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MATHEMATICS: CONTRIBUTIONS BY WOMEN

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Summary

Neither history nor a liberal arts education gives much recognition to mathematicians — regardless of their sex. Therefore it is not surprising that women have had almost no recognition in a field where men have had so little. It has been argued that this helps perpetuate the impression that math is a male domain. To combat this myth the author has developed a course for liberal arts students that includes the study of the biographies of 12–14 women mathematicians and of mathematical topics related to their work. In addition, math anxiety, math avoidance and sex-related differences in mathematics learning are investigated. At Loyola Marymount University this course can count toward the science core curriculum requirement or as a core course in the women's studies program. This paper will describe the course and provide information, resources, and an annotated bibliography useful for making students more aware of women's contributions to mathematics.

Neither history nor a liberal arts education gives much recognition to mathematicians — regardless of their sex. College students taking calculus can rarely identify Gauss, Cauchy, Euler, or Hilbert, although they are mathematical equivalents to Tolstoy, Beethoven, Rembrandt, Darwin, and Freud. Very few mathematicians have fame comparable to that of their counterparts in other disciplines. Usually, when asked to name some famous mathematicians, college calculus students can only manage to recall 2 or 3 of Einstein, Euclid, Pascal, and Newton. Therefore it is not surprising that women have had almost no recognition in a field where men have had so little.

There are a number of women who have made substantial contributions in mathematics. Yet they are rarely mentioned in history of math texts. Often when they are mentioned, it is for their non-mathematical activities which involved famous men. That so few women receive credit for their accomplishments in math helps perpetuate the myth that math is a male domain.

To combat this myth, the author developed a college level course for liberal arts students that includes the study of the biographies of 9 women mathematicians born before the twentieth century and 4 twentieth century women mathematicians along with mathematical activities related to their work. The course fulfills a science core requirement for liberal arts students and is a recognized elective for the women's studies program. It is designed to:

- (1) give non-science majors a new insight into mathematics as a creative art and science;
- (2) give students some experience of the kinds of investigations that make mathematics so fascinating to mathematicians;
- (3) improve attitudes towards mathematics;
- (4) change the impression that math is a male domain.

The course, entitled *Mathematics: Contributions by Women*, alternates math activities with readings of the biographies of women mathematicians and discussions of the causes of math anxiety and math avoidance. Through activities students survey a broad range of topics in mathematics, including conic sections, functions, limits, velocity, Venn diagrams, the cycloid curve, finite differences, modular arithmetic, and groups. (See the Appendix for a more complete list of the mathematical topics covered.) The presentations are given at a level requiring minimal math background. In addition, through readings and discussion, students examine questions, such as:

- Why are so few women mathematicians known?
- Can one delineate common experiences in the lives of women who have been successful in a stereotypically male field such as mathematics?
- Are males better at math than females are?
- Do males like math better than females do?
- Has math education and counseling been different for females?

The course has been advertised as being a good choice for anyone who feels insecure with mathematics and usually attracts 2 or 3 re-entry women in a class of 20-25.

The workload is substantial: homework and weekly quizzes on mathematical content; 2 papers; 2 hour exams and a final exam; and a special project. The special project, chosen by the student in consultation with the instructor, involves one of the following: researching a mathematical topic, such as how honey bees navigate by polar coordinates; undertaking a program of study to improve basic math skills or decrease math anxiety; or reporting on psychological or sociological aspects of math avoidance or math anxiety.

There are two factors that make teaching this course difficult. One is that selecting interesting mathematical topics and presenting them at a level accessible to a group of students with a wide range of mathematical backgrounds is a challenge. The other has to do with the one or two males who enroll. It is not easy to get them truly engaged in the discussions.

Perhaps because of its challenges, there can be great satisfaction in teaching this course. Through the discussions, papers, and the selection and work on the special projects, the instructor gets acquainted with students on a more personal level than is usual in a typical mathematics class. The students also appear to benefit from this deeper involvement as is evidenced by the following quotes from evaluations. "I have enjoyed the class tremendously. Now, I don't hate math anymore like I did when I entered college." "I'm not as afraid and seem more relaxed taking math related exams." "I think now that anyone can learn to do math — it just takes some longer." "I feel that I have learned to appreciate the advances that have been made."

Try to imagine getting comments like these from students at the end of a traditional calculus class!

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APPENDIX

(The numbers in parentheses refer to the attached bibliography.)

0. The Problems of Math Anxiety and Math Avoidance (9, 11, 34, 35)
- I. Hypatia 370-415 A. D. (17, 24, 27) (Greek mathematician, inventor, philosopher, teacher, textbook author)
 - A. Related mathematical topics
 1. Conic sections as the intersection of a plane and a cone. (27)
 2. Conic sections as paths of points subject to certain distance conditions. (27)
 3. Diophantine equations: How many ways can you make change for a dollar using nickels, dimes, and quarters? (23, 27)
- II. Emile du Chatelet 1760-1749 (8, 21, 24, 27) (Expositor of Newton's *Principia*)
 - A. Related mathematical topics
 1. Function machines (27)
 2. Velocity — average and instantaneous (27)
 3. Limit concept (27)
- III. Maria Agnesi 1718-1799 (24, 27) (Translator, textbook author, servant of the poor)
 - A. Related mathematical topics
 1. Cartesian coordinate system (27)
 2. Symmetry and graphing (27)
 3. Witch of Agnesi curve (10, 27)
- IV. Sophie Germaine 1776-1831 (24, 27) (Researcher in number theory and mathematical physics, winner of grand prize in French Academy of Science Contest)
 - A. Related mathematical topics
 1. Number bases
 2. Clock arithmetic (27)

3. Minimal surfaces — Soap film demonstration (23, 27)
 4. Related geometric constructions (27)
- V. Mary Somerville 1780–1872 (24, 26, 27) (Popular science writer)
- A. Related mathematical topics
 1. Cycloid curve (2, 10, 27)
- VI. Ada Byron Lovelace 1815–1852 (22, 27, 32) (“Mother” of computer programming)
- A. Related mathematical topics
 1. Functions (27)
 2. Difference Tables (27)
 3. Applications to various puzzles (27)
- VII. Sonya Kovalevskaya 1850–1891 (5, 13, 18, 20, 24, 27, 29) (Researcher in applied mathematics, recipient of Prix Bordin by French Academy of Science, autobiographer)
- A. Related mathematical topics
 1. Infinite sequences (27)
 2. Geometric series (27)
 3. Chain letters
- VIII. Grace Chisolm Young 1868–1944 (27) (First woman to receive a formal doctorate in any subject in Europe, geometer, textbook author)
- A. Related mathematics topics
 1. Paper-folding approach to geometry (37)
 2. Binary number system and “mind reading cards” (27)
 3. Regular polyhedra (23)
 4. Euler’s formula (23)
- IX. Emmy Noether 1882–1935 (3, 7, 16, 24, 27) (“Mother” of modern algebra)
- A. Related mathematical topics
 1. Groups (27)
 2. Flexagons (25)
- X. Other Twentieth Century and Living Women Mathematicians (1, 4, 6, 12, 14, 15, 28, 29, 31, 33, 36, 38)
- Lenore Blum (28)
 - Grace Hopper (38)
 - Cathleen Morawetz (19)
 - Mina Rees (6)
 - Julia Robinson (30)
 - Mary Ellen Rudin (1)
 - Charlotte Angas Scott (15)