



THE TEACHING IMPLICATIONS OF GENDER Inequality

“**T**rain a child in the way he should go, and when he is old he will not turn from it.”¹

This text can be applied both to a lifelong relationship with God and to other worthwhile commitments. How do teachers and parents raise up children to enter into science, technology, engineering, and mathematics (STEM) careers? There is an unwritten rule that 100 percent of students need to be prepared to pursue collegiate-level mathematics. However, the National Science Foundation has estimated that only 18 percent of U.S. female college freshmen plan to enter STEM careers, and a 2009 poll indi-

cated that as few as five percent of U.S. girls age 8 to 17 were interested in engineering.²

Further problems continue at the workplace level, where even though women are more likely than men to be hired, Cathy Trower of Harvard University found a higher turnover rate for women in STEM careers due to lower job satisfaction, as compared to their male counterparts.³ How can we guide more male and female students to study math and science, and to find happiness in these fields?

For Christians, career choice has both a temporal and eternal component. Parents and teachers guide young people to make informed choices based on their gifts, the world’s needs, and God’s calling. Hence, it is important to

properly interpret this comment by Ellen G. White in 1905: “Many of the branches of study that consume the student’s time are not essential to usefulness or happiness. . . . If need be, a young woman can dispense with a knowledge of . . . algebra . . . but it is indispensable that she learn to make good bread, to fashion neatly-fitting garments, and to perform efficiently the many duties that pertain to home-making.”⁴ In today’s world, studying mathematics has more practical applications than a hundred years ago before the era of technology, when almost no women attended college. The statement’s principle is still relevant, however—women (and men) need practical training that will be useful in their

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daily lives and careers.

So what type of education will provide a solid and happy future for students? This article reviews modern educational literature concerning student preference and ability in mathematics classes and offers suggestions for teaching based on this literature, recent student surveys, and the author's 20 years of teaching experience.

Student Interest

Students' needs, desires, ability, and access do not necessarily converge or even intersect. More frequently, interest supersedes ability, regardless of need or access. For instance, recent studies agree with Heller and Ziegler⁵ who showed that females from around the world express less interest than males in physics and mathematics, and the magnitude of the difference increases at upper-grade levels. Currently, worldwide, more women than men enroll in

almost every area of graduate education—with the exception of mathematics, engineering, computer sciences, and the physical sciences.⁶

Gender differences are also evident in a number of countries other than the U.S. Consider the following male/female ratios in academic areas for 12th and 13th graders in Germany: two to one in math and chemistry, eight to one in physics, but one to three in biology. Around the world, significantly fewer women than men work in mathematical fields.⁷

The male/female ratio for the SAT achievement test, mathematics portion (SAT-M), performing at the average level is 2:1.⁸ This ratio jumps to 4:1 for the top 15 percent and 132:1 for the highest 2 percent. Interest in STEM courses can be measured by student success on Advanced Placement (AP) courses. A recent post by The National Math and Science Initiative (NMSI) revealed that 2011 data indicate persistent achievement disparities in STEM

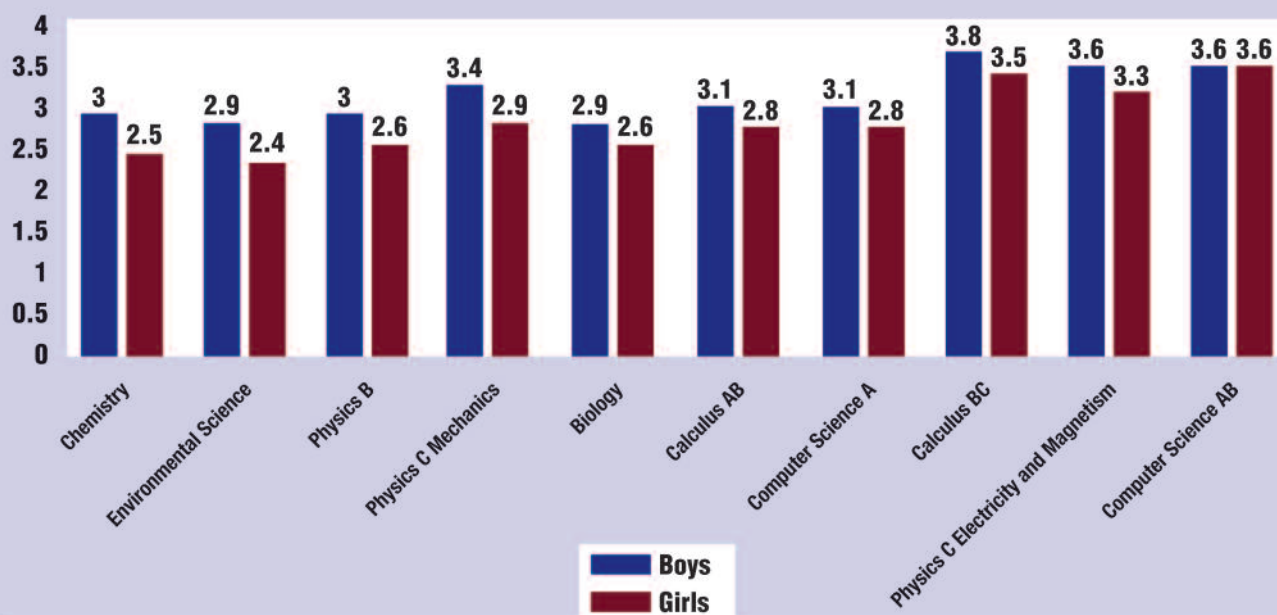
courses at the K-12 level, as revealed in Advanced Placement scores.⁹

Are All Inequalities the Result of Discrimination?

At the undergraduate level in the average U.S. university, more women than men receive passing grades. This does not result from discrimination against men, but simply reflects the fact that more females than males enroll in college. Likewise, more women than men receive Bachelor of Arts degrees (133 to 100), according to the National Science Foundation,¹⁰ simply because they outnumber male candidates. (The situation might indicate a biased climate if one were able to demonstrate favoritism toward female students or discrimination against male students.)

What about research showing that women make only 77 percent as much as men? This currently occurs because women, on average, work fewer hours in less highly remunerated occupations.

Figure 1. Advanced Placement (AP) Average Scores by Gender, 2009



Source: Data from Hill, Corbett, and Rose, *Why So Few? Women in Science, Technology, Engineering, and Mathematics* (Washington, D.C.: AAUP, 2010).



However, this is rapidly changing as the number of women increases in fields such as medicine, dentistry, and law, which were once dominated by men. In America, the number of enrolling and graduating women continues to surpass the number of men in many of the fields traditionally dominated by men.¹¹

Now, what about the statistics previously mentioned concerning student interest levels? Boys score higher than girls on the SAT-M as well as the ACT.¹² There are groups that allege that high-stakes standardized test questions are biased toward males. Conversely, there are groups that claim that because the male and female brains are formed differently in the womb, boys and girls develop different interests and hobbies. Should the SAT-M testing difference be treated as a simple inequality or an egregious form of discrimination? The way a teacher chooses to regard—and address—this dichotomy will shape the type of pedagogy he or she employs in the classroom and flavor his or her interaction with students.

Educators' Views of Gender Testing Differences

Teachers who consider differential math-test scoring as simple disparity may point out that even though males score significantly higher on the SAT-M than females do, the SAT poorly predicts college readiness or college GPA. But the fact that women score lower on the SAT-M disadvantages them, since 92 percent of universities require SAT scores, and 75 percent of them use these scores as part of the admission process.¹³ Therefore, even if testing differences are considered to be the product of genetic differences, the situation quickly becomes unfair if test scores are used to disadvantage one group. The use of SAT-M scores effectively reduces a girl's chance for a college education and scholarships.

The claim of unfairness is further bolstered when one considers that

more selective schools require a higher score on the SAT-M than do open-admissions institutions. For example, Texas A&M requires a minimum of 600 on the SAT-M for acceptance. This means "one in every four college-bound males in Texas is eligible, [but] only one in every seven females qualify."¹⁴ And the more selective the school, the larger the gender difference in mathematical performance.¹⁵ Mathematics thereby becomes the doorway, or the blockade, that leads into, or prevents, access to higher-paid, more-prestigious jobs. Each of the top 15 highest-paying careers requiring a college degree has a heavy dose of mathematics as a common denominator.¹⁶ With midcareer salaries between \$90,000 and \$100,000, the most profitable majors include aerospace, electrical, chemical, and industrial engineering, physics, statistics, biochemistry, and mathematics.¹⁷ Herein lies the root of the assertion that lack of access to college opportunities produces an unfair situation due to the SAT-score differences between boys and girls. Though there are surely biologically related gender differences, the continual low performance in mathematics among women is not one of them.¹⁸ Instead, candidate interest levels and opportunity play a foundational role.

Gender Differences in Math

Teachers who consider math score differences as simply indicating gender-based phenomena may instead point to the fact that the non-gendered human fetus forms differently during the first trimester when sex is determined, depending on whether it is flooded with estrogen or testosterone. For example, among other differences, the brain develops a higher neuron density if the fetus becomes female, and the eyeball acquires a higher propensity for track-

ing fast-moving objects in the male fetus. These natural variations, which develop before birth, result in differences in the senses (sight, smell, hearing) as well as in personality traits (risk taking, empathy, aggression), according to Evans and Chancellor.¹⁹

In general, females are more verbal than males. They tend to know more words at an earlier age, have more acute hearing, are better able to read faces and body language, have a higher perceptual speed, are more content to observe, and in stressful situations will ask for help sooner or put up with the situation longer. Boys, on the other hand, are better at spatial reasoning, have more acute vision, learn best using kinesthetic activities, have a greater need for activity, recall better with visual cues, and in stressful situations tend toward "fight-or-flight" responses.²⁰ Input from the senses, as interpreted by the brain, can be claimed to create differences, which result in variations in test scores.

Further widening the achievement gap is the fact that boys tend to score higher on complex problem-solving due to the personality trait of risk-taking and their willingness to consider multiple problem-solving procedures, whereas girls are more timid about trying new approaches and adhere more closely to prescribed formulas or algorithms.²¹ Even though females receive higher grades in both high school and college, males outperform them on tests that cover material not specifically taught in class.²² On beginning-level problems, boys and girls score about the same, but boys score higher on complex and multi-step procedures.²³ In other words: Girls are better at following the teacher's instruction, while boys are better at independent thinking.

Teaching Implications

As a rule, the art of teaching presupposes that there are differences among

students. Certainly in God's eyes everyone is equally valued, but in the classroom not everyone is intellectually equal, is equally educable, and, for a variety of reasons, not everyone is equally motivated. For educators, worrying about why differences exist between the genders is probably less important than focusing on a plan of action for the students seated in their classroom. At that moment, they need an education rather than an *a priori* explanation as to why they are the way they are. It is prudent not to pit nature against nurture but instead concentrate on research-based methodologies to enhance students' collaborative and separate contributions.²⁴ An appropriate plan of action should include four important areas: motivation, spatial-skills practice, representative teaching, and student involvement.

Motivation

First and foremost, the student has to want to learn. Or as Belcher expressed it succinctly: "ultimately nothing an instructor can say or do will make a difference if the student is unmotivated to implement it."²⁵ This reflects the wisdom of the old cliché "you can lead a horse to water, but you can't make him drink." Of course, you can always salt the oats!

Motivation is the teacher's primary objective in educating both boys and girls—and each student requires a different type and level of motivation. For example, in a comparison of girls and boys with similar grades, girls report feeling more hopelessness and shame and less enjoyment and pride in their accomplishments than boys do. Though recent research is finding declining differences between the genders in mathematical achievement, there does not seem to be a comparable decline in the affective differences. In other words, progress is being made in cognitive per-

formance, but the gap remains large in terms of attitudes about mathematical learning.²⁶ Any student who wants to succeed must first acquire the appropriate attitude toward learning.

Studies in the U.S. have shown that motivational differences start to take a toll as girls progress toward high school. There are almost no gender differences in mathematics performance at age 9. Small differences are seen by age 13, and larger differences become clear (in favor of males) around age 17.²⁷ In the U.S., the most damaging period for a young girl occurs when she transitions to middle school.²⁸ Girls "are characterized by a debilitating pattern of mathematics-related emotions, and of underlying competence beliefs and value beliefs which can be observed as early as at the age of eleven."²⁹

The best approach for teaching girls is to focus on the influence of the environment on affective factors such as self-confidence, attitude, and perception.³⁰ Teachers need to find ways to convince girls that they *can* learn mathematics. Providing encouragement is especially important since for girls, confidence is significantly related to their mathematics achievement because studies show that both confidence and achievement decline in the

middle school years. Thus, it is critical that teachers help girls form correct (and positive) estimations of their capacity to learn mathematics.³¹

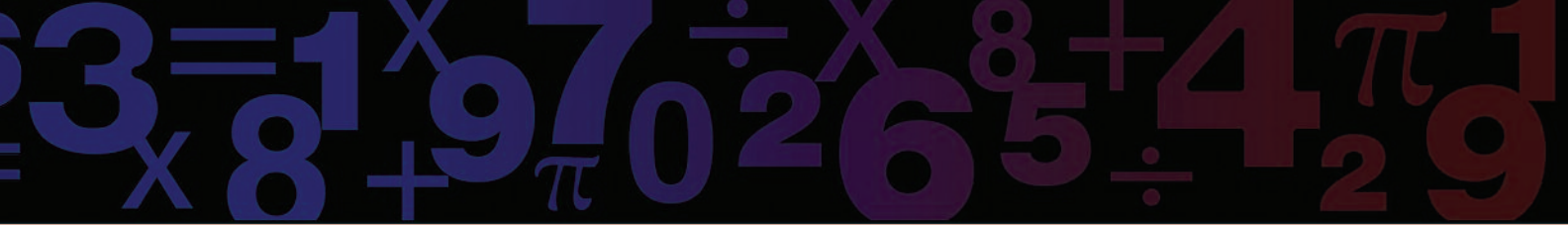
Most students find regular continual feedback helpful for motivational purposes. Student success usually results from a combination of high-quality instruction and motivation. When pedagogy is solid, expectations are clear, and consequences consistent, students are more likely to achieve to the best of their ability.³²

Representative Teaching

While teachers should be aware of archetypal gender strengths and preferences, they should not embrace harmful stereotypes. Believing that every student can achieve and using a variety of teaching methods will help to ensure success for every student. Girls benefit from hearing more than seeing; therefore, descriptive explanations are helpful. Boys are attracted to moving objects, so teachers should move about during lectures. Girls will ask an overabundance of questions, so teachers need to use the Socratic method to provide answers. Boys tend not to ask during a struggle; thus it can be helpful to pair them up in

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order to encourage communication. Girls will read faces, so a teacher must be wary of his or her body-language clues during the answering process. Although boys tend to look down or away when answering questions, this lack of eye contact is not an indication of ignorance or disrespect. Often, boys are simply processing information (and in some cultures it is considered impolite to make eye contact), so providing ample time to answer will help elicit thoughtful responses.³³

Teaching to attitude is similar. The mindset of students can be gauged by their reaction to puzzles and brain-teasers. Do they persist or give up easily? Does failure induce in them a sense of challenge or helplessness? Some students believe that puzzles come easy to smart people, so if an answer is not clear to them, then they classify themselves as not being smart. Students with this perspective believe that intelligence is a static, inherited trait, and do not comprehend that it can be grown. To the contrary, intelligence and spatial skills are most certainly developed rather than innate. The learning environment created by the teacher can change the mindset—and the achievement—of his or her students.³⁴

Spatial Skills

One of the more significant contrasts revealed by the majority of modern research on gender differences is large inequalities between boys and girls in the area of spatial skills. Of particular interest is the disparity in the ability to mentally rotate three-dimensional objects. The disparity is important because girls' SAT-M performance is significantly predicted by this skill.³⁵ Strategies that will have the greatest impact for girls combine both affective factors and spatial skill practice. For instance, between 1989 and 2009, boys won 17 of 20 National Geographic Bees, and even at the local level, girls

tend to score significantly lower on social-studies tests where spatial and geographic abilities are required. Spatial skills, however, can be learned, and girls who participate in activities that improve their spatial awareness show improvement in related skills and achievement in STEM classes. Early-childhood education should include shape manipulation, visualization, measurement, and estimation, all of which develop skills that play a prominent role in higher-level mathematics. Throughout the grades, teachers should incorporate mental-rotation skills and other spatial-skill training into the curricula.³⁶

Including puzzles and/or games that teach concepts such as proportionality and symmetry are beneficial, as well. Blocks and other building toys like LEGO sets and drawing will help students develop spatial skills. Be sure to consider the color and theme of the toys in order to appeal to both genders. Games such as chess can be introduced, especially to girls, since chess strengthens spatial skills as well as logic and trains participants to think ahead.³⁷

Sports also improve spatial skills through movement—throwing and catching, aiming, and judging reaction time. All students, but girls in particular, will reap many benefits from greater participation in athletics and physical education.³⁸ Dr. J. J. Edwards found that, besides spatial skill improvement, exercise provides the added benefit of motivation and camaraderie.³⁹

Spatial skills can also be improved by the use of video games that involve fast-paced hand-eye coordination. Students who spend more structured time on the computer develop their capacity to solve technological problems and understanding of software.⁴⁰ As students become aware of applications, software, and connectivity, this builds

interest and appreciation for technological applications.

Student Involvement

Teachers must confront students' stereotypes concerning mathematics and their ability to do math. All students should be urged to participate in mathematics-related activities, and girls especially should be encouraged to apply to math and science programs, regardless of the schools' cut-off scores. Students can be admitted on worthiness based on alternate sources of ability/effort.⁴¹ Other suggestions: Provide hands-on opportunities, encourage all students to be creative, and teach students to take calculated risks and make educated guesses. Unless there are scoring penalties, students should attempt to answer all test questions. Collaboration time on mathematics is also important for confidence building.

Conclusion

Whether one considers mathematical score differences between boys and girls to be innate or the result of flawed policies and prejudicial treatment, the use of SAT-M scores for admission purposes runs the risk of creating barriers for girls attempting access to a college education and especially to STEM majors. Compounding this problem is the likelihood American higher education will continue to require high SAT and ACT scores for entrance. These types of tests present the appearance of supporting high standards, so dropping the requirement would give the impression of de-emphasizing academic rigor.⁴²

To shape young people's attitudes about STEM careers, teachers, administrators, and parents should emphasize that mathematics, formulas, and equations are the source of today's technology—including cell phones, medical advances, new cosmetics, and advances in digital and sound technology, and



that mathematics and science are the common denominator in high-paying careers. Career counseling, peer representation in STEM classes, and role models are of paramount importance in encouraging both genders to succeed at math and science and to choose STEM-related careers.⁴³ Teachers should teach to students' strengths while simultaneously avoiding harmful stereotypes. For further information, I highly recommend the report *Why So Few? Women in Science, Technology, Engineering, and Mathematics* by Hill, Corbett, and Rose⁴⁴ listed in the references.

And finally, teachers need to keep learning themselves and seek input from professionals to develop a pedagogical style that enhances every student's academic achievement. ✍



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