Title	Closing the gender-gap in mathematics: some insights for educators
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Source	*The Mathematics Educator, 1*(2), 181-191
Published by	Association of Mathematics Educators

The Mathematics Educator
1996, Vol. 1, No. 2, 181-191

Closing The Gender-Gap In Mathematics: Some Insights For Educators

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Abstract

Gender-differences in mathematical tests seem to exist. While girls often do well in classroom tests, boys outperform them in standardised tests. Educators attempt to understand such differences from a social and cultural perspective. Gender is a social concept. Gender-identity and gender-roles are developed during the socialization process. If parents and educators provide a gender-free learning environment, it is believed that both boys and girls can do well in mathematics. It is undeniable that males and females are to a certain extent biologically different. Educators should pay intensive attention to the social and economic factors that shape a person's self-beliefs and social perception. Discussion of ways to narrow the gender-gap in mathematics is presented.

Introduction

Gender similarities and differences have been an essential theme of research. While some researchers focus on similarities between females and males, others concentrate on differences between them (Kimball, 1994). Biologically, there are minor differences between men and women (Kimura, 1987). However, there is no significant evidence that these differences affect females' and males' ability in any field. It is appropriate to claim that men and women from a given culture are quite similar to each other in the context of diverse culture (Kashima et al., 1995).

Gender issues in mathematics education have drawn the attention of many researchers (Zaher, 1996; Pollina, 1995). Mathematics often possesses a public image as difficult, cold, abstract, theoretical, important, but largely masculine (Ernest, 1995). It is perceived as a harder subject for women than for men (Morgade & Bonder, 1995). Some gender differences in mathematical achievement seem to exist (Kimball, 1989). The frequent difference between boys and girls is found in standardised tests (Byrnes & Takahira, 1993). In the classroom situation, female students generally achieve as good as or even higher grades in mathematics than male students (Kimball, 1989). It is hypothesised that these differences may be caused by females' and males' attitudes towards and self-confidence in mathematics rather than

by their actual achievement (Boli, Allen & Payne, 1985). Fortunately, differences in performance have been decreasing over the years (Benbow, 1992; Friedman, 1989). It is the main concern of the educators to narrow the gender-gap in this respect. Gender differences in mathematics are a result of a social and cultural imbalance in nurturing rather than of biological differences.

When we retrieve the social and pedagogical environment of Emmy Noether (1882-1935), one of the greatest mathematicians of this century, we have to admit that females' mathematics learning and teaching environment today, to a large extent, has been improved. Emmy Noether was rejected from holding an official lecture position at the university because she was a woman (Ernest, 1976).

A survey on the secondary technical and vocational education was carried out in 90 countries and territories by the Division of Statistics of UNESCO (Clair, 1995). Results showed that there is a slight increase in the proportion of women studying technical subjects in a certain population of European countries and Arab states. Nevertheless, on the whole, men are clearly dominant (three-fourths or more) in the broad field of industry and engineering, and in agricultural courses. Factors that influence women's work are more than just physical strength and child-care compatibility. Minimal exposure to danger and shorter travel distance are two of many other factors that may govern females' choice of work (Nadine, 1991).

Gender as a Social Concept

A person is a complex entity. He or she can be "defined" by features associated with him or her in *biological, cultural, social and economic,* and *psychological* dimensions (Figure 1). These dimensions interact and often overlap. The *biological* dimension is associated with a person's in-born features, for instance, physical appearance, sex and age. The *cultural* dimension comprises elements such as language, ethnicity and race. It is a person's inherited background and has a long history of development (over many generations). Elements that construct the *social and economic* dimension are one's social and economic status, education and profession, as well as religion and beliefs. To a certain extent, a person can exert control over and influence on the social and economic dimension. Education, for instance, is a social institution that can generate social and economic transformation for a person and/or a group. The *psychological* dimension is related to an individual's personality, behaviour and cognition. Whereas the *biological* dimension deals with a person's natural growth, the *psychological* dimension concerns an individual's development which may be influenced by *cultural, social and economic* factors. A person usually forms a

perception of himself or herself and of other people by referring to the information available in these dimensions.

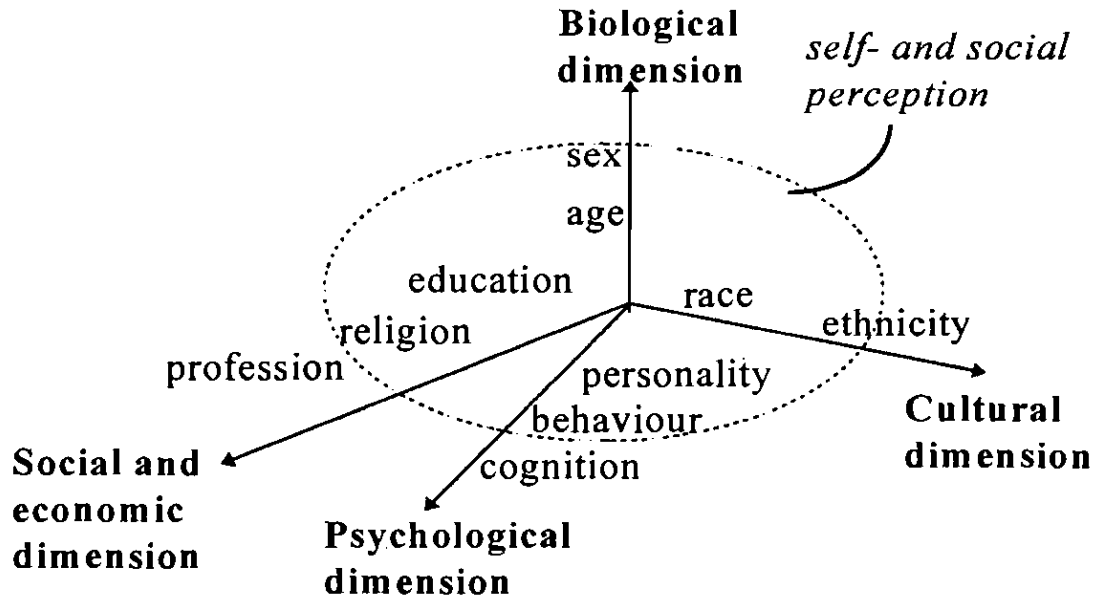

Figure 1. A Person's Perception in Reference to Information Available in Various Dimensions

Gender is often used interchangeably with *sex*. Both terms can denote the meanings of male and female categories. While *sex* can usually be decided on the basis of physical anatomical evidence, *gender* is a social or cultural concept built on this physical distinction (Berry et al., 1992; Cross & Markus, 1993). The latter is associated with cultural experiences, feelings, beliefs, and attitudes. A child usually gains the knowledge of its *gender-identity* at the age of two or three. At this stage, it learns to label other boys and girls accurately (Leinbach & Fagot, 1986), and becomes aware that it belongs to one category or another (Thompson, 1975). Children and adolescents use gender as an organizing theme to classify and understand their perception of the world (Bem, 1981). According to Fagot, Leinbach and O'Boyle (1992), children who understand labels for boys and girls display more knowledge of *gender stereotypes* than children who do not. Children learn stereotypes through observing and modeling what adults do. "*Stereotypes* are standardized beliefs about an identifiable group" (p.225). They can function as schemata about group members. *Gender schemata* are cognitive structures that organize an individual's gender-related knowledge, beliefs, attitudes and preferences. The degree of the influence of stereotype varies according to age and sex. "Very young pre-school children express more flexibility prior to stereotype acquisition, which decreases as stereotype information is learned and increases again in middle grade school" (Katz & Ksansnak, 1994, p. 281).

Gender Development in Cultural Transmission

According to Segall and colleagues (1990), gender roles are culturally rooted prescriptions of male and female behaviours, for instance, the division of labour by sex. Gender identity concerns how one perceives oneself in respect to sex and gender roles. Sex-role ideologies are related to sex-types, the attitude governing relations between the two sexes, and their relative statutes. Gender-role, gender identity and sex-role stereotypes are inherent culturally (Segall et al., 1990). *Cultural transmission*, according to Berry and colleagues (1992), is a process in which a cultural group can perpetuate its behavioural, social, cognitive features among subsequent generations through *teaching* and *learning* mechanisms. An individual's psychological outcomes are determined by cultural transmission which occurs in three directions (Figure 2). Parents, other adults and peers form a network of influences on the individual, all of which can "limit, shape, and direct the development of the individual" (Berry et. al., 1992, p.19). The *vertical* transmission involves the general enculturation and specific socialization from parents in the child rearing process. Enculturation is learning without specific teaching. Socialization refers to the process of deliberate shaping of the individual. A child is the receiver and parents are transmitters. Both enculturation and socialization are the development of behavioural, cognitive, and affective similarities within cultures. Parental expectations and beliefs towards a child's, a daugther's or son's, ability may influence his or her self-beliefs in that ability. A child will likely develop a similar or analogical behaviour and/or cognition through imitation and modeling. If parents believe that mathematics is a subject for sons but not for girls, it is likely that their daughters will set low self-expectations in this subject.

In the *oblique transmission* a child learns from other adults its cultural setting through general enculturation and specific socialization. It also learns from adults of other cultural settings during the acculturation and specific resocialization. Whereas enculturation takes place in childhood, acculturation can occur at any time in one's life. Acculturation refers to "cultural and psychological change brought about by contact with other peoples belonging to different cultures and exhibiting different behaviours" (Berry et. al., 1992, p.19). Resocialization occurs when the deliberate influences come from other cultures. Teachers are, for example, the socializing agents in the oblique transmission. If a teacher's cultural beliefs are different from those of the students, acculturation and resocialization may take place in learning. Teachers' expectations and beliefs have a strong influence on a student's performance. If teachers hold the belief that mathematics is a subject for males, and set high expectations for them, it is very likely that they

will perform well. On the other hand, if teachers possess egalitarian attitudes and set no gender bias expectations, it is likely that girls and boys will have similar patterns of achievement.

Horizontal transmission involves general enculturation and specific socialization from peers. Peer's values, beliefs, and behaviours transmit horizontally to the growing child, but overtake parents' influence gradually from the late childhood. Positive and mutual communication between female and male students should exist to maximize optimal *gender-free* learning environment. Some research findings show that girls do not receive much information from peers, particularly male peers, in small groups within mathematics classes (Webb, 1984; Webb & Kenderski, 1985). The lack of information may be one of the reasons why gender-differences in performance exist. Educators should be aware that females and males may possess different styles of learning. There is a positive correlation in girls' performance and a cooperative environment, but a negative correlation with a competitive environment (Peterson & Fennema, 1985).

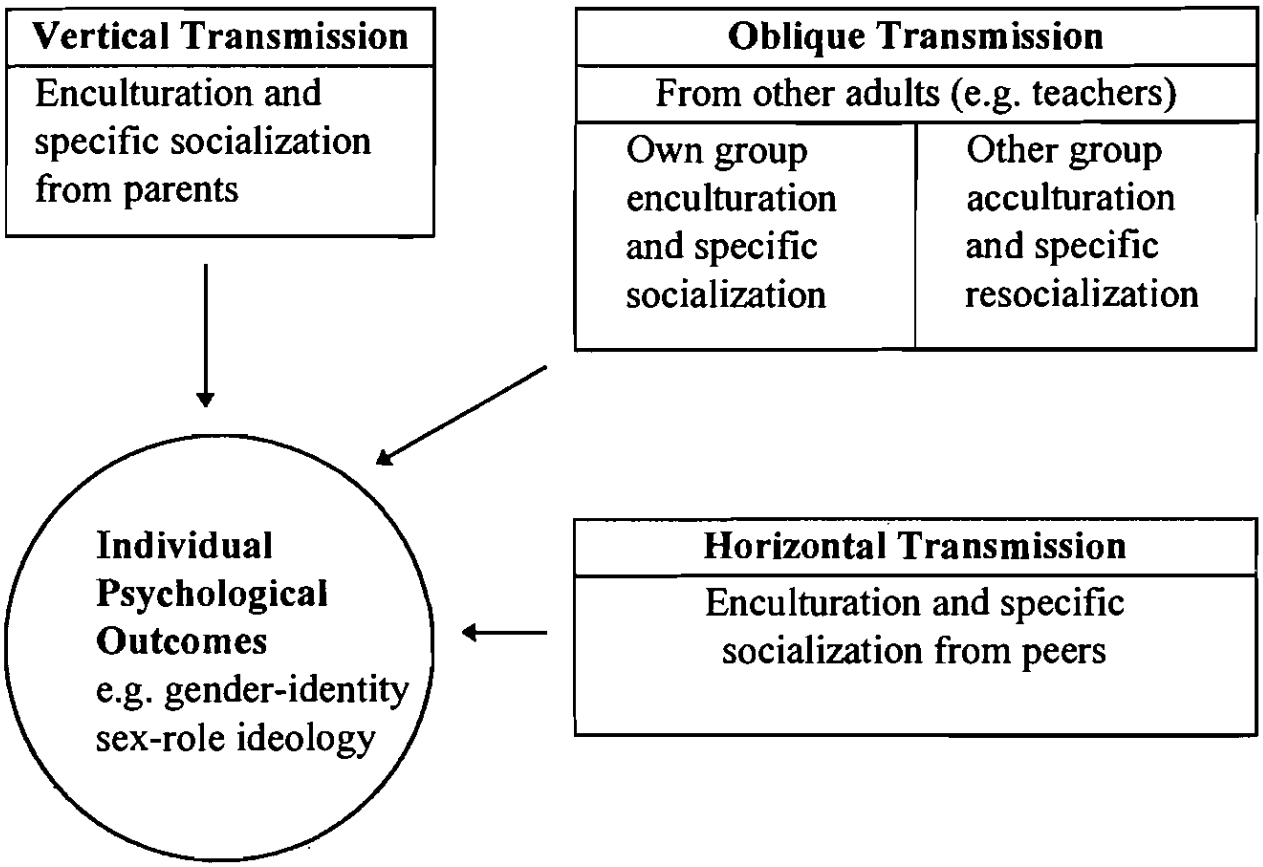

Figure 2. Cultural Transmission and Gender Development, Modified from Berry et. al. (1992)

Boys Outperform Girls in Mathematics - A Gender Effect?

It is inappropriate to generalize that boys outperform girls in mathematics. Research findings show that in standardised tests boys often do better than girls. It is not always so in classroom tests. As Byrnes and Takahira (1993) discovered, male high school students' outperforming females on the math subset of the Scholastic Aptitude Test (SAT) was due to their prior knowledge and strategies. Standardized tests are perceived as tests of ability, whereas tests in the classroom situations may be considered as tests of effort. Mathematics as compared to other subjects is often referred to as a subject that demands a person's ability. In Seegers and Boekaerts' (1996) study, boys from a group of 8th graders (ages 11-12) performed better than their female counterparts on a mathematics test (algorithmic problems, mental arithmetic, fractions, ratios, measuring, and percentage problems). Seegers and Boekaert found that these differences were paralleled by differences in trait-like, self-referenced cognition in general learning situations and task-specific appraisals. Self-referenced cognition is defined as "cognitive variables that refer to the perception individuals have of themselves, including their attitudes, feelings, and knowledge about their abilities and skills" (p.216). They can be motivators or inhibitors of behaviour and thinking. Seegers and Boekaerts' (1996) results showed that girls tend more than boys to attribute failure to lack of ability. Boys were more inclined to explain a good result in terms of their superior capacity. On the other hand, girls reported that they were more prepared to invest efforts in mathematics tasks than boys. If we assume that females and males receive equal pedagogical materials and attention, one of the factors that may cause gender differences is males' positive self-beliefs and strong interests in learning mathematics. It is believed that motivation, personal beliefs, appropriate attributions, and affective states influence the development of metacognitive systems. Male students have more role models than female students, especially in the higher learning and in professional, engineering and technical fields (Clair, 1995).

Loudet-Verdier and Mosconi (1995) reported in their study on mathematics classes that boys interact more and longer with their teachers than do girls. Inequality seems clearer in classes taught by female teachers. There are other reasons for male students receiving more attention from teachers. Teachers pay more attention to male students than to female students, especially in relation to negative conduct (Hamilton et. al., 1991). Furthermore, boys are more prone to boredom than girls (Sundberg et. al., 1991).

Accommodate Differences: Towards Gender-Free Education in Mathematics

The notion of *gender-free* learning and teaching is introduced. *Gender-free,* but not sex-free, is emphasized because the former is bound to the influence of a person's social and cultural development. In a *gender-free* environment, individuals receive equal opportunities to grow and to develop. Physical and anatomical differences are considered as variations and parts of individuals. Adults are facilitators. They set up a variety of tasks, learning situations, and role models that are free from gender biases. Gender-stereotypic behaviours and thinking patterns are not emphasized. An individual, boy or girl, is taught with the same material, same pedagogical methods and attitudes. Equality in learning is based on a person's needs, interests, strengths, and weaknesses. Under the *gender-free* concept, boys and girls grow and learn in a psychologically safe environment. They receive optimal attention from the facilitators. Each individual's strengths will be developed, whereas his or her weaknesses will be remedied. Flexibility in teaching and learning is encouraged. A learner is allowed to participate in any kind of activity of his or her choice. It is shown that pre-school children with more flexible norms exhibit less gender-typed toy choice than children with rigid norms (Lobel & Menashi, 1993).

Multicultural education in mathematics should be introduced along the line of the concept of *gender-free* learning and teaching. Multiculturalism accepts differences and deficiencies (Manning & Baruth, 1996). Each individual is unique. In a multicultural environment for learning mathematics, females and males, gifted and disabled, rich and poor, young and old, people of various cultural and linguistic practices, will be treated as individuals. They are given optimal learning conditions.

Closing the Gap

Educators are interested in regulating changeable factors for an optimal development. The long history of the division of labour may have caused minor biological differences between males and females (Kimura, 1987). Considering this argument, educators should try to design long-term fair and gender-free learning and teaching programmes. To assist girls to build-up confidence in mathematics, Kimball (1989) suggests that school grades in mathematics be taken into account in evaluation. Parental attitudes towards and media reports on a child's mathematics performance should not be *gender-biased.* Schools are institutions that can transform a person's beliefs and perceptions. It is, thus, indispensable to design a mathematics curriculum that incorporates *gender-free* attitudes. Gender research should look into the development of various learning

behaviours, peer and student-teacher interactions in school, and school as a social situation (Tittle, 1986). The topic selected for research should also be a topic of interest to women, sample selection should not be based just on age, and age does not always assure that life activities or priorities are comparable (McHugh, Koeske & Frieze, 1986). In the data analysis, it is important to examine the data distribution. Favreau (1993) discovers that in some women's scores, the distribution is bimodal rather than normal as shown in males' scores. By considering the above-mentioned perspectives, I hope that the gender-gap in mathematics performance will be narrowed, and eventually be eliminated.

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