Women and Minorities in Mathematics

Incorporating Their Mathematical Achievements Into School Classrooms

Putting the Model in Mathematician Role Models

Sarah J. Greenwald
Jill E. Thomley
Appalachian State University

The National Council of Teachers of Mathematics suggests that ``Students should have numerous and varied experiences related to the cultural, historical, and scientific evolution of mathematics so that they can appreciate the role of mathematics in the development of our contemporary society and explore relationships among mathematics and the disciplines it serves.'' (National Council of Teachers of Mathematics, 1999) Previous articles in this column have showcased classroom use of the lives and work of a woman or minority mathematician (Greenwald, 2006). This article is devoted to broader reflection about mathematician role models in the classroom.

Where do our students get their impressions of what mathematicians are like? Numerous women mathematicians, including one of the co-authors, have been told they don't look or sound like a mathematician. From research ``We know that many students perceive mathematics as a discipline that is done by others rather than people like themselves. The `others' may be the smartest students (Oakes 1990), boys (Meyer and Koehler 1990), or specific ethnic groups (Moody 1997).'' (Wilson & Chauvot, 2000) While the importance of role models is well documented, students would probably place examples of exceptional women mathematicians such as Emmy Noether firmly into the category of `others' who do math, and some authors note that these kinds of exceptional mathematicians can have negative influences on perceptions (e.g., Lynch, 2001). Nancy G. Leveson, a professor of computer science and engineering has said:

> *A well-documented phenomenon called the ``imposter syndrome'' with an accompanying fear of being ``found out'' is found in much higher percentages of women and minority students... White males have lots of successful men with whom they can identify - they benefit from the self-reinforcing concept that they ``belong.'' On the other hand, women and minorities have few role models who have been successful before them, and they often feel like outsiders.* (Leveson, 1990)

Jocelyn Steinke, a professor of communication with specialties in science communication and the images of women scientists in the mass media, asserts that in the absence of real-life role models, children will construct mental models of women in science from the images they see in the popular media. She analyzed various portrayals of women scientists in television and film (Steinke, 1998, 1999, 2005). In one case study she used a framework of five themes derived from gender theory and previous literature on the experiences of women scientists in the United States: early encouragement in science, professional status, professional reputation, professional

relationships and the impact of personal relationships on professional goals.

Some of Steinke's themes are similar to concepts included in the Fennema-Sherman mathematics attitudes scales (Fennema & Sherman, 1976), which assess several components deemed by mathematics educators as critical for success in math: attitude towards success in mathematics, mathematics as a male domain, mother/father support, teacher support, confidence in learning mathematics, mathematics anxiety, motivation for challenge in mathematics, and mathematics usefulness. In a more recent presentation Fennema discussed perspectives from many different fields regarding gender equity in mathematics and science, emphasizing the importance of using multiple approaches to further our understanding, and to address the questions about girls' study of and participation in mathematics (Fennema, 2002).

However, exposing students to role models who satisfy Steinke's and Fennema-Sherman's criteria will not necessarily result in a corresponding increase in the number of students who see themselves as part of the ``in-group'' who can be successful in mathematics. In its annual review of literature on women in engineering, the Society of Women Engineers (SWE) notes, ``Simple one-shot exposure is probably not enough to get more girls involved in engineering programs. If that were true, then we would expect to see young female fans of *Star Trek Voyager*, with its strong female engineering characters, flocking to the field.'' (Frehill, 2006) The authors would go a step further and assert that for maximum benefit, students also need to be able to personally identify with mathematicians. In other words, they need both to see people who are ``like them'' doing mathematics in the same ways they do and to connect with them on a personal level.

The authors have applied all of these criteria in examining the representations of mathematically talented women in Hollywood (Greenwald & Thomley, 2006) and in developing a classroom segment on *What is a Mathematician?* (Greenwald, 2005). As one student remarked,

> *I thought that it was great that my mathematical style was so close to hers. It made me appreciate her way of thinking better, as well as my own way of thinking. I had never before really labeled my train of thought, but because of our studies I am aware of the way my mind works, and I find it very handy when I come across difficulties that I must deal with. Thanks!*

Many students only know about scientists and mathematicians from popular TV and movies. The purpose of these types of programs is to entertain, and fictional shows should not necessarily be held to some kind of role-model standard; instead it is our responsibility as educators to be proactive about these representations and to make an effort to include real-life history or other role models to balance these stereotypes. Any individual mathematician is likely to be a poor role model for the entire set of criteria presented here, because the issue of identification is very complex. Biographies and interview comments rarely address all of the points, and even if they did, students are likely to respond based on their own experiences; what inspires one student may not interest another. In order to ensure that all of our students will see themselves as part of the ``in-group'' who is capable of succeeding in mathematics, we can expose students to numerous role models with diverse styles and lives who collectively earn high marks (see Mathematician Role

Model Checklist). It is not only our students who benefit, as the future of our country ultimately depends on our ability to attract and retain talented people in science and mathematics.

References

Fennema, E. (2002). Gender Equity for Mathematics and Science (invited faculty presentation) [On-line]. Available: http://www.woodrow.org/teachers/math/gender/02fennema.html

Fennema, E. and Sherman, J. (1976). Fennema-Sherman Mathematics Attitudes Scales: Instruments Designed to Measure Attitudes Toward the Learning of Mathematics by Females and Males. *Signs: Journal of Personality and Social Psychology,* 7(5), 324-326.

Frehill, L et al., (2006). Women in Engineering: A Review of the 2005 Literature. *Magazine of the Society of Women Engineers*, Summer, 1-18.

Greenwald, S.J. (2005). Incorporating the Mathematical Achievements of Women and Minority Mathematicians into Classrooms. In R. Jardine & A. Shell-Gellasch (Eds.), *From Calculus to Computers: Using the Last 200 Years of Mathematics History in the Classroom*. Washington, DC: Mathematical Association of America [Reprinted On-line]. Available: http://www.mathsci.appstate.edu/~sjg/history/womenrecenthistory2.pdf

Greenwald, S.J. (2006). NCCTM Centroid Columns and Classroom Activity Sheets. Available: http://www.mathsci.appstate.edu/~sjg/ncctm/activities/

Greenwald, S.J. & Thomley J.E. (2006). Mathematically Talented Women in Hollywood. Available: http://www.mathsci.appstate.edu/~sjg/simpsonsmath/wim.html/womenangel.pdf

Leveson, N.G. (1990). Educational Pipeline Issues for Women. *Computing Research News*, October [Reprinted On-line]. Available: http://www.cs.washington.edu/research/projects/safety/www/papers/snowbird.ps

Lynch, J. et al. (2001). Mathematics: a Dilemma for Feminists. In E.L. MacNabb et al. (Eds.), *Transforming the Disciplines*. New York: Haworth Press.

National Council of Teachers of Mathematics. (1999). Curriculum and Evaluation Standards for School Mathematics. Reston, VA: Author.

Steinke, J. (1998). Connecting Theory and Practice: Women Scientist Role Models in Television Programming. *Journal of Broadcasting and Electronic Media*, 42(1), 142-151.

Steinke, J. (1999). Women Scientist Role Models on Screen: A Case Study of Contact. *Science Communication*, 21(2), 111-136.

Steinke, J. (2005). Reinforcing Cultural Representations of Gender and Science: Portrayals of Women Scientists and Engineers in Popular Films. *Science Communication*, 27(1), 27-63.

Wilson, P. & Chauvot, J. (2000). Who? How? What? *Mathematics Teacher*, 93(8).

Mathematician Role Model Checklist

Here we list the names of mathematicians whose profiles have appeared previously in this Centroid column. These profiles can be downloaded on-line (Greenwald, 2006). In each case, comments from the profile relating to the specified theme are particularly well suited to help students connect to mathematics and mathematicians.

Steinke Framework

- early encouragement in science: *David Blackwell, Florence Nightingale*
- professional status: *David Blackwell, Carolyn Gordon, Florence Nightingale*
- professional reputation: *Carolyn Gordon, Kate Okikiolu, Florence Nightingale, David Blackwell*
- professional relationships: *David Blackwell, Carolyn Gordon, Hypatia*
- the impact of personal relationships on professional goals: *Carolyn Gordon*

Fennema-Sherman Framework

- attitude towards success in mathematics: *Marjorie Lee Browne*
- mathematics as a gender/racial neutral domain: *Carolyn Gordon, David Blackwell*
- mother/father support: *Marjorie Lee Browne, David Blackwell, Hypatia, Florence Nightingale*
- teacher support: *David Blackwell*
- confidence in learning mathematics: *Thomas Fuller, Florence Nightingale*
- mathematics anxiety: *Marjorie Lee Browne*
- motivation for challenge in mathematics: *David Blackwell, Marjorie Lee Browne, Carolyn Gordon*
- mathematics usefulness*: Thomas Fuller, Hypatia, Florence Nightingale*

Our Additional Indicators

- students personally identify with the mathematician: *Marjorie Lee Browne, Carolyn Gordon, David Blackwell*
- students personally identify with way the mathematician does mathematics: *Carolyn Gordon, David Blackwell*