formerly of Cito in the Netherlands), Hanako Senuma (formerly of the National Institute for Educational Policy Research, NIER, in Japan), Margaret Wu (formerly of ACER), Raymond J. Adams (ACER), Béatrice Halleux (HallStat SPRL, Belgium).

Contents

Part I The Foundations of PISA Mathematics

1	The Evolution and Key Concepts of the PISA Mathematics Frameworks	5
	Kaye Stacey and Ross Turner	
2	Mathematical Competencies and PISA	35
	Mogens Niss	
3	The Real World and the Mathematical World	57
	Kaye Stacey	
4	Using Competencies to Explain Mathematical Item Demand: A Work in Progress	85
	Ross Turner, Werner Blum, and Mogens Niss	
5	A Research Mathematician’s View on Mathematical Literacy	117
	Zbigniew Marciniak	

Part II Implementing the PISA Survey: Collaboration, Quality and Complexity

6	From Framework to Survey Data: Inside the PISA Assessment Process	127
	Ross Turner	
7	The Challenges and Complexities of Writing Items to Test Mathematical Literacy	145
	Dave Tout and Jim Spithill	
8	Computer-Based Assessment of Mathematics in PISA 2012	173
	Caroline Bardini	

9	Coding Mathematics Items in the PISA Assessment	189
	Agnieszka Sułowska	
10	The Concept of Opportunity to Learn (OTL) in International Comparisons of Education	207
	Leland S. Cogan and William H. Schmidt	
Part III PISA’s Impact Around the World: Inspiration and Adaptation		
11	Applying PISA Ideas to Classroom Teaching of Mathematical Modelling	221
	Toshikazu Ikeda	
12	The Impact of PISA on Mathematics Teaching and Learning in Germany	239
	Manfred Prenzel, Werner Blum, and Eckhard Klieme	
13	The Impact of PISA Studies on the Italian National Assessment System	249
	Ferdinando Arzarello, Rossella Garuti, and Roberto Ricci	
14	The Effects of PISA in Taiwan: Contemporary Assessment Reform	261
	Kai-Lin Yang and Fou-Lai Lin	
15	PISA’s Influence on Thought and Action in Mathematics Education	275
	Kaye Stacey, Felipe Almuna, Rosa M. Caraballo, Jean-François Chesné, Sol Garfunkel, Zahra Gooya, Berinderjeet Kaur, Lena Lindenskov, José Luis Lupiáñez, Kyung Mee Park, Hannah Perl, Abolfazl Rafiepour, Luis Rico, Franck Salles, and Zulkardi Zulkardi	
	About the Authors	307
	Index	315