Gender Differences and the Teaching of Mathematics

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Abstract
The author presents research concerning gender differences in learning mathematics and practical suggestions for teachers based on that research.

One reason students give for attending a community college is that the mathematics requirements appear to be less rigorous. Many of my students have told me that they have chosen to seek an associate's degree first because they do not feel confident that they could successfully complete the mathematics requirement at a four-year institution. There are many reasons why this situation exists, but for the mathematics instructor in a community college, the reasons are not important. The fact that so many of our students are not sure of their math background and, if my students are any indication, do not have good math skills are problems enough. An understanding of what skills our students have when they come to us and of the cognitive gender differences that add to the problems will help the mathematics instructor frame lessons and activities to help more students succeed in math.

How Well Prepared Are Students?

The National Association for Educational Progress (NAEP), sometimes referred to as "The Nation's Report Card," is a standardized assessment of what students in the United States know in fundamental areas. Students in grades 4, 8, and 12 are periodically tested on their skills in mathematics, science, reading, and writing and occasionally tested on their knowledge of geography, U.S. History, economics, civics, and world history (NCES, 2005). Recent results indicate that all students are doing better in math. Girls have made progress in math proficiency over almost 20 years; however, reading skills for boys are slipping (see Table 1).

Table 1: NAEP Data Comparing Math and Reading Proficiency by Gender *

	2004	1986
Math Proficiency		
4th grade	3	0
8th grade	4	2
12th grade	3	6
Reading Proficiency		
4th grade	-5	-6
8th grade	-10	-9
12th grade	-14	-10

* score obtained by subtracting the average female score from the average male score. A negative score indicates that females are doing better. (NCES, 2005)

The National Center for Education Statistics also reports results from the NAEP on specific proficiencies in mathematics and the percentage by gender of students who have reached proficiency in those particular areas (see Table 2).

Table 2: Percentage of Selected Proficiencies in Mathematics on the NAEP by Gender for 2004

	Males	Females
9 year olds		
Simple arithmetic facts	99.3%	99.3%

Numerical operations and beginning problem solving	43.5	40.3
13 year olds		
Beginning skills and understanding	98.3	98.8
Moderately complex procedures and reasoning	32.6	25.6
17 year olds		
Numerical operations and beginning problem solving	96.6	96.8
Multi-step problem solving and algebra	8.8	5.1

(Snyder & Tan, 2005)

At each level, boys and girls are similarly successful on the most basic levels, but for more complex areas, boys show more proficiency. It is distressing to note that few students, either boys or girls, graduate from high school with the ability to work multi-step problems or to understand basic algebra. These data underscore what mathematics instructors have to confront: males with poor reading skills who find it difficult to obtain information from textbooks and females who appear less confident in math. Why do these differences between genders exist, and is there anything that the classroom teacher can do to ameliorate the problems?

Cognitive Gender Differences

It has long been accepted that females are more verbal than males (Halpern, 2000). What that means is that very young girls can say more words clearly than can very young boys and more girls are ready to read at time of school entrance than are boys. By the time students get to college, these differences are no longer as extreme. The cause of the extreme deficits that most males have in reading by the end of high school is probably a factor of school practices which do not take into account the differential verbal developmental progress of boys relative to girls (Frater, 2000). In middle school, for example, most girls are reading easily, so little instruction in reading is offered. The problem is that – at that level – many boys are just beginning to develop the verbal skills necessary to become fluent readers and, without specific instruction or attention to their particular needs, may decide that reading is not for them. Boys in single-sex schools where books are provided that appeal to them and where their level of reading skills is not compared with that of the girls appear to make more progress in language arts and in communication skills, as well (James & Richards, 2003).

Males, on the other hand, are better at spatial relations (Halpern, 2000). This skill was thought to be the reason males generally performed better on math tests, but research indicated that, in fact, verbal skills rather than spatial skills were better correlated with math proficiency (Friedman, 1995). Recently, research has shown that girls' poorer spatial-mechanical skills may contribute to a lack of success in areas of mathematics in which boys do well (Casey et al., 2001). Whether or not their problems with spatial skills contribute to the difficulties that women have in mathematics, females believe that they do and that belief affects their performance in math.

Other gender differences also affect how males and females react to the classroom environment:
• Females have more acute hearing than do males and are more sensitive to loud sounds, as well.
• Males have more acute vision than do females although they are more likely to be color blind.
• Females are better able to read faces and body language.
• Males learn best in kinesthetic activities, and females may be content to simply observe.
• Females are less likely to suffer from learning disabilities although both males and females are equally likely to be diagnosed with dyscalculia (a learning disability in math).
• Males have greater need for activity, are more impulsive, and develop fine motor skills at a slower rate than do females.
• Females are better at perceptual speed, which is essential in proofreading.
• Males are better able to remember visual cues; females are better able to remember placement of objects and words.
• Men deal with stress through "fight-or-flight," women through "tend-and-befriend."
(James, In Press)

These statements are global in nature and apply to the average student, not to any particular student. The differences between the average performance of females and males are not as great as the differences among either group (Halpern, 2000), but generally apply to students.

Implications for the Classroom

Teachers of the elementary levels are beginning to understand that boys and girls develop at different rates, so best practices in education should differ, as well. Students attending post-secondary schools do not appear to have marked developmental

differences and, as a result, teachers in higher education have not modified their teaching practices to account for developmental gender differences. If these gender differences in post-secondary students are not large, why should teachers need to be aware of them and revise their courses?

The hearing and vision differences continue to exist in students attending community colleges although most students have learned to compensate. True, more women will sit at the front of the class, but there are men who have figured out that in order to catch everything the teacher says, they must join the women – usually by sitting near the front on the side of the room. The other differences have usually ameliorated somewhat or, at least, self-selection has taken place. It is possible that men who attempt to obtain post-secondary education are able to compensate for the cognitive gender differences that made sitting in class, reading textbooks, and writing papers difficult earlier in school. Women who attempt to obtain post-secondary education may choose educational paths that do not require much math or science. However, there are simple classroom accommodations as well as methods that help students to access mathematics that can make an astounding difference in the way students in post-secondary mathematics classes perform.

The cognitive gender differences and accommodations exist. Methods that are used by the instructor to help students access the material should not be thought of as sexist or as assuming that one gender is somehow better at math than the other. In fact, in 2003, 46 percent of all bachelor's degrees in mathematics were awarded to women ("Digest of education statistics," 2006) and there are many distinguished women scholars in mathematics. The NAEP data referred to earlier indicate that while girls may be behind boys in mathematics proficiency, the differences are small and are certainly not as large as the differences in reading skills. The problem is that by the time some students seek a post-secondary education, they are convinced that they cannot do math. The following recommendations may help your students realize that they can.

Hearing Differences

Don't talk to the blackboard. Most mathematics teachers face the black or white board while they are working problems, so the men at the back may not be able to hear. Instead, use an overhead projector, acetate sheets, and water-soluble markers so that you can face the class while you work problems. The advantage here is that you can use permanent markers to prepare problems in advance and then wipe the sheets clean after each class. In addition, the bright image projected on the screen may attract the attention of the visual men in the class. This is very low-tech, but an effective method. The digital visual presenters (ELMO) can be adapted to allow you to write on your presentation. If your school has interactive boards, see if your school will purchase the hand-held devices that will allow you to write on the board while you are facing the class.

Do describe each step of the problem as you show how to solve it. Women, with their greater verbal skills, will benefit from hearing what you are doing, as seeing it does not make quite the same impact on them. Many mathematics instructors are unaware that they do not fully describe each step, as they may not need the verbal prompts.

Vision Differences

Using color to delineate different steps in a problem will be a great help to some women. If you use a black marker to write the problem, a red for the first step, a green for the second, and so forth, you will help separate the different stages in solving the problem. However, if you have color-blind men in the class, they may not be able to tell the difference between the red and green markers although they are less likely to need the colors to separate the steps. You can also use different colors to outline geometric figures to help students who are having trouble visually identifying a simple figure in a complex one.

Men's vision is attracted to moving objects. If you never move, some of the men may shift their attention to something that is moving, such as a bird flying outside or a student who is moving his foot. That does not mean that you have to jog back and forth in front of the class, but do provide some visual interest. If you are using the overhead projector, watching the movement of your pen may be enough.

Classroom behavior

It is axiomatic that men don't ask for help; women ask for too much. This is partially related to the differences in the ability to read faces. Women ask for help because they are unsure of their ability in math, because they see learning as a collaborative venture, and because they want to see your face as they work so that they can tell from you if they are on the right track. Become Socratic in your approach. When a student asks you what the problem is asking, ask them, "What does the problem say? Pick out the directions. What do you generally do when you are directed to do that?" Get them to look at the words in the problem and learn to identify key terms. Pair students up to work problems in class or for an out-of-class exercise. Require students, particularly men, having trouble in the class to come to your office hours to review the material. They may not ask for help, but they will take it when offered.

If you ask a question of a man and he drops his eyes, do not assume he does not know the answer. A woman looks at the instructor's face as she answers to see if she is on the right track. The man does not read faces or body language well, so he looks down. Give all students at least 30 seconds to answer before you ask if she or he would like to ask another student for

help. The helper may not answer, but is allowed to assist the original student find the answer. This process will not take as long as it sounds, and the advantage is that students will learn to figure out answers and not just depend on you to give them the solutions.

Women are more likely to read body language or gain information from facial expressions. Consequently, when working with you, women want to look at your face, especially if you are helping them deal with material that is difficult for them. Men, on the other hand, are less likely to obtain information this way and may be somewhat embarrassed if you look at them as they work. They are much more comfortable working with you shoulder-to-shoulder focusing on the work and not how they feel about it. Remember: it is the student's comfort that is important.

Active versus Passive Learning

Men will do homework because it gives them a concrete task that appeals to their kinesthetic learning style. Women may read the text and not believe that they need to work problems because they understand the material. You may have to ask the students to turn in their homework for a small daily grade. This sounds like elementary school, but if students have not yet found out that the best way to learn math is to do it, you may have to require that they do so.

Reality projects help both men and women for different reasons. They provide an active learning opportunity for the men, and they tie mathematics to everyday life for women. Women who are convinced that they can't do math are sometimes astounded to discover how much math is required for interior decorating, shopping, and dieting. Reality projects also provide a welcome change from the daily grind of going over material in the text and working problems. Pair students up and give them a small amount of class time to start, but have most of the work completed outside of class. Develop multi-step problems that utilize the mathematics in your course. For example, students may be asked to determine the best parking plan for an odd-shaped lot at your school. Borrow a meter wheel from the physics teacher for the students to take the measurements of the lot. The students will then use the Internet to discover the standards for parking size and back-up room in square feet (don't warn them about the mismatched units; that is part of solving the problem). They should then produce a map of several different parking possibilities. If your school is having problems with the air handling system, the students might be assigned to determine what the volume of the school building is and how much air the system is designed to move. They should use information from the Internet to determine the suggested ratios of air available to system capacities and, if there is a substantial difference, suggest the specifications for a replacement system. One class period should be set aside for the groups to present their problems and for the class to analyze the solutions.

Dysgraphia is a learning disability that is usually diagnosed through poor handwriting, but is actually a problem with output of information. Symptoms include poor formation of letters and numerals and inability to maintain straight columns or rows in solving problems. If you suspect that a student has dysgraphia, refer him or her to a counselor for evaluation. The major accommodation given to these students is extra time in which to do written work. In addition, you can suggest that they turn their notebook paper sideways to provide blue columns which will help keep their work straight. (Some suggest that the students do the work on large scale graph paper, but the grid is often distracting.) Also, give the student plenty of space in which to work as the dysgraphic can be more legible if allowed to write larger. You will find additional information at www.ldonline.org .

Perceptual Speed

Proofreading can be a major problem for some men. They find it difficult to find errors on a page, so they simply do not check their work. Suggest that a student go out in the hall or to some empty classroom and direct him or her to read their work aloud. It is astounding how many errors can be located when the student speaks what is written. This also has the advantage of requiring the student to slow down a bit while proofreading, which improves his or her chance of finding errors.

If the problem is that the student does not locate directions on the page, which is a common problem, put all of the directions in boldface font, and before beginning a test or exercise, tell the students to highlight all words in boldface. That makes the directions stand out from the page and increases the chance of finding the directions to read.

Visual Versus Verbal Learning

Some students find acquiring the vocabulary of mathematics difficult. Require all students to keep a math dictionary in the back of their folder. It is astounding that some students do not know that multiply and times refer to the same operation and that divide by and divide into are not the same operation. A theorem dictionary can also be helpful especially in geometry.

By far, the most common complaint that women have with mathematics is word problems. The issue is that many women, and some men, find it difficult to disembed the math (separate the math from the words). There is a simple solution to this difficulty that I call "Box the Operator." Here is a sample problem:

> If 3 times a number is increased by 7, the result is the same as when 72 is decreased by twice the number.

Step 1. Box the operator – draw a box around or highlight each of the words that refer to a mathematical operation. Here those words are *times, increased, decreased,* and *twice* (a difficult term because it represents both an operation and a number). *Step 2*. Underline all the numbers – draw a line (preferably in red or some other color that stands out) under each number whether it is represented by a numeral or words. Here those numbers are *3, 7, 72*, and *twice*. *Step 3*. Mark the variables – Draw a big V or a ? over the words that represent the variable. Here the variable is the word *number*. *Step 4*. Find the equals – in any equation, there will be an equals sign. The student should draw a large = over those words. Here those words are *is the same as*. Step 5. Write the problem – the student should then write each portion as marked. Here that will look like: $3 \cdot N = 72 - 2 \cdot N$. Start with simple problems and the students will learn to disregard the story in favor of the math.

Dealing with Stress

We have long known that stress in men results in the "fight or flight" response. Whether the stressor is a threat to one's body, such as an automobile accident, or to one's self-esteem, such as a test, the body reacts the same way. Blood is pumped to the muscles along with sugar and adrenaline to help the individual prepare to deal with the situation. The advantage for men is that blood goes to their brains, so they can think well under stress. But the problem is that the blood is in their muscles, so they may react impulsively. Recently, research found that women do not react the same way. The term which describes the response of women is "tend and befriend" and refers to the tendency of women to become less active in response to stress (Taylor et al., 2000). For women, blood moves to the body's core and away from muscles and brain, so they find it difficult to move or think when severely stressed.

To help a woman deal with stress associated with school, especially with regard to tests, suggest that she leave the room and walk up and down the hall outside until she feels better. This simply gets the blood moving around her body, and she will find that she is not so stressed and can think better. Discuss this strategy with the student in advance of the test so that she will not be surprised by your suggestion.

To help a man deal with such stress, suggest that he go outside and walk vigorously or jog until he settles down. What he is doing is allowing his muscles to move as his body is directing and, as he does that, he will use up some of the adrenalin and blood sugar so that he does not feel so restless. Again, be sure to discuss this strategy with the student ahead of time.

Both men and women who are adversely affected by stress will benefit from regular exercise combined with purposeful relaxation, such as meditation or yoga. This will help them learn to be in control of their bodies rather than at the mercy of their emotions.

Problem Solving

One other issue which is gender related – only because men seem to have less trouble with it and women more – is that of problem solving. When I first began to teach high school in the early 1970s, most of my students were able to figure out what a problem gave them, what they needed to solve the problem, and what method was necessary to find the answer. Lately, I find that most students tend to look to the teacher to give them guidance and are somewhat reluctant to attempt to solve a problem if the method is not perfectly obvious or if the problem is one that is unfamiliar. I suspect that the loss of confidence in problem solving may be related to the push in schools to teach students to pass the state standardized tests by memorizing solutions combined with a lack of opportunity to solve problems because children are not given much personal freedom. In any case, the solution is to give students problems to solve that don't have anything to do with their math.

Sudoku and logic puzzles are excellent ways to learn problem-solving techniques. I assign logic problems along with other homework. In the next class period, I walk the students through the solution so that they can observe various problem-solving methods. If the period in which you teach your class is long, working on the logic puzzle is a great break in the class. If your periods are shorter, just do them once a week when your class seems to need a change of pace.

Dyscalculia

Dyscalculia is to math as dyslexia is to reading and language arts, and it has a wide variation in severity. As mentioned before, dyscalculia seems to affect men and women equally, but their responses to the learning disability differ greatly. In elementary and secondary schools, girls with the disorder will give up because math is too hard, arguing that, besides, they are not supposed to do well in math anyway. Boys with the disorder will frequently sabotage themselves by failing to write down their homework assignment or losing their homework so that the teacher will not know that they cannot do math. In post-secondary education, the student with severe dyscalculia will try to get out of any math requirement or will take a practical math such as bookkeeping. However, there are students with mild dyscalculia who benefit from knowing that their mistakes are not careless, but due to a learning disability. Once they are aware of this, they are usually much more willing to go ahead in math even though they may continue to make simple mistakes. Symptoms of dyscalculia include the following:

- Recall of numbers may result in reversal of digits, omissions or additions of numerals, or substitution of numerals,
- Poor attack skills, particularly with multi-step problems,
- Difficulty with mental math,
- Problems with retention of math skills – can get it in class but forgets the technique by the next class, and
- Inability to understand math concepts.

A fuller description of this disorder can be found at www.dyscalculia.org or at www.ldonline.org .

The student with mild dyscalculia will benefit from using a calculator, particularly a graphing calculator, because she or he can keep track of what was keyed in. For those with more serious problems, a homework tutor who will go over the material and who will prepare the student for the next class will be invaluable.

Benefits for Learning and Teaching

Teaching mathematics involves a great deal more than just showing how to do problems and correcting tests. Which skills each student brings to the classroom and how the instructor presents the material can make a huge difference in the outcome for both students and teacher. An understanding of cognitive gender differences and simple accommodations based on that understanding can improve the experience of teaching and learning mathematics.

References

Casey, M. B., Nuttall, R. L., & Pezaris, E. (2001). Spatial-mechanical reasoning skills versus mathematics self-confidence as mediators of gender differences on mathematics subtests using cross-national gender- based items. *Journal for Research in Mathematics, 32*(1), 28-57.

Digest of education statistics. (2006). In U. S. Department of Education (Ed.).

Frater, G. (2000). Boys and literacy. In K. Bleach (Ed.), *Raising boys' achievement in schools*. Stoke on Trent, England: Trentham Books.

Friedman, L. (1995). The space factor in mathematics: Gender differences. *Review of Educational Research, 65*(1), 22-50.

Halpern, D. F. (2000). *Sex differences in cognitive abilities* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

James, A. N. (In Press). *Teaching the male brain*. Thousand Oaks, CA: Corwin Press.

James, A. N., & Richards, H. C. (2003). Escaping stereotypes: Educational attitudes of male alumni of single-sex and coed schools. *Psychology of Men and Masculinity, 4*(2), 136-148.

NCES. (2005). *The nation's report card: An introduction to the national assessment of educational progress (NAEP)*. Washington, DC: U. S. Department of Education.

Snyder, T. D., & Tan, A. G. (2005). Digest of education statistics 2004. In U. S. Department of Education (Ed.): IES National Center for Education Statistics.

Taylor, S. E., Klein, L. C., Lewis, B. P., Gruenewald, T. L., Gurung, R. A. R., & Updegraff, J. A. (2000). Biobehavioral responses to stress in females: Tend-and-befriend, not fight-or-flight. *Psychological Review, 107*(3), 411-429.

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