



Information Sheet: Female Interest in Mathematics



By
Catherine T. Amelink
Virginia Tech

Megan enjoys her math class this year. Her teacher has the students work together in groups, and they spend time working on problems that use people and places to which Megan can relate. Megan is starting to think that math might be an area she would like to study more. However, she is unsure about whom to talk to about her interests. Her mother admits she is not good at math herself, and neither parent seems to like helping Megan with math homework when she has questions. Some of Megan's close friends don't seem to like math either, describing it as boring and useless.

While student interest in mathematics is low overall, female interest in math is markedly lower than that of their male peers (Frenzel, Goetz, Pekrun, & Watt, 2010; Nosek, Banaji, & Greenwald, 2002; Wells, Sanchez, & Attridge, 2009). This trend begins just prior to middle school and continues throughout the educational career of females (Boswell, 1985). The lack of interest in mathematics among females directly affects the number of females pursuing math-related degrees, including science, technology, and engineering (Linver, Davis-Kean, & Eccles, 2002; Spelke, 2005; Watt, 2006). Despite research that has documented these trends, lower interest in math may not be evident because females enroll in math-based courses throughout middle and high school at the same rate as their male peers do and perform as well on math-based standardized performance tests (Freeman, 2004).

Social and cultural factors that manifest themselves as gender-based stereotypes in educational settings and outside of these institutions negate female interest in mathematics starting at a young age (Spelke, 2005; Spelke & Grace, 2007). Influential role models such as parents and teachers reinforce harmful stereotypes about who is good at math, further dampening female interest in this field (Usher, 2009).

Barnett and Rivers (2004) contend that cultural forces influence interest in mathematics, with socialization occurring at a young age about who should be interested in mathematics, why mathematics is useful for accomplishing everyday tasks, and which careers are suitable for which gender. Girls receive implicit and explicit messages from parents, teachers, peers, and the media that math is a male-dominated field that is of little use to women, who should be more interested in socially based endeavors. Research indicates that the greater the math gender stereotypes that girls possessed, the less likely they were to indicate an interest in math (Nosek, et al., 2002).

Moreover, some students are often led to believe by influential others, such as parents or teachers, that math ability is innate or a gift (i.e., one they were born with), while others are led to believe that math ability is something that can be developed by hard work (Dweck, 1999). If students view math ability as innate, they are more likely to lose interest when they encounter difficulty. If students view math ability as something that can be developed through study and by seeking additional resources and assistance when they feel challenged, they maintain interest in math despite obstacles or difficulties they may face (Dweck,

1999). Views related to math ability influence student achievement and interest, especially among females (Dweck, 2007).

Math anxiety, commonly experienced by students of both genders but more likely to occur among females, can also negate female interest in the field (Licht & Dweck, 1984). This anxiety occurs as students experience confusion when learning a new mathematical task. Among girls this confusion is believed to reinforce gender-based stereotypes that they are not or should not be “good at math,” leading them to report a decreased interest in math after being faced with confusion. Some of female math anxiety can be attributed to female role models such as female elementary school teachers and mothers. Having a female teacher who says she is anxious about math leads her female students to share that attitude and score lower on tests (Beilock, Gunderson, Ramirez, & Levine, 2010). A mother’s interest and perceived ability to perform mathematical tasks has also been shown to influence a student’s confidence and interest in mathematics among both males and females. Fathers did not have this same type of influence (Usher, 2009).

Lack of interest in mathematics has direct implications for student motivation to learn skills needed for accomplishing everyday tasks and for student involvement in science, technology, engineering, and math (STEM) disciplines, particularly for females. Lower interest is closely related to lower performance on math-related achievement tests and lower grades in math (Betz, 1978; Singh, Granville, & Dika, 2002; Uerz, Dekkers, & Beguin, 2004), less interest in taking challenging mathematics curricula prior to enrolling in college (Nosek et al., (2002), and less interest in pursuing a career in STEM disciplines (Usher, 2009), with females at a higher risk (Betz, 1978; Usher, 2009).

Educators, program directors, and others involved in educational settings play a critical role in cultivating female interest in mathematics. As practitioners consider the following tools that can be used to improve female interest in math, it should be noted that interventions that work to increase female interest in math also increase male interest in math (Tobias, 1989). Overall, this can lead to more balanced gender representation among individuals pursuing jobs that need a solid background in math, including STEM careers (Barnett & Rivers, 2004).

- Teachers can help improve math interest and performance among students by providing encouragement and helping students believe that mathematical competencies can be improved through consistent effort (Schunk & Zimmerman, 2007). Female interest has been shown to increase when they understand the skills that are necessary for math performance as well as how to develop those skills (Dweck, 2007; Good, Aronson, & Inzlicht, 2003). This includes teaching students how to study and apply needed skills in math as well as how to make connections with previously learned material. Not all students have honed the skills necessary for success in this area, and taking these actions has been shown to have favorable results for students’ interest in math (Tobias, 1989). Faculty development efforts should be designed to support this initiative, providing educators with information about the usefulness of math across content areas and providing training for all educators on teaching math skills so that cross-disciplinary activities can be designed appropriately.
- Formulating lessons that use collaborative strategies can reduce anxiety among students and give them an opportunity to reflect on new material being acquired (Tobias, 1989). Lessons should be designed to emphasize how famous mathematicians or other influential individuals arrived at their

conclusions through hard work rather than emphasizing the idea of “math geniuses” who were born with a gift (Dweck, 2007).

- Involving students in hands-on, inquiry-based activities can increase math interest and motivate male and female students to pursue STEM based activities, additional education in these areas, and careers in a variety of areas including STEM fields. Providing students with socially relevant problem sets and activities that can be examined using mathematical concepts may increase interest and performance among students, particularly among females (Bartell, 2007). The Engaging Students in Engineering program (www.engageengineering.org) provides a research-based framework that mathematics educators can use to design similar products for math classrooms.
- Parents should support females who indicate an interest in math-based careers and become involved in helping students select the courses that provide appropriate academic preparation for such fields. This type of behavior among parents is associated with greater retention and success in females pursuing math-based careers such as engineering (Mau, 2003).
- Providing access to female role models who are involved in math, engineering, or other math-based careers indirectly through pictures or directly through networking and long-term mentoring opportunities can increase female interest and negate gender-based stereotypes (Marx & Roman, 2002). MentorNet (www.mentornet.net) is an online forum that is designed to facilitate connections between mentors and protégées in science, technology, engineering, and math.
- Because math anxiety and subsequent lack of interest in mathematics is transferred from female teachers to female students, practitioners should examine whether teachers possess math anxiety. Implementing service programs that can help teachers gain confidence when teaching students mathematics would be an important remedial step.
- Practitioners who design courses and major requirements within STEM disciplines should be careful about how they emphasize the mathematical skills and abilities needed for success, including de-emphasizing the idea that students need to be math geniuses. Emphasizing instead the academic preparation that is needed and the study skills necessary to succeed can help dispel myths based upon gender-based stereotypes about who should be involved in math and math-related careers. In addition, long-term mentoring and other programs that introduce and prepare students for challenging coursework can counteract misconceptions that students need to be born with an innate aptitude for mathematics to succeed (National Academy of Engineering, 2008).

Recommendations for action and future research include the following:

- Studies should look more closely at how the teaching of mathematics may inadvertently convey gender-based stereotypes (Hand, 2010). This could include specifically examining what teacher-led practices, pedagogy, and peer interactions in classrooms lead to lack of female interest.
- Relevant frameworks and theories that have looked at female engagement in either STEM more broadly or in math performance could be used to study female interest in mathematics specifically. For instance, stereotype threat (Singletary, Ruggs, Hebl, & Davies, 2011), attribution theory (Assessing Women and Men in Engineering, 2005), and academic self-concept (Beier & Rittmayer,

2011) have been linked to female interest in STEM fields or math performance. Discovering how these theories apply to female interest in mathematics could provide interesting insights about why females disengage and what factors are linked to disengagement from mathematics. Information collected from these studies could be used to shape educational settings so that all students could benefit from positive exposure and involvement in math-related activities leading to more diverse groups pursuing STEM careers.

References

- Assessing Women and Men in Engineering (AWE). (2005). *Attribution theory: He says, she says: The difference in how women and men perceive success and failure* (AWE Research Overview). Retrieved from http://www.engr.psu.edu/awe/misc/ARP_WebPages/attrib.aspx
- Barnett, R., & Rivers, C. (2004). *Same difference: How gender differences are hurting our relationships, our children, and our jobs*. New York, NY: Basic Books.
- Bartell, T. G. (2007). Culture, race, power, and mathematics education. In F. K. Lester Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 405–434). Reston, VA: National Council of Teachers of Mathematics.
- Beier, M. E., & Rittmayer, A. D. (2011). *Motivational factors in STEM: Interest and academic self-concept: Identifying what keeps students motivated to persist in STEM* (SWE-AWE CASEE Overviews). Retrieved from http://www.engr.psu.edu/awe/misc/ARP_WebPages/selfconcep.aspx
- Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *PNAS Early Edition*, 1–4. doi: 10.1073/pnas.0910967107
- Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology*, 25(5), 441–448.
- Boswell, S. L. (1985). The influence of sex-role stereotyping on women's attitudes and achievement in mathematics. In S. F. Chipman, L. R. Brush, & D. M. Wilson (Eds.), *Women and mathematics: Balancing the equation* (pp. 175–198). Hillsdale, NJ: Lawrence Erlbaum.
- Dweck, C. S. (1999). *Self-theories: Their role in motivation, personality, and development* (Essays in Social Psychology). Philadelphia, PA: Psychology Press.
- Dweck, C. S. (2007). Is math a gift? Beliefs that put females at risk. In S. J. Ceci, & W. M. Williams (Eds.), *Why aren't more women in science? Top researchers debate the evidence* (pp. 47–56). Washington, DC: American Psychological Association.
- Freeman, C. E. (2004). *Trends in educational equity of girls & women: 2004* (NCES 2005–016). Washington, DC: U.S. Government Printing Office.
- Frenzel, A. C., Goetz, T., Pekrun, R. & Watt, H. M. G. (2010). Development of mathematics interest in adolescence: Influences of gender, family, and school context. *Journal of Research on Adolescence*, 20(2), 507–537.

- Good, C., Aronson, J., & Inzlicht, M. (2003). Improving adolescents' standardized test performance: An intervention to reduce the effects of stereotype threat. *Journal of Applied Developmental Psychology, 24*, 645–662.
- Hand, V. M. (2010). The co-construction of opposition in a low-track mathematics classroom. *American Educational Research Journal, 47*(1), 97–132.
- Licht, B. G., & Dweck, C. S. (1984). Determinants of academic achievement: The interaction of children's achievement orientations with skill area. *Developmental Psychology, 20*(4), 628–636.
- Linver, M. R., Davis-Kean, P. E., & Eccles, J. S. (2002). *Influences of gender on academic achievement*. Retrieved from www.rcgd.isr.umich.edu/it/New/sra02_fullpaper.doc
- Marx, D. M., & Roman, J. S. (2002). Female role models: Protecting women's math test performance. *Personality and Social Psychology Bulletin, 28*(9), 1183–1193.
- Mau, W-C. (2003). Factors that influence persistence in science and engineering career aspirations. *Career Development Quarterly, 51*, 234–245.
- National Academy of Engineering. (2008). *Changing the conversation: Messages for improving public understanding of engineering*. Washington, DC: National Academies Press.
- Nosek, B. A., Banaji, M. R., & Greenwald, A. G. (2002). Math = male, me = female, therefore math ≠ me. *Journal of Personality and Social Psychology, 83*(1), 44–59.
- Schunk, D. H., & Zimmerman, B. J. (2007). *Motivation and self-regulated learning: Theory, research, and applications*. New York, NY: Routledge.
- Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *The Journal of Educational Research, 95*(6), 323–333.
- Singletary, S. L., Ruggs, E. N., Hebl, M. R., & Davies, P. G. (2011). *Stereotype threat: Causes, effects, and remedies* (SWE-AWE CASEE Overviews). Retrieved from http://www.engr.psu.edu/awe/misc/ARP_WebPages/stereotypethreat.aspx
- Spelke, E. (2005). Sex differences in intrinsic aptitude for mathematics and science? A critical review. *American Psychologist, 60*(9), 950–958.
- Spelke, E. S., & Grace, A. D. (2007). Sex, math, and science. In S. J. Ceci & W. M. Williams (Eds.), *Why aren't more women in science? Top researchers debate the evidence* (pp. 57–58). Washington, DC: American Psychological Association.
- Tobias, S. (1989). *They're not dumb, they're different: Stalking the second tier*. Tucson, AZ: Research Corporation.
- Urerz, D., Dekkers, H., & Beguin, A. A. (2004). Mathematics and language skills and the choice of science subjects in secondary education. *Educational Research and Evaluation, 10*(2), 163–182.

- Usher, E. L. (2009). Sources of middle school students' self-efficacy in mathematics: A qualitative investigation. *American Educational Research Journal*, 46(1), 275–314.
- Watt, H. M. G. (2006). The role of motivation in gendered educational and occupational trajectories related to maths. *Educational Research and Evaluation*, 12(4), 305–322.
- Wells, B. H., Sanchez, H. A., & Attridge, J. M. (2009). *Modeling student interest in science, technology, engineering and mathematics*. Raytheon Company. Retrieved from http://www.raytheon.com/responsibility/rtnwcm/groups/public/documents/content/rtn_stem_whpaper.pdf