

PREFACE

This book is the final report of the ICMI study on the Teaching and Learning of Mathematics at University Level. As such it is one of a number of such studies that ICMI has commissioned. The other Study Volumes cover assessment in mathematics education, gender equity, research in mathematics education, the teaching of geometry, and history in mathematics education.

All of these Study Volumes represent a statement of the state of the art in their respective areas. We hope that this is also the case for the current Study Volume.

The current study on university level mathematics was commissioned for essentially four reasons. First, universities world-wide are accepting a much larger and more diverse group of students than has been the case. Consequently, universities have begun to adopt a role more like that of the school system and less like the elite institutions of the past. As a result the educational and pedagogical issues facing universities have changed.

Second, although university student numbers have increased significantly, there has not been a corresponding increase in the number of mathematics majors. Hence mathematics departments have to be more aware of their students' needs in order to retain the students they have and to attract future students. As part of this awareness, departments of mathematics have to take the teaching and learning of mathematics more seriously than perhaps they have in the past.

As a consequence, university mathematicians are more likely to take an interest in mathematics education and what it has to offer. In the past the contact between mathematics educators and practising university teachers had been poor. Thus there is a need to bridge the gap that exists in many countries, between mathematics educators and university mathematicians.

Finally, university mathematicians tend to teach as they were themselves taught. Unless they have a particular interest in teaching they are unlikely to make changes in their teaching or to exchange views, experiences or knowledge with their colleagues at other institutions. Hence this Study was commissioned to provide a forum for discussing, disseminating and interchanging, educational and pedagogical ideas between and among, mathematicians and mathematics educators.

As in every study, an International Programme Committee was appointed by the ICMI Executive Committee to oversee our Study's development. The members of the IPC were

Nestor Aguilera, Argentina
 Michèle Artigue, France
 Frank Barrington, Australia
 Mohamed E.A. El Tom, Qatar
 Joel Hillel, Canada
 Derek Holton, New Zealand
 Urs Kirchgraber, Switzerland
 Lee Peng Yee, Singapore
 Mogens Niss, Denmark
 Alan Schoenfeld, USA
 Hans Wallin, Sweden
 Ye Qi-xiao, PRC.

The progress of ICMI Studies takes the following pattern. Once the IPC is appointed they produce a Discussion Document that contains a discussion of the key issues of the Study. This is widely circulated along with a call for reactions by way of abstracts of papers, proposals, the raising of other issues, etc. The Discussion Document for this Study appeared in the ICMI Bulletin, No. 43, December 1997.

As a result of the submissions, participants were invited to attend the Study conference that took place in Singapore in December 1998. This working conference included plenary sessions, submitted papers, panel discussions and working groups. The conference and the ideas and material developed at the conference forms the basis for this Study Volume. Extra material has been assembled since the conference by a number of authors.

One publication related to this Study, which is not in the general pattern of ICMI Studies, was the publication in February, 2000, of a special issue of the International Journal of Mathematics Education in Science and Technology. Papers produced for this issue were expanded versions of papers given at the Singapore conference.

As I said above, the Study conference was a working conference. It consisted of Plenary Sessions, Panel Discussions and Working Groups. The Plenary Sessions were as follows:

Claudi Alsina: Why the Professor should be a stimulating teacher: Towards a new paradigm of teaching mathematics at university level.

Michèle Artigue: What can we learn from didactic research carried out at university level?

Hyman Bass: Research on university-level mathematics education: (Some of) what is needed and why

Bernard Hodgson: Teaching and learning mathematics at the university level: a personal perspective.

Lynn Arthur Steen: Redefining university mathematics: the stealth campaign.

There were three Panel Discussions. The titles of these and the panel members are listed below.

Secondary/Tertiary Transition

Frank Barrington, Myriam Dechamps, Francine Gransard

Mass Education

Garth Gaudry, Gilah Leder

Technology

Ed Dubinsky, Celia Hoyles, Richard Noss

Finally there were eleven working groups. The Titles and Chairs of these Working Groups are listed below. As the titles alone do not necessarily give a clear view of the area covered we have added some explanation.

Secondary-Tertiary Interface, Leigh Wood and Sol Garfunkel

the interface between secondary and tertiary mathematics learning and teaching; interactions between secondary and tertiary teachers.

Mathematics and Other Subjects, Jean-Pierre Bourguignon

what mathematics is needed in other disciplines; which department should undertake this teaching?

Preparation of University Teachers, Harvey Keynes

what is the role of technology in mathematics education at the tertiary level; what should that role be; what programmes exist that use technology?

Assessing Undergraduate Mathematics Students, Ken Houston

principles and purposes of assessment; methods of assessment; obstacles to change.

Trends in Curriculum, Joel Hillel

what topics are common to many curricula; what changes have occurred in the recent past; what changes are anticipated in the future?

Practice of University Teaching, John Mason

some principles of teaching; examples of innovative practice.

Mass Education, Nestor Aguilera and Hans Wallin

mathematics as a service course; what mathematics do students need; what is a good model for teaching students with a range of abilities and interests?

Preparation of Primary and Secondary Mathematics Teachers, Honor Williams

what is the current state of preparation; how might this change in the future; what is the role of academic mathematicians in teacher preparations?

Policy Issues, Hyman Bass

what are the different means of policy development? how do these affect practice? in what ways can policy be effected?

The Future of Research in Tertiary Mathematics Education, Annie Selden and John Selden.

what research is being and has been undertaken; how can this be translated into practice; what new directions should be explored?

I would like to thank the participants of the various working groups for their input to the Study. In particular, I would like to thank those who made contributions to the working group reports that appear in this volume. Unfortunately there has not been space in this book to mention them all individually.

As the result of the Study conference and reflecting on the issues raised in the working groups and in the more formal sessions, the Study seemed to naturally fall into seven parts, the seven sections of this book. These are an Introduction, Trends in Curriculum and Teaching Practice, Research, Mathematics and Other Disciplines, Technology, Assessment in Tertiary Mathematics Education, and Teacher Education. Each section has been edited by the people named at the start of that section.

Finally, I should like to thank the following people. First, there are the other members of the IPC. Without their considerable help the Study would never have reached the conference stage. They also provided an invaluable initial refereeing of papers for the special issue of the *iJMEST*

Second, I would like to thank Lee Peng Yee and his Local Organising Committee. They worked extremely hard to produce a conference that ran like clockwork but that still had a friendly personal touch.

Third, I would like to thank the conference participants and contributors to this Study Volume. It is their expertise that enabled us to produce a book that provides the latest thinking in a range of aspects of university-level mathematics education.

Then fourthly I am extremely grateful for the contribution of the editors of this Volume. Their knowledge and ability have carried this volume over a wide range of areas to present a thorough overview of the topic, and their individual knowledge and skills have enabled the volume to extend to great depths in all areas of the Study.

Next I would like to thank Leanne Kirk, Lenette Grant and Irene Goodwin for their considerable secretarial help throughout my period of engagement with this Study.

Sixth, I would like to thank the two people who were Executive Secretaries of ICMI during the period of the Study, Bernard Hodgson and Mogens Niss. Bernard shepherded through the Study to its final published form; Mogens was indispensable to me throughout and was always available with wise counsel from the beginning to the end of the project. So much that happened could not have happened without his support and guidance.

Finally I want to thank my wife Marilyn for supporting me through this and many other endeavours.

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