A CLASS IN GEOMETRY: LESSONS IN OBSERVATION AND EXPERIMENT

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BY

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A CLASS IN GEOMETRY.

The Study of Geometry can begin with Observation.—The general disfavor with which my schoolfellows used to open Euclid is a vivid remembrance of my boyhood. In vain did the teacher say that geometry underlies not only architecture and engineering, but navigation and astronomy. As we were never given any illustration of this alleged underlying to make the fact stick in our minds, but were kept strictly to theorem and problem, Euclid remained for most of us the driest and dreariest lesson of the week. Not so with me; for geometry was my favorite study, and the easy triumph of leading the class in it was mine. As years of business life succeeded my school days I could not help observing a good many examples of the principles set forth in the lines and figures I had conned as a boy: examples which, had they been presented to my schoolfellows, would certainly have somewhat diminished Euclid's unpopularity. In fulness of time it fell to my lot to be concerned in the instruction of three boys, one fourteen years of age, the second twelve years of age, the third a few months younger. In thinking how I might make attractive to them what had once been my best-enjoyed lessons, I took up my ink-stained Euclid, Playfair's edition. A glance at its pages dispossessed me of all notion of going systematically through the propositions,—which took on at that moment a particularly rigid look, as if their connection with the world of fact and life was of the remotest. Why, I thought, not take a hint from the modern way of studying physics and chemistry? If a boy gets a better idea of an electro-magnet from a real electro-magnet than from a picture, or more clearly understands the chief characteristic of oxygen when he sees wood and iron burned in it than when he only hears or reads about its combustive energy, why not give him geometry embodied in a fact before stating it in abstract principle? Deciding to try what could be done in putting book and blackboard last instead of first, I made a beginning.

A House-lot and Two Fields tell us Much.—Taking the boys for a walk, I drew their attention to the shape of the lot on which their house stood. Its depth was nearly thrice its width, and it was surrounded by a low fence. As we went down the road, in a western suburb of Montreal, we noticed the shapes of other fenced lots and fields. Counting our paces and noting their number, we walked around two of those fields. This established the fact that both were square, and that while the area of one was an acre and a half, that of the other was ten acres. When we returned home I asked the boys to make drawings of the two fields, showing to a scale how they differed in size. [Fig. 1.] This task accomplished, they drew a diagram of the house-lot, and of a square equal in area to the house-lot. With a foot-rule passed around the latter diagram it was soon clear to them that if the four sides of the lot were equal, some fencing would be saved. [Fig. 2.] The next question was whether any other form of lot having straight sides could be enclosed with as little fence as a square. Rectangles and triangles were drawn in considerable variety and their areas computed, only to confirm a suspicion the boys had entertained from the first,—that of lots of practicable form square ones need least fencing. In comparing their notes of the number of paces taken in walking around the two square fields, a fact of some importance came out. While the larger field contained

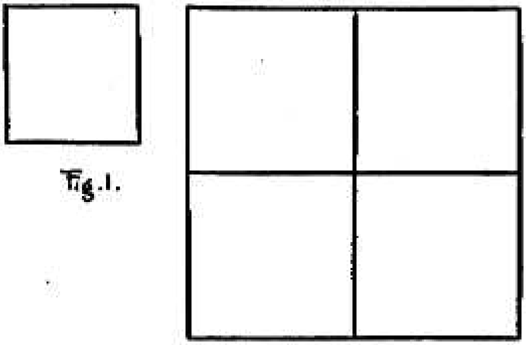

Fig. 1.

nearly seven times as much land as the smaller, it needed only about two and a half times as much fence to surround it. Taking a drawing of the larger enclosure, I divided

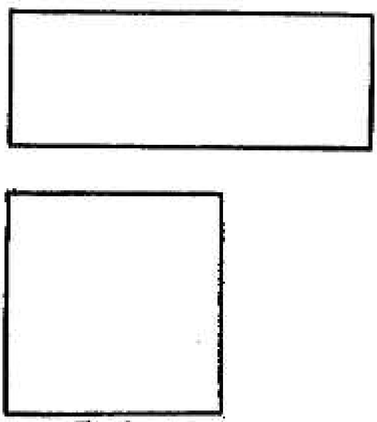

Fig. 2.

it into four equal parts by two lines drawn at right angles to each other. It needed only a moment for the boys to perceive that these lines of division, representing as they did so much new boundary, explained why the small field had proportionately to area so much longer a fence than the large field. [Fig. 1.] A chess-board served as another illustration. With each of its sixty-four squares representing a farm duly enclosed, it was easy to see how a farmer who bought the whole number, were he to combine them in one stretch of land, could discard seven eighths of the fencing. During a journey by steamer from Montreal to Quebec, I directed the boys' attention to the disadvantageous way in which many of the farms had been divided into strips long and narrow. "Just like a row of chess squares run together," said one of the lads.

From Fact to Law.—When a good many examples had impressed our first lesson on their minds pretty thoroughly, I had the boys draw on large sheets of paper two squares, respectively 1 inch and 1 foot in length. Beneath these figures they wrote: "1 inch square has 4 lineal inches for boundary, 1 foot square has 48 lineal inches for boundary; 1 inch square has 1 square inch for area, 1 foot square has 144 square inches for area. Plane figures of the same form have boundaries varying *directly* as their like linear dimensions (length and breadth); they have areas varying as the *square* of their like linear dimensions." It proved, however, that while the boys knew this to be true of squares, they could not at first comprehend that it is equally true of other plane figures. They drew equilateral and other triangles, and in measuring their sides and areas ascertained that they conformed to the rule; but I was taken aback a little when the eldest boy said, "It isn't so with circles, is it?" His doubt was duly removed, but the remark showed how easy it is to make words outrun ideas,—how hard it is for a young mind to recognize new cases of a general law which in other examples is quite familiar.

Cinders Terrestrial and Celestial.—One chilly evening the room in which my pupils and I sat was warmed by a grate-fire. Shaking out some small live coals, I bade the boys observe which of them turned black soonest. They were quick to see that the smallest did, but they were unable to tell why, until I broke a large glowing coal into a score of fragments, which almost at once became black. [Fig. 3.] Then one of them cried, "Why, smashing that

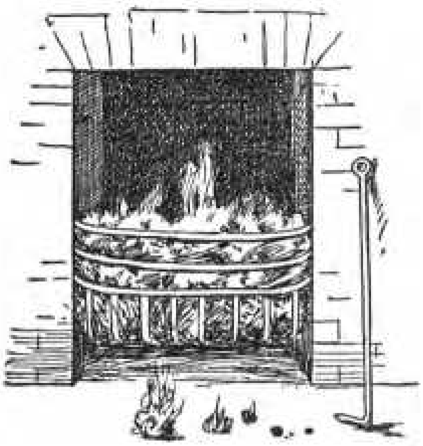

Fig. 3

coal gave it more surface!" This young scholar was studying the elements of astronomy at school, so I had him give us some account of how the planets differ from one another in size, how the moon compares with the earth in volume, and how vastly larger than any of its worlds is the sun. Explaining to him the theory of the solar system's fiery origin, I shall not soon forget his keen delight —in which the others presently shared—when it burst upon him that because the moon is much smaller than the earth it must be much cooler; that, indeed, it is like a small cinder compared with a large one. It was easy to advance from this to understanding why Jupiter, with