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International Group for the
Psychology of Mathematics Education**



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**Plenaries, Research Forums, Discussion Groups,
Working Sessions, Short Oral Communications, Posters**

Editors: Helen L. Chick & Jill L. Vincent

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University of Melbourne**

*Proceedings of the 29th Conference of the
International Group for the Psychology of Mathematics Education*

Volume 1

Editors

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INTRODUCTION

We want to thank the following sponsors:

The Australian Government Department of Education, Science and Training, for a generous donation.

The Victorian Government Department of Education and Training, for a generous donation.

The University of Melbourne, for making facilities available.

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The City of Melbourne for support for the Conference Dinner.

WELCOME TO PME29: LEARNERS AND LEARNING ENVIRONMENTS

We are delighted to welcome you to the 29th Annual Conference of the International Group for the Psychology of Mathematics Education, being held in Melbourne, Australia. PME29 is being hosted by the University of Melbourne, and the theme of the conference is *Learners and Learning Environments*. This reflects PME's interest in what it is about learners and the circumstances in which they undertake learning experiences that contributes to the successful learning of mathematics. The talks and papers being presented at the conference will give insight into these important questions. We invite all participants to contribute actively to the discourse and analysis of ideas, so that our understanding is deepened. We also encourage all of you to foster a welcoming and stimulating atmosphere at the conference, that all participants may feel included as members of the PME community. We extend a special "G'day" to those attending their first PME conference. Our hope is that the conference will prove a fruitful learning environment for ourselves as learners.

Many of you will be aware of Australia's simultaneously old and young history. We acknowledge the Wurundjeri people of the Kulin Nations, the traditional custodians of the country on which the university stands. The area around Melbourne and the Yarra River was home to the Wurundjeri people for about 40000 years prior to the arrival of European settlers. In contrast to the thousands of years of indigenous history that contribute to our sense of place and identity, the city of Melbourne is much younger, dating from the 1830s. Its character has been influenced heavily by the gold rushes of the 1850s, and The University of Melbourne dates from this time. Melbourne is now a modern city of about 3.5 million people. Waves of immigration, first from the United Kingdom and Ireland, then post-war refugees from Europe, followed by large numbers of other immigrants, including Italian, Greek, Lebanese and Vietnamese, have given Melbourne a wide diversity of cultures.

The history of mathematics education in Australia is one of growing influence and contribution. The Mathematics Education Research Group of Australasia, whose conference precedes PME this year and whose members have contributed to the PME community over many years, is only a year or so younger than PME itself. Australian mathematics educators hosted PME in Sydney in 1984 and ICME in Adelaide in the same year, and always form a large contingent at international mathematics education conferences. With the conference here in Melbourne, we are grateful to those of you who have made the long journey so often made by Aussies in the opposite direction! We promise to be sympathetic if you are feeling slightly jet-lagged!

The Programme Committee and the Local Organising Committee want to express our thanks for the support we have received from experienced PME people, including previous conference organisers who provided useful information. Chris Breen's quiet wisdom and support have been appreciated, and Joop van Dormolen's encyclopaedic

knowledge of PME has been vital. Their advice, suggestions, encouragement, reminders, and understanding have made life easier for us. Joop's amazing database—a labour of love specially designed to keep track of all the things necessary for a PME conference—has been a wonderful asset and its capacity to do many tasks automatically has helped to reduce the workload of the organisers.

Finally, on a personal note, I would like to thank the many people who have contributed to what I hope will be a very successful conference. The Program Committee, listed in full later, laboured mightily and with care over many important decisions, including the consideration of all the proposals. The Level 7 maths education folk of the Department of Science and Mathematics Education—Kaye Stacey, Lynda Ball, Vicki Steinle, Gloria Stillman, Anne Briner, and Jill Brown—have provided both tangible contributions and a wonderfully supportive environment in which to tackle this task. Kaye's wisdom and experience have been especially valuable. Ela Lugin, Sandra Papa, Craig McBride, and Stephen Goldstraw, together with others in the Department of Science and Mathematics Education, have provided extensive administrative support. Finally, and most importantly, my thanks to Jill Vincent without whom the conference would never have happened: her attention to detail and capacity to keep track of the important things have been incredible.

Helen Chick, Conference Chair

THE INTERNATIONAL GROUP FOR THE PSYCHOLOGY OF MATHEMATICS EDUCATION

History and Aims of PME

PME came into existence at the Third International Congress on Mathematics Education (ICME3) held in Karlsruhe, Germany in 1976. Its former presidents have been Efraim Fischbein (Israel), Richard R. Skemp (UK), Gerard Vergnaud (France), Kevin F. Collis (Australia), Pearla Nesher (Israel), Nicolas Balacheff (France), Kathleen Hart (UK), Carolyn Kieran (Canada), Stephen Lerman (UK) Gilah Leder (Australia), and Rina Hershkowitz (Israel). The present president is Chris Breen (South Africa).

The major goals* of PME are:

- To promote international contacts and the exchange of scientific information in the psychology of mathematics education.
- To promote and stimulate interdisciplinary research in the aforesaid area with the co-operation of psychologists, mathematicians and mathematics educators.
- To further a deeper understanding into the psychological aspects of teaching and learning mathematics and the implications thereof.

PME Membership and Other Information

Membership is open to people involved in active research consistent with the Group's goals, or professionally interested in the results of such research. Membership is on an annual basis and requires payment of the membership fees (AUD\$70) for the year 2005 (January to December). For participants of PME29 Conference the membership fee is included in the Conference Deposit. Others are requested to contact their Regional Contact or the Executive Secretary.

Website of PME

For more information about International Group for the Psychology of Mathematics Education (PME) as an association, history, rules and regulations and future conferences see its home page at <http://igpme.org> or contact the Executive Secretary.

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* Item 2 of the Constitution of PME, <http://igpme.org>

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PME PROCEEDINGS OF PREVIOUS CONFERENCES

PME International

The tables indicate the ERIC numbers of PME conference proceedings.

No.	Year	Place	ERIC number
1	1977	Utrecht, The Netherlands	Not available in ERIC
2	1978	Osnabrück, Germany	ED226945
3	1979	Warwick, United Kingdom	ED226956
4	1980	Berkeley, USA	ED250186
5	1981	Grenoble, France	ED225809
6	1982	Antwerp, Belgium	ED226943
7	1983	Shoresh, Israel	ED241295
8	1984	Sydney, Australia	ED306127
9	1985	Noordwijkerhout, Netherlands	ED411130 (vol.1), ED411131 (vol.2)
10	1986	London, United Kingdom	ED287715
11	1987	Montréal, Canada	ED383532
12	1988	Veszprém, Hungary	ED411128 (vol.1), ED411129 (vol.2)
13	1989	Paris, France	ED411140 (vol.1), ED411141 (vol.2), ED411142 (vol.3)
14	1990	Oaxtepec, Mexico	ED411137 (vol.1), ED411138 (vol.2), ED411139 (vol.3)
15	1991	Assisi, Italy	ED413162 (vol.1), ED413163 (vol.2), ED41364 (vol.3)
16	1992	Durham, USA	ED383538
17	1993	Tsukuba, Japan	ED383 536
18	1994	Lisbon, Portugal	ED383537
19	1995	Recife, Brazil	ED411134 (vol.1), ED411135 (vol.2), ED411136 (vol.3)
20	1996	Valencia, Spain	ED453070 (vol. 1), ED45307 1 (vol.2), ED453072 (vol.3), ED453073 (vol.4), ED453074 (addendum)
21	1997	Lahti, Finland	ED416082 (vol.1), ED416083 (vol.2), ED416084 (vol.3), ED416085 (vol.4)
22	1998	Stellenbosch, South Africa	ED427969 (vol.1), ED427970 (vol.2), ED427971 (vol.3), ED427972 (vol.4)
23	1999	Haifa, Israel	ED436403
24	2000	Hiroshima, Japan	ED452301 (vol. 1), ED452302 (vol.2), ED452303 (vol.3), ED452304 (vol.4)
25	2001	Utrecht, The Netherlands	ED466950
26	2002	Norwich, United Kingdom	ED476065
27	2003	Hawai'i, USA	http://onlinedb.terc.edu
28	2004	Bergen, Norway	

Copies of some previous PME Conference Proceedings are still available for sale. See the PME web site at <http://igpme.org/publications/procee.html> or contact the Proceedings manager Dr. Peter Gates, PME Proceedings, University of Nottingham, School of Education, Jubilee Campus, Wollaton Road, Nottingham NG8 1 BB, UNITED KINGDOM, Telephone work: +44-115-951-4432; fax: +44-115-846-6600; e-mail: peter.gates@nottingham.ac.uk

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No.	Year	Place	ERIC number
2	1980	Berkeley, California (with PME2)	ED250186
3	1981	Minnesota	ED223449
4	1982	Georgia	ED226957
5	1983	Montreal, Canada	ED289688
6	1984	Wisconsin	ED253432
7	1985	Ohio	ED411127
8	1986	Michigan	ED301443
9	1987	Montreal, Canada (with PME11)	ED383532
10	1988	Illinois	ED411126
11	1989	New Jersey	ED411132 (vol.1), ED411133 (vol.2)
12	1990	Oaxtepec, Mexico (with PME14)	ED411137 (vol.1), ED411138 (vol.2), ED411139 (vol.3)
13	1991	Virginia	ED352274
14	1992	Durham, New Hampshire (with PME16)	ED383538
15	1993	California	ED372917
16	1994	Louisiana	ED383533 (vol.1), ED383534 (vol.2)
17	1995	Ohio	ED389534
18	1996	Panama City, Florida	ED400178
19	1997	Illinois	ED420494 (vol.1), ED420495 (vol.2)
20	1998	Raleigh, North Carolina	ED430775 (vol.1), ED430776 (vol.2)
21	1999	Mexico	ED433998
22	2000	Tucson, Arizona	ED446945
23	2001	Snowbird, Utah	ED476613
24	2002	Athens, Georgia	ED471747
25	2003	Hawai'i (together with PME27)	

Abstracts from some articles can be inspected on the ERIC web site (<http://www.eric.ed.gov/>) and on the web site of ZDM/MATHDI (<http://www.emis.de/MATH/DI.html>). Many proceedings are included in ERIC: type the ERIC number in the search field without spaces or enter other information (author, title, keyword). Some of the contents of the proceedings can be downloaded from this site. MATHDI is the web version of the Zentralblatt für Didaktik der Mathematik (ZDM, English subtitle: International Reviews on Mathematical Education). For more information on ZDM/MATHDI and its prices or assistance regarding consortia contact Gerhard König, managing editor, fax: (+49) 7247 808 461, e-mail: Gerhard.Koenig@fiz-karlsruhe.de

THE REVIEW PROCESS OF PME28

Research Forums. The Programme Committee and the International Committee accepted the topics and co-ordinators of the Research Forum of PME29 on basis of the submitted proposals, of which all but one were accepted. For each Research Forum the proposed structure, the contents, the contributors and the role of the contributors were reviewed and agreed by the Programme Committee. Some of these proposals were particularly well-prepared and we thank their coordinators for their efforts. The papers from the Research Forums are presented on pages 1-93 to 1-202 of this volume.

Working Sessions and Discussion Groups. The aim of these group activities is to achieve greater exchange of information and ideas related to the Psychology of Mathematics Education. There are two types of activities: Discussion Groups (DG) and Working Sessions (WS). The abstracts were all read and commented on by the Programme Committee, and all were accepted. Our thanks go to the coordinators for preparing such a good selection of topics. The group activities are listed on pages 1-205 to 1-218 of this volume.

Research Reports (RR). The Programme Committee received 187 RR papers for consideration. Each full paper was blind-reviewed by three peer reviewers, and then these reviews were considered by the Programme Committee, a committee composed of members of the international mathematics education community. This group read carefully the reviews and also in some cases the paper itself. The advice from the reviewers was taken into serious consideration and the reviews served as a basis for the decisions made by the Programme Committee. In general if there were three or two recommendations for accept the paper was accepted. Proposals that had just one recommendation for acceptance were looked into more closely before a final decision was made. Of the 187 proposals we received, 130 were accepted, 26 were recommended as Short Oral Communications (SO), and 18 as Poster Presentations (PP). The Research Reports appear in Volumes 2, 3, and 4.

Short Oral Communications (SO) and Poster Presentations (PP). In the case of SO and PP, the Programme Committee reviewed each one-page proposal. A SO proposal, if not accepted, could be recommended for a PP and vice versa. We received 73 SO proposals initially, of which 59 were accepted and 5 were recommended as posters; later an additional 19 SO proposal were resubmitted from RR. We received 33 initial PP proposals, of which 24 were accepted and 2 were recommended as SO; later an additional 6 PP proposals were resubmitted from RR. The Short Oral Communications and Poster Presentations appear in this volume of the proceedings.

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The PME29 Program Committee thanks the following people for their help in the review process:

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