mathematicians, however, have always acquired their disciplined powers while in the pursuit of knowledge having intrinsic worth, which indicates that mathematics should be related to actually useful and related things.

The past decade has seen a revolution in the schools. The old-time school with its barrenness of resource has been abolished, and the pupil has been placed in direct contact with all the vital activities of his time. To-day the child thinks through his hands, and it is currently believed that mathematics can play only a limited part in the new education. Yet since the whole universe is a manifestation of energy, mathematics must find its place in every subject. As a matter of fact, it is closely identified with physics and has already found its place in biology, botany, zoology, etc.

A radical change in the usual methods of presenting the mathematical branches must be made. Instead of taking them tandem fashion, the subjects of arithmetic, geometry and algebra must go hand in hand. The child solves the question for himself by introducing them all at once even before he enters school. It becomes then simply a question of assisting the pupil in the further development of the mathematical powers which he began to employ spontaneously before he came to school at all.

To illustrate the preceding principles and methods an outline of some work done in the eighth grade of the University Elementary School (Chicago) is given. The subject was botany and the pupils were allowed to take their time to work out the problems, as their observations demanded. In doing the work, the following principles were observed:

1. There must be a clear, general notion of the image to be developed.

2. There must be a careful selection of appropriate units of measurement.

3. The most expeditious methods of measurement or of applying the units must be chosen. Estimate first; then measure.

4. There must be a careful selection of processes by which the comparisons are made.

5. This must be followed by an objective representation of the results in the form of data obtained by observation. Gallons, quarts, pints, feet, yards, square feet, square yards, acres, miles, etc., must be seen until they become a part of the mental equipment.

6. Using the results obtained as data, a great nature picture must be constructed. That is to say, through the original and primary conception under which the pupil has been working, the real magnitude of world operations should be made to appear in definite quantitative results.

To illustrate these principles, the dispersal of seed was chosen as subject matter. The observation material in this case was found in a vacant city lot adjoining the school, and by extending the calculations to allied subjects, such as the amount of solar radiation, and of annual rainfall, the fundamental operations of arithmetic were thoroughly covered. The details of the work are fully explained in the last-mentioned article.

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WILLIAM EIMBECK, 1841–1909[1]

Mr. William Eimbeck, the subject of this sketch, and myself were close friends for many years. His ambitions were well known to me, and I am very well aware that his failure to attain the final success he had hoped for was due to an organic disease which slowly crept upon him during the later years of his life.

[1] Memorial address before the Philosophical Society of Washington, May 22, 1909.

He was born January 29, 1841, in Brunswick, Germany, and beginning his education in the public schools and gymnasiums of his native city, he came to the United States at an early age and completed his training as civil engineer under private instruction in St. Louis. His first professional experience was in connection with the building of the Eads bridge at St. Louis, and in the offices of the St. Louis City and County Engineers. Later for two years he was professor of mechanics and civil engineering in Washington University.

In 1869 Professor J. E. Hilgard, the assistant in charge of the Coast Survey, and later its superintendent, had organized a series of parties to observe the solar eclipse of August 7 of that year. Mr. Eimbeck was an enthusiastic volunteer observer and was assigned to the party of Julius Pitzman, county engineer of St. Louis, and stationed near Mitchell, Ill. After the eclipse he took part in the determination of the latitude and longitude of St. Louis, and the connection of the various eclipse stations in Missouri and Illinois with this base station. His enthusiasm and success in this work led to his selection as an observer in the expedition organized by Professor Benjamin Peirce, then superintendent of the Coast Survey, to go to southern Europe to observe the solar eclipse of December 22, 1870. Mr. Eimbeck was assigned to the party of Professor C. H. F. Peters, the distinguished astronomer, with whom he observed the eclipse on Monte Rosso near Catania in Sicily. His ability, acquirements and enthusiasm displayed on these two expeditions led to his appointment on the Coast Survey, July 1, 1871, and his connection with it continued for thirty-five years.

His first assignment was to one of the triangulation parties on the survey along the thirty-ninth parallel of latitude which was operating in Missouri, extending the work westward from the base in the Great American Bottom opposite St. Louis; and later he was engaged in astronomical duties in connection with determination of latitudes, longitudes and azimuths in Kansas, Texas and Louisiana.

In 1872 he was assigned to the Pacific coast and for five years was engaged in astronomical and primary triangulation work along that coast from Oregon to the entrance of the Gulf of California; one of his undertakings being a determination of the geographical coordinates and magnetic elements at thirteen stations between San Diego and Cape San Lucas for the control of the survey of the coast and Lower California then in process of execution by the Navy Department. In 1872 in the superintendent's report is an evidence of the thorough spirit in which he entered upon securing a thorough command of all the details of the scientific operations upon which he was engaged, this being shown by his paper suggesting improvements in the Hipp chronograph then used in connection with the telegraphic longitude operations.

In 1877 he returned to the eastern coast, where he was assigned to an extensive astronomical and magnetic campaign for determination of latitudes, longitudes and the magnetic elements in Kentucky, Illinois, Tennessee, South Carolina and Georgia, and later, after making the necessary preparations, in 1878 he was again assigned to the western coast and began at Pah Rah in Nevada the extension of the primary work eastward from the coast triangulation, which was to follow approximately the thirty-ninth parallel of latitude to the capes of Delaware. This was the inception of what was to be the main life work of Mr. Eimbeck and to which for eighteen years he gave all that was best in both mind and body. Stretching from the Sierra Nevadas to Pikes Peak and the east line of the Rocky Mountains, and including in its list of occupied stations mountain peaks reaching an elevation of 14,400 feet, in regions where supplies had to be carried for hundreds of miles through deserts and wastes, destitute of roads and almost destitute even of water; the successful conduct of this work called for the endurance of the most rugged of pioneers, the undaunted courage of the explorer, while the operations represent the highest type of

work demanded from the scientist and observer. In this triangulation one line, observed in both directions, is over 183 miles long and is not exceeded in the work of any country.

There are two instances where the change between adjoining stations necessitated a journey of 300 miles, one of these being the transfer of parties from Mount Ellen to Mt. Tavaputs, made under fierce suns of August and September, across a desert section which tested almost to their limits the endurance of the men and animals, and it is remarkable to relate that in his most expansive moments Eimbeck never seemed to consider that any special merit could be claimed for successfully overcoming all these hardships and dangers. A reference to the annual report of the superintendent will emphasize this feature of our friend's character, as therein will be found only a simple statement of the work completed each year, because of the modesty which would not permit him to give adequate account of the toils he faced and conquered.

Near the close of this great triangulation, Mr. Eimbeck designed the duplex base apparatus which was constructed at the Coast and Geodetic Survey Office and used by him in the measurement of the Salt Lake base.

In addition to the field work upon which he was so actively engaged, he was always deeply interested in every branch of the work of the survey, and specially those pertaining to geodesy. In 1900 he undertook an elaborate series of experiments for the study of the seasonal range in the value of the coefficient of refraction, but a final report was never received from him; although he made several announcements of the satisfactory progress he was making in the perfection of a theory for this important term. His study of the question of the existence of sensible tides in the earth's surface had also occupied his attention for many years and was the object of study with him up to his last days. It is known that he gave profound study to the problems of the tides, gravity, the causes of the variations of latitudes, etc., and it is also known from his own statements that he was preparing his theories for publication. The most frequent references to Mr. Eimbeck by his intimate associates are appreciations of his suggestive and illuminating discussions of many of the problems that attract the physicist and astronomer, and all the problems to which the geodesist gives attention.

In appearance Mr. Eimbeck was the elegant and distinguished gentleman. Tall, erect, of fine proportions and handsome features, he was often admired as he walked the streets of Washington carrying an overcoat on his arm, which he disdained to wear even in the coldest weather. In his early days he was of robust health, but as early as 1890 he began to complain that he could no longer endure either the physical or mental strain of former years. A few years later he thought he had Bright's disease, but would not consult a physician. This disease, with the complications that so frequently come with it, slowly crept upon him, till in 1906 he resigned from the survey, hoping a life free from care would improve if not restore his health. It was too late—he gradually failed, and finally on March 27, 1909, his death resulted from a stroke of paralysis.

Mr. Eimbeck was a founder member of the Cosmos Club, for thirty years a fellow of the American Association for the Advancement of Science, a member of the Washington Academy of Sciences, of the National Geographic Society, of the Geological Society and of the Washington Philosophical Society.

In closing this sketch of the life of Mr. Eimbeck, I wish to quote from a little notice that was issued to the members of the Coast and Geodetic Survey a few weeks since:

> A lifetime of study and research added to charming natural eloquence and marked clarity in exposition made Mr. Eimbeck one of the most interesting and instructive companions, these distinguished qualifications being set off by a modesty as extraordinary as the merits it failed to obscure. Broad and tolerant in his sympathies and with no thought for self in his generosity to the unfortunate, the life just closed is one that can justly claim only praise when it is referred to; and affection when it is recalled.

Edwin Smith