The Teaching Implications of Gender Inequality

By Dr. Murray Cox

“Train a child in the way he should go, and when he is old he will not turn from it” (Proverbs 22:6 New International Version).

How do we raise up children to enter into science, technology, engineering, and mathematics (STEM) careers? There is an unwritten rule that 100% of students need to be prepared to pursue collegiate level mathematics. However, only 18% of U.S. female college freshman plan to enter STEM careers (National Science Foundation, 2009). For instance, a 2009 poll indicated that as few as 5% of U.S. girls age 8 to 17 were interested in engineering (Hill, Corbett, & Rose, 2010). Dissatisfaction continues at the workplace level where even though more women than men are likely to be hired, Cathy Trower of Harvard University found a higher turnover rate for women in STEM careers due to lower job satisfaction than seen in their male counterparts (Hill, Corbett, & Rose). How can we guide each student, male or female, to find interest and happiness in STEM careers? We want each student to study the topic that most arouses their interest and provides self-fulfillment (by self-assessment).

If students’ future career needs are accurately perceived by their elders, who are to raise them up in the way they should go, then students are wise to follow the path their leaders believe to be of most importance. Hence, it is important to properly interpret the E. G. White (1905) comment or suggestion: “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 homemaking” (p. 216). In today’s world studying mathematics has more practical applications than it once did and a larger number of women are no longer training for home-making and child rearing. In other words the suggestion loses relevancy in contemporary society. So what type of education truly provides 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 20 years of teaching experience.

Student Interest

In the field of education, students' needs, desires, ability, and access do not necessarily converge in an effectively functioning ratio. More frequently, interest supersedes ability regardless of need or access. For instance, modern studies agree with Heller and Ziegler (1996) who showed that women from around the world express less interest in physics and mathematics and the magnitude of the difference increases with the grade level. More women study in nearly every area of graduate education with exceptions including mathematics, engineering, computer sciences, and the physical sciences (Tsui, Xu, & Venator, 2011). Gender differences are evident in a number of countries. Consider the following male/female ratios in academic areas for 12th and 13th graders in Germany: 2 to 1 in math and chemistry, 8 to 1 in physics, but 1 to 3 in biology. Analogously, the male/female ratio for the SAT achievement test, mathematics portion (SAT-M), performing at the average level is 2:1. This ratio jumps to 4:1 for the top 15% and 132:1 for the highest 2%. Significantly fewer women than men, from around the world, participate in mathematical fields (Heller & Ziegler).

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) stated that recent data indicate persistent achievement disparities in STEM courses at the K-12 level as seen in Advanced Placement scores (National Math and Science Initiative, 2012).

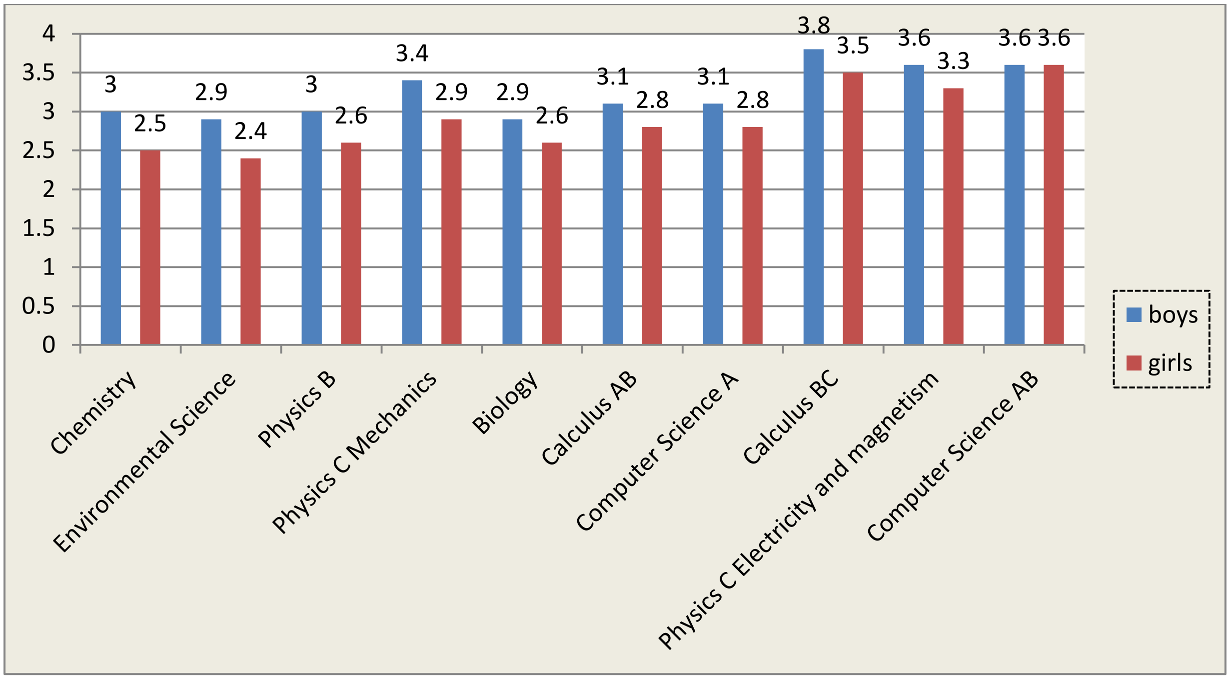

Figure 1: Advanced Placement (AP) Average Scores by Gender, 2009.

Source: Data from Hill, Corbett, and Rose (2010).

Inequality Versus Inequity

Two terms that are often confused are "inequality" and "inequity." For the purposes of this article, I am referring to an inequality as a situation that is different by nature and not an unscrupulous, unjustifiable difference. An inequity is defined as a biased and/or injurious situation. Inequities grate against our sense of fairness and should be changed; inequalities are facts of life in need of acknowledgement.

In the average U.S. university more undergraduate women receive passing grades than men. Is this an inequity or an inequality? Since more women than men receive Bachelor of Arts degrees (133 to 100) according to the National Science Foundation (2009), this is merely an inequality without the sense of unfairness that an inequity produces. The situation might be an inequity if one were able to demonstrate favoritism towards female students.

What about the often recited statistic that women make $.77 on the dollar when compared to men. Inequality or inequity? This is another inequality since women, on average, work fewer hours in less richly remunerated occupations. On a side note, this is rapidly changing as the number of women increase 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 controlled by men (Tsui, Xu, & Venator, 2011).

Boys pay more for car insurance than girls. Inequality or inequity? This, again, is an inequality even though boys are safer drivers (fewer accidents per mile). Multiple studies by the University of Michigan, Johns Hopkins, and Purdue found that women are far more likely to be involved in an accident, especially when the other car is also driven by a woman (Dye, 2011). Boys' insurance rates are higher because they tend to drive more miles than girls, not because they are more reckless. For teenagers, gender is merely being used as a proxy for miles driven.

Now, what about the statistics previously mentioned concerning student interest levels? Consider the fact that boys score higher than girls on the SAT-M as well as the ACT (Hill, Corbett, & Rose, 2010). Is this an inequality or an inequity? There are groups that claim that high-stakes standardized test questions are biased towards males (inequity). Conversely, there are groups that claim the male and female brains are formed differently in the womb, and boys and girls simply have differing desires (inequality). Should the SAT-M testing difference be treated as a simple inequality or an egregious inequity? The way a teacher chooses to answer this dichotomy affects the type of pedagogy he/she employs in the classroom and flavors his/her interaction with students.

Educators Who See Gender Testing Differences As An Inequity

Teachers who consider differential math-test scoring as an inequity may point out that even though males score significantly higher on the SAT-M than do females, the SAT has little to do with college readiness. And yet the fact that women score lower on the SAT-M creates a disadvantage since 92% of universities require SAT scores, and 75% of them use SAT scores as part of the admission process (Nankervis, 2011). Therefore, even if testing differences are considered to be an inequality, the situation quickly becomes an inequity if test scores are then used to disadvantage one group. Hence, the use of SAT-M scores effectively reduces a girl's chance at a college education and scholarships.

The claim of inequity is further bolstered when one considers that more selective schools, such as Texas A&M, require a minimum of 600 on the SAT-M which means "one in every four college-bound males in Texas is eligible, (but) only one in every seven females qualify" (Nankervis, 2011, p. 29). And the more selective the school, the larger the gender difference in mathematical performance (Tsui, Xu, & Venator, 2011). Mathematics becomes the doorway, or the blockade, that leads to, or prevents, higher paying, more prestigious jobs. Every one of the top 15 highest paying college degree careers has a heavy dose of mathematics as their common denominator (Pepitone, 2009). 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 (Larson, 2010). Herein lies the root of the inequity claim: access to college opportunities produces an unfair situation due to the SAT scoring differences found between boys and girls. Though there are surely biologically-induced gender differences, the continual low performance in mathematics among women is not one of them (Tsui, Xu, & Venator). Instead, candidate interest levels play a foundational role.

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Teachers who consider math score differences as an inequality 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 tracking fast moving objects in the male determination. These natural differences developed before birth result in both sense differences (sight, smell, hearing) and personality differences (risk taking, empathy, aggression) according to Evans and Chancellor (2008).

Globally speaking, females are more verbal than males, they tend to know more words at an earlier age, they have more acute hearing, they are better able to read faces and body language, they have a higher perceptual speed, they are more content to observe, and in stressful situations they will ask for help sooner or put up with the situation longer. Boys, on the other hand, are better at spatial reasoning, they have more acute vision, they learn best in kinesthetic activities, they have a greater need for activity, they recall better with visual cues, and in stressful situations they tend to “fight-or-flight” (James, 2007). The very senses as interpreted by the brain can be claimed to be inborn inequalities which results in measureable testing differences.

Further widening the achievement gap is the fact that boys tend to score higher on complex problem solving at high levels due to their personality tendency to be risk-takers and their consideration of multiple problem solving procedures whereas girls tend not to leave prescribed formulas or algorithms (Rebhorn & Miles, 1999). Even though women receive higher grades in both high school and college, men outperform women on tests that cover material not specifically taught in class (Tsui, Xu, & Venator, 2011). At beginning level problems, boys and girls score about the same, but boys score higher on complex and multi-step procedures (James, 2007). The indication is that girls are better students while boys are better at free thinking.

Teaching Implications

As a rule, the art of teaching presupposes inequality. Not everyone is equal. Certainly in God's eyes everyone is equally valued, but in the classroom not everyone is intellectually equal, not everyone is equally educable, and, for a variety of reasons, not everyone is equally motivated. Being retrospective about why differences exist between the genders may not be as important as focusing on a plan of action for students who are sitting in a desk ready to learn. At that immediate moment, they are in need of an education not an *a priori* explanation as to why they are the way they are. As a teacher in front of a classroom, it is more prudent not to pit nature against nurture but instead concentrate on methodologies for their joined and separate contributions (Casey, Nuttall, & Pezaris, 1997). An appropriate plan of action should include four important ideas: motivation, spatial skills practice, representative teaching, and student involvement.

Motivation

First and foremost, the learner has to want to learn. Or as Belcheir (2002) stated, "…ultimately nothing an instructor can say or do will make a difference if the student is unmotivated to implement it" (p. 2). This is simply the wisdom of the age-old cliché "you can lead a horse to water, but you can't make him drink." Of course, not all horses may be thirsty, but a person could always feed them salt.

Motivation is the teacher's primary objective in the education of boys and girls, and each student requires a different type and level of motivation. For example, even when girls and boys, with similar grades, are compared, girls report feeling more hopelessness and shame and less enjoyment and pride in their accomplishments than do boys. Though recent research is finding declining differences between the genders in mathematical achievement, there does not seem to be a considerable decline in the affective differences. In other words, progress is being made in cognitive performance, but the gap remains large in terms of attitudes that relate to learning in mathematics (Frenzel, Pekrun, & Goetz, 2007). The student who discovers how to educate himself/herself must first acquire the appropriate motivational attitude towards learning.

Motivational differences start to take a toll as girls progress towards high school. There are nearly 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 (Rebhorn & Miles, 1999). The most damaging period for a young girl occurs when she leaves elementary school and transitions to middle school (Sadker & Zittleman, 2009). 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" (Frenzel, Pekrun & Goetz, 2007, p. 509). The best educational approach for girls is to focus on the influence of the environment on affective factors such as self-confidence, attitude, and perception (Rebhorn & Miles). Teachers need to focus on enhancing females' conviction of their ability to learn mathematics. This encouragement is especially important because their assurance in learning mathematics is significantly related to their mathematics achievement, which tends to decline in the middle school years. It is critical that teachers help girls form correct estimations of their capacity to learn mathematics (Casey, Nuttall & Pezaris, 1997).

Students are most interested in continual feedback for motivational purposes. Students tend to find success with a combination of high-quality instruction and motivation. When pedagogy is solid, expectations are clear, and consequences are adhered to, students produce to the best of their ability (Cox, 2011).

Representative Teaching

In the learning environment it is worth considering archetypal gender strengths and preferences without resorting to harmful stereotypes. Girls benefit from hearing more than seeing; therefore, descriptive explanations are helpful. Boys are attracted to moving objects so teachers should not stand still during lecture. Girls will ask an overabundance of questions and teachers need to be Socratic with answers. Boys tend not to ask during a struggle and it could be helpful to pair them up in order to encourage communication. Girls will read the teacher's face, so a teacher must be wary of providing body language clues during the answering process. Boys tend to look down or away when answering questions; however, this lack of eye contact is not an indication of ignorance. Often they are simply processing (and in some cultures it is considered impolite to make eye contact), so providing them ample time to answer will help (James, 2007).

Teaching to attitude is similar. The mindset of students can be gauged by their reaction to puzzles and brainteasers. Are the students persistent or do they give up easily? Does failure induce 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 consider themselves non-smart. With this perspective, students believe that intelligence is simply a static fact and are unaware that it can be grown. To the contrary, Intelligence and spatial skills are most certainly developed and not innate. The learning environment created by the teacher can change the mindset of the student (Hill, Corbett, & Rose, 2010).

Spatial Skills

One of the more significant contrasts indicated in the majority of modern research on gender differences is the revelation of large inequalities in spatial skills. Of particular interest is the disparity in three-dimensional mental rotation ability. The disparity is of interest because girls' SAT-M performance is significantly predicted with this mental rotation skill (Casey, Nuttall, & Pezaris, 1997). Girls are best served with both affective factors and spatial skill improvement. For instance, between 1989 and 2009 boys won 17 of 20 National Geographic Bee's, 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 partake in activities to improve their spatial awareness show improvement in STEM classes. Early education should provide the opportunity for students to practice shape-manipulation, visualization, measurement, and estimation. All these skills play a prominent role in higher level mathematics. Teachers should include mental rotation skills and other spatial-skill training directly in the curricula (Eliot, 2009).

The inclusion of puzzles and/or games that make use of concepts such as proportionality and symmetry are beneficial. Teachers could encourage the use of building blocks, drawing, and other building toys like LEGO sets. 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. The ratio of male-to-female grand-masters in chess is around 99 to 1. Chess exercises spatial skills as well as logic and thinking ahead (Eliot, 2009).

Sports also improve spatial skills with movement, throwing and catching, aiming and reaction time. All students, girls in particular, reap benefits from a greater participation in athletics (Eliot, 2009). Dr. J. J. Edwards (2012) found that, besides the spatial skills being improved, exercise has the added benefit of creating a motivating camaraderie that encourages students' efforts. In other words, exercise also provides highly desired affective qualities such as motivation.

Additional spatial skills can be improved with video games that involve fast-paced hand-eye coordination. Furthermore, students who spend more time on the computer also build fluency solving technological problems and build an understanding of software (Eliot, 2009). Awareness of applications, software, and connectivity all build interest and appreciation for technological applications.

Student Involvement

Students should have the opportunity to address stereotypes concerning mathematics and the ability to do math. Collaboration time on mathematics is also important for confidence building. All students should be encouraged to participate in mathematics-related activities, and girls especially should be encouraged to apply to math and science programs regardless of cut-off scores. They can be admitted on alternate sources of ability/worthiness evidence (Rebhorn & Miles, 1999). Other suggestions are to 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, all test questions should be attempted and answered.

Conclusion

Whether one considers mathematical score differences between boys and girls to be an inequity or an inequality, the use of SAT-M scores for admission purposes runs the risk of being misused as a barrier for girls attempting access to a college education. To compound matters, it is unlikely that the current education system will do away with SAT scores. These types of records present the appearance of scholarly values, and dropping the requirement of SAT scores would give the impression of lowering academic standards (Nankervis, 2011).

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. Furthermore, it should be pointed out that mathematics and science are the common denominator in high-paying careers. Career counseling, peer representation, and role models are of paramount importance (Eliot, 2009). Teachers should teach to students' strong suit 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 Rose (2010) listed in the references. Finally, it is important that teachers not stop learning themselves. Teachers should seek input from professionals with a pedagogical style that promotes and/or results in academic achievement.

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