social and a moral universe as well as a physical one; the facts of experience with which he starts are found in his relations to his fellows as well as in those of the material world. In these facts, too, he must find laws, and through laws he must pass to the conception of that moral system, in which alone he can find the true freedom of rational and self-realizing activity."

Having set forth his view of the function of logic and of education, Mr. Welton is prepared to discuss their relation to each other. The points which logic emphasizes in educational theory, he says, are (1) 'that all true education must be relative to the society in which it is given'; and (2) 'that logic equally with psychology, teaches the educator that the attainment of knowledge is the result of mental exertion.'

That these are fundamental principles of a rational educational theory, every one will admit. Both deserve strong emphasis; and at the present stage of the development of educational theory, particularly the first. I say particularly the first, because the second has been emphasized from time immemorial, while the first has only recently come to receive the attention it deserves at the hands of writers and speakers on education. Education is primarily a social study, like economics, or government. The development of the individual is fruitless unless it proceeds with constant reference to his membership in the contemporary social organism; and the maintenance, organization, and direction of education constitute one of the most important functions of society.

Both of these points are discussed briefly by Mr. Welton. One finds himself regretting that so little space is devoted to the discussion of these important topics; and the value of the book consists, not in a fresh contribution to educational theory, nor in a discussion of the relation of logic to educational theory; but in the general intellectual stimulus such a book must give to every earnest teacher.

The teacher may learn from this book what knowledge is, and how knowledge is tested and assimilated. But he will not find in it an enumeration of the kinds of knowledge to be sought, nor a discussion of the relative efficacy of different kinds of knowledge in promoting individual and social well being. He will get from it no teaching devices, but he may expect to derive from it valuable assistance toward gradually developing within himself the right professional attitude throughout the whole range of his activity.

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*The Theory and Practice of Interpolation*, including Mechanical Quadrature and other Important Problems concerned with the Tabular Values of Functions, with the requisite tables. By Herbert S. Rice, M.S., Assistant in the Office of the American Ephermis, and Professor of Astronomy in the Corcoran Scientific School, Washington, D. C. Lynn, Mass., The Nichols Press. 1899.

Perhaps the first impression which this book produces is one of surprise that the author has found enough material relating to interpolation to fill 234 pages of small quarto. A brief inspection, however, shows that we have to do with a work dealing with most if not all of the important problems which arise in connection with the formation and use of the numerical tables which play so conspicuous a part in applied mathematics. In short, we find here a development not only of the familiar processes of interpolation, but those of numerical differentiation and integration, with a variety of applications to astronomical and other problems.

The author's preface informs us that he has attempted no marked originality, either in subject matter or method. "Indeed, sufficient has hitherto been written of interpolation, quadratures, etc., to firmly dissuade one from such an endeavor." * * * "But while viewing the matter in this practical sense, the writer regards his work as no mere compilation."

In the development of the subject the derivation and discussion of the important formulæ of Newton, Stirling and Bessel naturally constitute the basis of the structure. As this work progresses we have each important step illustrated by a number of numerical examples, together with the development of such precepts as are important in the practical application. For instance, in the great majority of cases we have to do with numerical quantities which, like the familiar logarithmic and trigonometrical

tables, can only be regarded as approximations to the truth. In arranging the computation of such a series of values it becomes a very practical matter so to select the intervals as to avoid unnecessary labor on the one hand and the possible introduction of inadmissible errors in the interpolated values on the other. We have here the practical rule evolved showing that this may ordinarily be accomplished by choosing our intervals such that differences beyond the fifth order may be disregarded. Of course, in the very uncommon case of a rational integral function we may reach absolute accuracy by carrying our computation to the point where the differences vanish.

The subject of mechanical quadrature is doubtless more familiar to the mathematical astronomer than to any other class of readers. Owing to the convenience and facility with which it may often be applied to the evaluation of definite integrals it seems to deserve a more prominent place in works treating of applied mathematics than is commonly the case. Here we find the processes of both single and double integration very fully developed, based in turn on Newton, Stirling and Bessel's formulæ.

Every one naturally assigns a somewhat exalted position to his own special line of investigation. It is, therefore, perhaps not surprising to find, on page 79, what to some may appear to be a somewhat 'dark saying,' viz: "Interpolation has undoubtedly done more for mathematical science than any other discovery excepting that of logarithms." Not to mention the Arabic system of notation, why may we not with equal propriety make a like assertion in regard to multiplication?

Among the problems solved the following are suggestive:

To solve any numerical equation whatever involving but one unknown quantity.

Given a series of numerical functions embracing a maximum and minimum value. To find the value of the argument which corresponds to the maximum and minimum function.

An appendix deals with symbolical methods. Fifteen pages are given to tables, principally the coefficients in Newton, Stirling and Bessel's formulæ, while two pages devoted to the bibliography of the subject complete the work.

Naturally a treatise like this will interest only a limited class of readers, such as workers and students in astronomy and mathematical physics. To all these it can be cordially recommended.

C. L. DOOLITTLE.

FLOWER OBSERVATORY.

BOOKS RECEIVED.

*Education in the United States.* A Series of Monographs prepared for the United States exhibit at the Paris Exposition, 1900. Edited by NICHOLAS MURRAY BUTLER. Albany, N. Y., J. B. Lyon Company. 1900. In two volumes. Pp. xviii+977.

*Department of Geology and Natural Resources of Indiana.* 1899. W. S. BLATCHLEY. Indianapolis, Wm. B. Burford. 1900. Pp. 1078.

*North America.* RALPH S. TARR and FRANK M. MCMURRY. New York and London, The Macmillan Co. 1900. Pp. xix+469. 75 cts.

*Familiar Fish, their Habits and Capture.* EUGENE MCCARTHY, with an introduction by DAVID STARR JORDAN. New York City, D. Appleton & Co. 1900. Pp. xi+216. $1.50.

*A Book of Whales.* F. E. BEEDARD. New York, G. P. Putnam's Sons; London, John Murray. 1900. Pp. xv + 320.

*Physiology for the Laboratory.* BERTHA MILLARD BROWN. Boston, U. S. A., Ginn & Company. 1900. Pp. v + 167.

*A Brief History of Mathematics.* KARL FINK. Translated by W. W. BEMAN and D. E. SMITH. Chicago, Open Court Publishing Co. 1900. Pp. xi + 333. $1.50.

*Exploitation technique des forêts.* M. H. VANUTBERGH. Paris, Gauther-Villars. 1900. Pp. 176.

*La garance et l'indigo.* GEORGE F. JAUBERT. Paris, Gauthier-Villars. 1900. Pp. 166.

*Lehrbuch der Photochromie.* WILHELM ZENKER. New edition edited by B. SCHWALBE. Braunschweig, F. Vieweg und Sohn. 1900. Pp. xiii + 157.

*Das soziale und sittliche Leben erklärt durch die seelische Entwicklung.* J. MARK BALDWIN. Translated from the second English edition by DR. R. RUEDEMANN, with preface by DR. PAUL BARTH. Leipzig, J. A. Barth, 1900. Pp. xv + 466.

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*SCIENTIFIC JOURNALS AND ARTICLES.*

THE *Journal of the Boston Society of Medical Sciences* for May is more exclusively technical than usual. Harold C. Ernst and W. H.