INVENTIONAL GEOMETRY: A SERIES OF PROBLEMS INTENDED TO FAMILIARIZE THE PUPIL WITH GEOMETRICAL CONCEPTIONS, AND TO EXERCISE HIS INVENTIVE FACULTY

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Inventional Geometry: A Series of Problems Intended to Familiarize the Pupil with Geometrical Conceptions, and to Exercise His Inventive Faculty by William George Spencer

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WILLIAM GEORGE SPENCER

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WITH A PREFATORY NOTE

BY HERBERT SPENCER.

NEW YORK:
D. APPLETON AND COMPANY,
1, 3, AND 5 BOND STREET.
1881.

PREFACE TO THE AMERICAN EDITION.

This little book, prepared by an experienced mathematical teacher for the use of his own pupils, is based upon the principle that the best and only true education is self-education. It introduces the beginner to geometry by putting him at work on problems which will not only thoroughly familiarize his mind with geometrical ideas, but will exercise, at the same time, his inventive and constructive faculties—a kind of mental practice of much importance, but generally neglected in our schools. These problems, which are simple at first and skillfully graded, the pupil is to solve, himself, without assistance. The author prepared no key to the work, considering that any such help in getting through it would defeat its purpose.

As this little book seems well suited to accompany the 'Science Primers," that are now appearing from time to time, it has been gotten up in the same form, and is included among the American reprints of that elementary series.

The author of this volume of exercises was the father of Herbert Spencer, the eminent philosophical thinker, and whose valuable work on Education has been translated into nearly all the languages of Europe. He cordially commends the method of the "Inventional Geometry" from both observation and experience, as will be seen by the following letter:

NOTE FROM HERBERT SPENCER.

LONDON, *June* 8, 1876.

MESSRS. D. APPLETON & CO.: I am glad that you are about to republish, in the United States, my father's little work on "Inventional Geometry." Though it received but little notice when first issued here, recognition of its usefulness has been gradually spreading, and it has been adopted by some of the more rational science-teachers in schools. Several years ago I heard of its introduction at Rugby.

To its great efficiency, both as a means of producing interest in geometry and as a mental discipline, I can give personal testimony. I have seen it create in a class of boys so much enthusiasm that they looked forward to their geometry-lesson as a chief event in the week. And girls initiated in the system by my father have frequently begged of him for problems to solve during their holidays.

Though I did not myself pass through it—for I commenced mathematics with my uncle before this method had been elaborated by my father—yet I had experience of its effects in a higher division of geometry. When about fifteen, I was carried through the study of perspective entirely after this same method: my father giving me the successive problems in such order that I was enabled to solve every one of them, up to the most complex, without assistance.

Of course, the use of the method implies capacity in the teacher and real interest in the intellectual welfare of his pupils. But given the competent man, and he may produce in them a knowledge and an insight far beyond any that can be given by mechanical lesson-learning.

Very truly yours,

HERBERT SPENCER.

INTRODUCTION.

WHEN it is considered that by geometry the architect constructs our buildings, the civil engineer our railways; that by a higher kind of geometry, the surveyor makes a map of a county or of a kingdom; that a geometry still higher is the foundation of the noble science of the astronomer, who by it not only determines the diameter of the globe he lives upon, but as well the sizes of the sun, moon, and planets, and their distances from us and from each other; when it is considered, also, that by this higher kind of geometry, with the assistance of a chart and a mariner's compass, the sailor navigates the ocean with success, and thus brings all nations into amicable intercourse—it will surely be allowed that its elements should be as accessible as possible.

Geometry may be divided into two parts—practical and theoretical: the practical bearing a similar relation to the theoretical that arithmetic does to algebra. And just as arithmetic is made to precede algebra, should practical geometry be made to precede theoretical geometry.

Arithmetic is not undervalued because it is inferior to algebra, nor ought practical geometry to be despised because theoretical geometry is the nobler of the two.

However excellent arithmetic may be as an instrument for strengthening the intellectual powers, geometry is far more so; for as it is easier to see the relation of surface to surface and of line to line, than of one number to another, so it is easier to induce a habit of reasoning by means of geometry than it is by means of arithmetic. If taught judiciously, the collateral advantages of practical geometry are not inconsiderable. Besides introducing to our notice, in their proper order, many of the terms of the physical sciences, it offers the most favorable means of comprehending those terms, and

impressing them upon the memory. It educates the hand to dexterity and neatness, the eye to accuracy of perception, and the judgment to the appreciation of beautiful forms. These advantages alone claim for it a place in the education of all, not excepting that of women. Had practical geometry been taught as arithmetic is taught, its value would scarcely have required insisting on. But the didactic method hitherto used in teaching it does not exhibit its powers to advantage.

Any true geometrician who will teach practical geometry by definitions and questions thereon, will find that he can thus create a far greater interest in the science than he can by the usual course; and, on adhering to the plan, he will perceive that it brings into earlier activity that highly-valuable but much-neglected power, the power to invent. It is this fact that has induced the author to choose as a suitable name for it, the inventional method of teaching practical geometry.

He has diligently watched its effects on both sexes, and his experience enables him to say

that its tendency is to lead the pupil to rely on his own resources, to systematize his discoveries in order that he may use them, and to gradually induce such a degree of self-reliance as enables him to prosecute his subsequent studies with satisfaction: especially if they should happen to be such studies as Euclid's "Elements," the use of the globes, or perspective.

A word or two as to using the definitions and questions. Whether they relate to the mensuration of solids, or surfaces, or of lines; whether they belong to common square measure, or to duodecimals; or whether they appertain to the canon of trigonometry; it is not the author's intention that the definitions should be learned by rote; but he recommends that the pupil should give an appropriate illustration of each as a proof that he understands it.

Again, instead of dictating to the pupil how to construct a geometrical figure—say a square—and letting him rest satisfied with being able to construct one from that dictation, the author has so organized these questions that by doing justice to each in its turn, the pupil finds that,