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COMMISSION INTERNATIONALE  
DE L'ENSEIGNEMENT MATHÉMATIQUE  
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*DISCUSSION DOCUMENT FOR THE TWELFTH ICMI STUDY*

THE FUTURE OF THE TEACHING  
AND LEARNING OF ALGEBRA

INTRODUCTION

This document introduces a new ICMI study entitled *The Future of the Teaching and Learning of Algebra*, to be held at the University of Melbourne (Australia) in December 2001. The intention is that the word 'Algebra' will be interpreted broadly to encompass the diversity of definitions around the world, extending beyond the standard curriculum in some countries. It will include, for example, algebra as a language for generalisation, abstraction and proof; algebra as a tool for problem solving through equation solving or graphing; for modelling with functions; and the way algebraic symbols and ideas are used in other parts of mathematics and other subjects. The principal interest of many participants is likely to be related to secondary school mathematics (ages 11–18) and algebra with real variables, but the study is also concerned with tertiary algebra (e.g. linear algebra and abstract algebra) and with algebra and its precursors for young children.

There are many reasons why it is timely to focus on the future of the teaching and learning of algebra. We are at a critical point when it is desirable to take stock of what has been achieved and to look forward to what should be done and what can be done. In many countries, increasing numbers of students are now receiving secondary education and this is causing every part of the mathematics curriculum to be scrutinised. For algebra, perhaps more than other parts of mathematics, concerns of equity and of relevance arise. As the language of higher mathematics, algebra is a

gateway to future study and mathematically significant ideas, but it is often a wall that blocks the paths of many. Should algebra be made more accessible to more students by changing the amount or nature of what is taught? Many countries have already embarked on such changes, hoping to increase access and success. Alternatively, are these changes necessary: is algebra truly useful for the majority of people and, even if it is, will it be useful in the future?

An algebra curriculum that serves its students well in the coming century may look very different from an ideal curriculum from some years ago. The increased availability of computers and calculators will change what mathematics is useful as well as changing how mathematics is done. At the same time as challenging the content of what is taught, the technological revolution is also providing rich prospects for teaching and is offering students new paths to understanding. In the past two decades, a substantial body of research on the learning and teaching of many aspects of algebra has been established and there have been many experiments with adapting curricula and teaching methods. There is therefore a strong scientific basis upon which to build this study.

#### OUTLINE OF THE PROGRAM

The study has two aims: to make a synthesis of current thinking and lessons from the past which will help set directions for future work in the field, and to suggest guidelines for advancing the teaching and learning of algebra. Following the pattern of previous ICMI studies, this study will have two components: an invited study conference and a study volume to appear in the *ICMI Study Series*, which will share the findings with a broad international audience. A report will also be made at ICME-10 in 2004. The study conference program will therefore contain plenary and sub-plenary lectures, working groups and panels. At least two panels are planned. One will attempt to make explicit some perspectives on algebra, algebra activity, algebraic thinking or algebraic understanding. A second aims to highlight the significant differences in algebra education around the world and identify the main strands in the goals, content and teaching methods of this worldwide enterprise. A major part of the working time will be spent in working groups addressing different aspects of the study problem. Working groups are likely to be established to correspond with each of the sections listed below.

#### WHY ALGEBRA ?

The technological future of a modern society depends in large part on the mathematical literacy of its citizens and this is reflected in the worldwide trend towards mass secondary education. For an individual, algebra is a gateway to much of higher education and therefore to many fields of employment. Educators also argue that algebra is part of cultural heritage and is needed for informed and critical citizenship. However, for many, algebra acts more like a wall than a gateway, presenting an obstacle that they find too difficult to cross. This section of the study is concerned with the significance of algebra for the broad population of secondary school students, recognising that regional and cultural differences may impact upon the answers in interesting ways. It addresses questions such as: