Textbook Series Preface

The University of Chicago School Mathematics Project

This textbook is part of a series of foreign mathematics texts that have been translated by the Resource Development Component of the University of Chicago School Mathematics Project (UCSMP). Established in 1983 with major funding from the Amoco Foundation, UCSMP has been since that time the nation's largest curriculum development and implementation project in school mathematics. The international focus of its resource component, together with the project's publication experience, makes UCSMP well suited to disseminate these remarkable materials.

The textbooks were originally translated to give U.S. educators and researchers a first-hand look at the content of mathematics instruction in educationally advanced countries. More specifically, they provided input for UCSMP as it developed new instructional strategies, textbooks, and materials of its own; the resource component's translations of over 40 outstanding foreign school mathematics publications, including texts, workbooks, and teacher aids, have been used in UCSMP–related research and experimentation and in the creation of innovative textbooks.

The resource component's translations include the entire mathematics curriculum (grades 1–10) used in the former Soviet Union, standard Japanese texts for grades 7–11, and innovative elementary textbooks from Hungary and Bulgaria.

The content of Japan's compulsory national curriculum for grades 7–11 is made available for the first time in English, thanks in part to the generosity of the Japanese publisher, Tokyo Shoseki Company, Ltd., which provided the copyright permissions.

Japanese Secondary School Mathematics Textbooks

The achievement of Japanese elementary and secondary students gained world prominence largely as a result of their superb performance in the International Mathematics Studies conducted by the International Association for the Evaluation of Educational Achievement. The Second International Mathematics Study surveyed mathematics achievement in 24 countries in 1981–82 and released its findings in 1984. The results are recapitulated in a 1987 national report entitled "The Underachieving Curriculum: Assessing U.S. School Mathematics from an International Perspective" (A National Report on the Second International Mathematics Study, 1987).

Let us take a brief look at the schooling behind much of Japan's economic success. The Japanese school system consists of a six-year primary school, a three-year lower secondary school, and a three-year upper secondary school. The first nine grades are

compulsory, and enrollment is now 99.99%. According to 1990 statistics, 95.1% of age-group children are enrolled in upper secondary school, and the dropout rate is 2.2%. In terms of achievement, a typical Japanese student graduates from secondary school with roughly four more years of education than an average American high school graduate. The level of mathematics training achieved by Japanese students can be inferred from the following data:

Japanese Grade 7 Mathematics (New Mathematics 1) explores integers, positive and negative numbers, letters and expressions, equations, functions and proportions, plane figures, and figures in space. Chapter headings in *Japanese Grade 8 Mathematics* include calculating expressions, inequalities, systems of equations, linear functions, parallel lines and congruent figures, parallelograms, similar figures, and organizing data. *Japanese Grade 9 Mathematics* covers square roots, polynomials, quadratic equations, functions, circles, figures and measurement, and probability and statistics. The material in these three grades (lower secondary school) is compulsory for all students.

The textbook *Japanese Grade 10 Mathematics 1* covers material that is compulsory. This course, which is completed by over 97% of all Japanese students, is taught four hours per week and comprises algebra (including quadratic functions, equations, and inequalities), trigonometric functions, and coordinate geometry.

Japanese Grade 11 General Mathematics 2 is intended for the easier of the electives offered in that grade and is taken by about 40% of the students. It covers probability and statistics; vectors; exponential, logarithmic, and trigonometric functions; and differentiation and integration in an informal presentation.

The other 60% of students in grade 11 concurrently take two more extensive courses using the texts *Japanese Grade 11 Algebra and Geometry* and *Japanese Grade 11 Basic Analysis*. The first consists of fuller treatments of plane and solid coordinate geometry, vectors, and matrices. The second includes a more thorough treatment of trigonometry and an informal but quite extensive introduction to differential and integral calculus.

Some 25% of Japanese students continue with mathematics in grade 12. These students take an advanced course using the text *Probability and Statistics* and a second rigorous course with the text *Differential and Integral Calculus*.

One of the authors of these textbooks is Professor Hiroshi Fujita, who spoke at UCSMP's International Conferences on Mathematics Education in 1985, 1988, and 1991. Professor Fujita's paper on Japanese mathematics education appeared in *Developments in School Mathematics Education Around the World*, volume 1 (NCTM, 1987). The current school mathematics reform in Japan is described in the article "The Reform of Mathematics Education at the Upper Secondary School (USS) Level in Japan" by Professors Fujita, Tatsuro Miwa, and Jerry Becker in the proceedings of the Second International Conference, volume 2 of *Developments*.

Acknowledgments

It goes without saying that a publication project of this scope requires the commitment and cooperation of a broad network of institutions and individuals. In acknowledging their contributions, we would like first of all to express our deep appreciation to the Amoco Foundation. Without the Amoco Foundation's generous long-term support of the University of Chicago School Mathematics Project these books might never have been translated for use by the mathematics education community.

We are grateful to UCSMP Director Zalman Usiskin for his help and advice in making these valuable resources available to a wide audience at low cost. Robert Streit, Manager of the Resource Development Component, did an outstanding job coordinating the translation work and collaborating on the editing of most of the manuscripts. George Fowler, Steven R. Young, and Carolyn J. Ayers made a meticulous review of the translations, while Susan Chang and her technical staff at UCSMP handled the text entry and layout with great care and skill. We gratefully acknowledge the dedicated efforts of the translators and editors whose names appear on the title pages of these textbooks.

Izaak Wirszup, Director
UCSMP Resource Development Component

FOREWORD TO THE JAPANESE EDITION

This textbook is intended for students who study basic analysis after completing the study of Mathematics 1 in grade 10.

Mathematics was originally linked with science and technology; however, it gradually became independent of science and technology, and present-day mathematicians think freely about virtually everything possible. Therefore, mathematics is said to be a free creation of the human spirit.

On the other hand, mathematics studies mathematical principles which lie behind phenomena in various other fields, as we mentioned in the Foreword to the Mathematics 1 textbook. Therefore, mathematics is useful because it can be applied to other fields. Mathematics is a very important discipline; it is basic for the study of various other sciences.

In Chapter I, Section 1, you will learn about roots and exponential functions and their properties. Logarithmic functions are the inverse of exponential functions. In Section 2, you will study logarithmic functions and their properties.

In Chapter II we will investigate trigonometric functions. Trigonometric functions are an extension of trigonometric ratio, which you studied in Mathematics 1. You will learn about general angles, trigonometric functions and their properties, and the graphs of trigonometric functions in Section 1. The addition theorem for trigonometric functions, which you will encounter in Section 2, is very important.

A progression is a sequence of numbers arranged in accordance with a certain rule. In Chapter III, you will study arithmetic and geometric progressions. Mathematical induction, which you will learn about in Section 2, is the most basic method of mathematical prrof.

Differentiation enables us to find the function which represents the rate of change of a function, while conversely, integration enables us to find the original function, given the funciton representing the rate of change. As a result of the application of differentiation and integration, originated by Newton and Leibniz, science and technology made remarkable progress after the eighteenth century. You will study limits of functions, and basic differentiation and simple applications in Chapter IV.

In Chapter V, you will study integration and its application. For example, in Section 2 you will investigate the calculation of area and volume as an application of integration.

You cannot master mathematics by merely reading books and memorizing; you should think through the material, do calculations, draw figures, and solve problems by yourself. You cannot master swimming by reading books about swimming; you must swim in the water. Similarly, in order to master mathematics, you must think about mathematics by yourself.