CONCRETE GEOMETRY FOR BEGINNERS

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Concrete Geometry for Beginners by A. R. Hornbrook

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FOR BEGINNERS

BY

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PREFACE.

"If you will put that into figures for me, perhaps I can understand it," was said to the author of this book by a pupil, who, having tried in vain to grasp a general proposition in demonstrative geometry, sought a kind of assistance which he had found to be useful. In his demand for figures (by which he meant numbers) he was expressing the universal demand of the learning mind for the concrete and the particular, as stepping stones to the abstract and the general.

Much of the material of this book was prepared to meet this demand on the part of the author's own pupils during several years of teaching, and all of it has been subjected to the test of the school-room under plans which encourage on the part of the pupils the freest disclosures of the mental processes induced by the work.

The aim of the work is to awaken gradually, by simple and natural methods, the mathematical consciousness of the child and to guide his perceptions in such a way as to lead him to lay a firm foundation for demonstrative geometry by means of his own observations and inventions. The recognition of different geometric forms and of their numerical relations, and the practicing of the geometric imagination, constitute for children a useful and delightful exercise, which this book is intended to promote.

The author has selected from standard mathematical works the statements of some important facts and principles that are capable of concrete demonstration from the standpoint of the child, and has presented them in various ways and in different relations. Emphasis is placed upon the number relations of geometric forms, as a means of arousing those definite and exact ideas of form that are induced by actual measurements and computations.

As a step towards the correlation of studies which is acknowledged to promote economy in educational effort, the algebraic equation in its simplest forms and uses has been introduced, as

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a convenient instrument for determining values in connection with geometric forms. Teachers who have used the algebraic equation in arithmetical or geometrical work are agreed that its use not only facilitates the work in hand, but that it tends to establish the habit of readily symbolizing the unknown, which is so valuable in mathematical work.

The author has tried, at the expense sometimes of completeness in arrangement, to avoid the pedagogical blunder of putting similars in proximity. Supplement and complement, rhomboid and rhombus, trapezoid and trapezium, are separated in presentation, with the hope that the first one presented will have made an ineffaceable impression of itself upon the mind of the pupil before the other is received.

Although designed especially for use in grammar grades in accordance with the recommendations of the Committee of Ten and with the practice of many of our foremost schools, this book will be found useful for supplementary work for beginners in demonstrative geometry or for a rapid preliminary drill for such students. Too often the pupil who can recite glibly demonstration after demonstration of geometric principles is unable to make the simplest applications of them, a fact which shows that his work in geometry is not accomplishing its object in developing his mathematical powers. The author trusts that the material of this book will be found useful to teachers in helping them to establish in the minds of learners the habit of making applications of mathematical truths.

Grateful acknowledgments for assistance in revising proof sheets and for valuable suggestions upon the work are due to Prof. O. L. Kelso of the State Normal School, Terre Haute, Ind. and to Prof. S. C. Davisson of the Department of Mathematics of the University of Indiana.

Further suggestions and criticisms from teachers will be gladly received. This little book is sent out with the hope that its use may be as enjoyable to other teachers as the writing of it and its applications in the schoolroom have been to the author.

SUGGESTIONS TO TEACHERS.

THE general method of the pupil's work in this book is that of constructing and inspecting geometric forms and of reporting in the language of mathematics the results of the inspection. His success depends very largely upon the teacher.

Experienced teachers do not need to be reminded that great care is necessary in order that each pupil shall construct carefully, inspect thoroughly, and report exactly.

The following suggestions may be found helpful:

Do not attempt to teach without models the measurements of cubes or other solids. While those measurements are very simple when made upon actual solids, it is beyond the power of the untrained geometric imagination to furnish them. The object of this work being to secure clear thinking, the pupil should not be allowed to form and use false or imperfect mental images of geometric forms.

Rulers, protractors, and dividers, or a substitute for them, are an absolute necessity in this work. The units of metric measurement are to be presented objectively. Very cheap rulers showing decimeter, centimeter, and millimeter can be obtained. A meter-stick marked like a yard-stick with divisions should be made and used. A square meter and its sub-

divisions marked on the floor or wall of the schoolroom will furnish the standard of thinking when the metric units of a problem are squares. A convenient form of protractor will be found at the end of this work, which may be detached without injuring the book. It will serve as a general model in the construction of protractors.

All solutions that use superposition as in G.C.M. and L.C.M. should be actually performed by cutting out and superposing until each child knows perfectly the significance of the operations — but no longer. The skill of the teacher in recognizing the moment when the pupil has gained clear and correct concepts of that which he illustrates, and in stopping the processes of illustration before they degenerate into wearisome and time-eating formalities, is like that of the physician who wisely adjusts his treatment of a case to its varying conditions.

The exercise of the geometric imagination should be encouraged by allowing pupils to substitute mental images for physical solids as soon as the teacher is absolutely sure that those images are accurate and complete. It is evident that the establishment of sympathetic relations between teacher and pupil is a very direct means of gaining this assurance and at the same time of facilitating the progress of the learner.

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