CATHARINE BEECHER, AMERICAN PIONEER IN MATHEMATICS EDUCATION

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A surprisingly large number of ideas in education, including the teaching of mathematics, that have determined the way we teach today, and that point the way toward the future, can be traced back to the influence of Catharine Beecher, one of the great pioneers in education for women in the United States. Significant as were her many contributions to education, Catharine Beecher has not been appreciated as much as she should have been for the very improbable but true reason that two other members of her immediate family were even more famous -- her brother, Henry Ward Beecher, an eloquent and dramatic Protestant pastor, and her sister, Harriet Beecher Stowe, the author of *Uncle Tom's Cabin*.

Catharine Beecher was born on Long Island, New York, on September 6, 1800. Her father, Lyman Beecher, was a Congregational Church minister, who became famous as a revivalist. Catharine was the oldest of 13 children in this remarkable family. Her mother had a great deal of natural ability in mathematics and logic, and solved mathematical problems because she enjoyed the mental effort. Fortunately, Catharine's early education was undertaken by her mother and aunts, and included more arithmetic than was usual for girls.

In 1810, the family moved to Litchfield, Connecticut. Catharine was sent to an academy for a short period, but did not feel she had learned very much. Her mother died when Catharine was only 16, but she immediately took on the responsibilities of womanhood, taking care of her younger brothers and sisters and making the family clothes.

The picture of women's education in the United States prior to 1820 is discouraging. There was free elementary education in New England in town schools only, but just a few academies throughout the nation were open to girls. New "female seminaries" were being opened, but often they were taught by women with very little education themselves, and were expensive to attend. The concept of free public high school education had not yet been accepted, and there was no university education for women at all.

By the age of 20, Catharine had decided to prepare herself to become a teacher. Two years later, she completed her preparation for teaching what was then called the "higher branches" by spending the winter with a friend who tutored her. One of the texts she studied was Daboll's Arithmetic. At first she found mathematics difficult and somewhat uninteresting, but the practical usefulness of the subject appealed to her and stimulated her to master it. She felt her domestic training had formed the habit of asking why any practical operation was to be performed, so she bagan to annoy her mathematics tutor by asking why the figures were put in a certain place, or why a certain answer was found. During this period she acquired an interest in really understanding the principles of arithmetic, and it was this abiding interest that eventually led her to publish an arithmetic text of her own. She also studied Day's algebra, some geometry and some logic, as well as many other subjects in addition to mathematics.

After this final year of preparation, Catharine and one of her sisters opened a school for girls in Hartford, Connecticut. Although they soon had nearly a hundred girls, they had only one room, with very little equipment. Catharine was an outstanding success as a teacher, and the quality of education received by the girls in her school was far superior to that in most female seminaries.

Catharine had fallen in love with a young Yale professor named Alexander Fisher, a mathematician and philosopher, and they were engaged to be married. But unfortunately, the happiness in her personal life was shortlived, for in 1823 her fiance was killed in a shipwreck off the Irish coast. This loss was a devastating blow to Catharine, and she never married. As in the period following the death of her mother, she found consolation in an extremely heavy work load.

Many modern educational ideas having particular significance in mathematics can be traced back to Catharine Beecher. She was one of the first to divide students below college age into smaller classes, approximately equal in achievement and who were taught by teachers who were expected to teach only two of three subjects, not all the subjects as was then common at this level. She also used the most able pupils as assistants. She herself trained her teachers in methods of instruction, because she realized that her teachers needed to learn methods as well as content, and there were no teacher-training institutions they could attend.

In the administration of her school, Catharine's ideal was a division of work and responsibility similar to that of a college. Her goal was a "faculty of coequal teachers," who would share all the responsibility of administration and would decide on new policies by majority vote. She also believed that the teaching load should be reduced so the teachers would have time for self-improvement and for bettering their departments.

As a result of years of overwork and a weak constitution to begin with, Catharine eventually suffered nervous prostration that forced her to withdraw from leadership of her school. Not long after, her father moved to Cincinnati, Ohio, considered in the West at that time, and she moved with the family. Her fame as a teacher had preceded her, and in spite of her recent illness she soon was asked to establish a higher school for girls. Within a short time she had set up the Western Female Institute, with four teachers in a coequal plan. As expected, they had more girls who enrolled than they had space. The expanded curriculum of this school included calisthenics classes, because Catharine Beecher was one of the first to advocate physical education for women. During this period she also wrote books on "domestic economy," and is recognized as one of the originators of home economics departments in schools.

Catharine Beecher was one of the first American women to write a text in the field of mathematics. Her text on arithmetic, called Arithmetic Simplified, was first published in 1832. It was successful to some extent, but the publisher did encounter resistance because it was written by a woman. The text was republished anonymously as The Lyceum Arithmetic three years later, with the comment, "By an Experienced Teacher," to avoid any complaints.

In the preface of Arithmetic Simplified, Catharine discussed some of the common problems in arithmetic texts and how her book avoided them. To solve the problem of a variety of ages and intellects of students, Catharine published Arithmetic Simplified in three parts. The first part was for young children, the second part for older classes, and the third part was a complete system of arithmetic containing everything needed to enter college.

Arithmetic Simplified contained an interesting sequence of topics, different from the typical modern order. Instead of presenting all the operations for whole numbers, then for fractions and decimals, the text first had addition for whole numbers, fractions and decimals, then subtraction for each type of number, and so on. Two other innovations that were new ideas at the time were that oral and written exercises appeared on the same page, and an attempt was made to give the reason for each rule. Although ideas of number properties were not employed, of course, this insertion of reasons anticipated the modern idea of teaching for meaning.

Arithmetic Simplified began with tables in front, rather than in the back. Besides questions on the four operations, the short first part included reduction (changing units). The second part began with numeration -- whole numbers, vulgar (common) fractions and decimals, then introduced the operations. Part 3 extended the numeration to Roman numerals and a brief discussion of other bases (called the radix of the system). After the four operations and reduction, part 3 went into many other topics of higher arithmetic, including interest, stocks, insurance, commission, loss and gain, duties, equations of payments, ratio and proportion, fellowship (partnership gains and losses), alligation (mean value of a mixture), duodecimals, involution (squaring), evolution (finding roots), progressions, annuities, and permutations.

From this listing of topics, one may find it difficult to believe her text was written as early as 1832. The order of presentation within many topics is also quite modern. For example, division in which the dividend only is a fraction appears on pages 137-141. The first pages are a discussion and questions. The rule, followed by exercises, is not stated until page 140. This development contrasts with a typical sequence in books of that period that begin with the rule.

One of Catharine Beecher's great dreams, going far beyond her interest in mathematics or any other single subject, was improvement in teacher education. She traveled, lectured, and wrote to organize societies to train teachers. Her plan was to secure educated and trained women in the established East to act as missionary teachers in the West and South. Another of Catharine's plans was to establish new higher schools for women on the college model in various cities in what was then the West. She hoped to organize these schools with a faculty of coequal teachers. Several such schools actually were established, the most successful probably being Milwaukee Female College in Wisconsin.

CATHERINE BEECHER

(Caption: Catharine Beecher, from Willystine Goodsell, Pioneers of Women's Education in the United States. Reprinted by AMS Press, Inc., New York.)

In her old age, Catharine lived in Elmira, New York. She died on May 12, 1878. Over a hundred years after her death, some of her ideas still seem current in mathematics classrooms. She believed in using "objects of sight" in mathematics instruction, or visual aids, as we could call them. Rather than the prevalent practice of memorizing the book, she advocated doing most operations in arithmetic, geometry, and algebra with chalk on the black boards. She suggested these should be placed around the room, a very advanced idea at that time. In arithmetic, she felt that students should not only be able to calculate the answers, but that they should understand what they were doing. They should understand everything so well that they would be able to explain it very carefully to others. She felt the ability to communicate using the language of mathematics was the sure sign of sufficient understanding.

A few of Catharine's views were so advanced for her time that they still sound idealistic. For example, her dream of coequal teachers continues to elude us. As a second example, more significant to mathematics teachers, she was a firm believer in small classes. She felt that in such subjects as arithmetic, geometry and algebra, from <u>six</u> to <u>ten</u> students were as many as one teacher could profitably instruct in one class.

Catharine Beecher was a great pioneer in education for women, and mathematics education is only one of several subjects in which she deserves some recognition. Even though it is rarely acknowledged, her spirit lives on in the work of mathematics teachers today.

BIBLIOGRAPHY

Beecher, Catharine E., Arithmetic Simplified, Prepared for the Use of Primary Schools, Female Seminaries, and High Schools, Hartford: D. F. Robinson and Company, 1832.

Beecher, Catharine E., Educational Reminiscences and Suggestions. New York: J. B. Ford and Co., 1974.

Beecher, Catharine E., The Lyceum Arithmetic. Boston: William Pierce, 1835.

Beecher, Catharine E., Suggestions Respecting Improvements in Education. Hartford: Packard and Butler, 1829.

Cross, Barbara M., The Educated Woman in America. New York: Teachers College Press, 1965.

Goodsell, Willystine, Pioneers of Women's Education in the United States. New York: McGraw-Hill Book Company, 1931.

Harveson, Mae E., Catharine Esther Beecher, Pioneer Educator. Lancaster, PA: The Science Press Printing Company, 1932. Reprinted by Arno Press and the New York Times; New York. 1969.