Commentary on the Chapter by Gabriele Kaiser, Maren Hoffstall, and Anna B. Orschulik, "Gender Role Stereotypes in the Perception of Mathematics: Results of an Empirical Study with Secondary Students in Germany"

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1 Affective Factors Matter

Since the mid-1970s gender differences favouring males in mathematics achievement at all levels of schooling and participation at post-compulsory levels of schooling have declined around the world. Yet gender differences in mathematics self-efficacy that favour males have remained intransigent, and the gender stereotyping of mathematics proficiency and interest persist. The study by Kaiser, Hoffstall and Orschulik is the latest in a series of studies commencing in the mid-1970s (Fennema and Sherman 1977) to provide evidence of higher self-concept in mathematics for male students compared to female students, and male stereotyped views of mathematics learning and achievement, especially among senior secondary aged students.

The early gender studies of mathematics set out to confront male hegemony with respect to mathematics. Feminists simply did not accept that males were innately better at and more interested in mathematics than females or that mathematics was a male domain. Along with research on affective factors, researchers also investigated the experiences and work of female mathematicians and the mathematical expertise of ordinary women (e.g., Burton 1995, 1999; Day 1997). They observed, analysed, and exposed mathematics classrooms in schools and tertiary institutions as male-biased environments (e.g., Jungwirth 1991; Leder 1993; Rodd and Bartholomew 2006; Shannon 2004; Vale 2002). Finally feminists exposed gender-biased and stereotyped perceptions of mathematics among the general community including parents (e.g., Forgasz et al. 2000; Walls 2010). Over time this research resulted in changes in curriculum, pedagogies and some methods of assessment to enhance learning, engagement and participation of female students in mathematics at all ages, and especially in secondary school mathematics. And, as noted above, researchers continue to monitor achievement, affect and participation by gender, and

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to press for developments in mathematics and mathematics teaching and learning that promote gender equity.

The instrument used for this and earlier studies captures the degree of gender bias in student perceptions for a range of factors associated with mathematics learning and use: capability, interest, work ethic, and value for their future. Previous studies have found that male stereo-typing of mathematics varies in intensity according to gender, age, country, and ethnicity. Kaiser et al. (Chap. 11) reported frequencies and means for individual items and compared mean scores by gender and age. For a number of items mean scores did not appear to differ much from neutral and statistical inference tests could have reported effect sizes to establish whether gender stereotyping was statistically evident. The authors note that their findings that male stereotyping of mathematics is more evident among male students and older students, both male and female, than among younger students concur with findings from other studies cited in their chapter.

Gender-stereotyping of mathematics matters, especially if we can establish a relationship with self-efficacy, achievement and/or participation. Kaiser et al. claim that in their study "the gender stereotypical perceptions of mathematics are so deeply rooted in the students' minds that the students… include them into their self-perception." Calculation of correlation coefficients for individual measures of gender role stereotyping and the item on self-perception was needed to establish a relationship that appeared to be present when reviewing the distribution of responses reported. Certainly males rated their achievement more highly than females overall and at the highest level (excellent), but the proportion of males and females rating themselves as excellent at age 15 showed an increase of 3.5% for males on those aged 12, and 3.4% for females, while the proportion of males and females rating themselves below average increased by 6%. Hence gender stereotyping in this study did not result in lower self-perception of females and higher self-perception of males at the older age. However, these data are not paired over time. A longitudinal study is needed to track changes in students' self-perception and perceptions of mathematics as a gendered domain over time. Such a study would provide evidence of the relationship between gendered perceptions of mathematics and self-concept that have been reported in narrative studies such as Walls (2010).

Just as gender differences in mathematics achievement vary from significant to insignificant among countries, the gender stereotyping of mathematics is more evident in Sweden, Germany and Israel than in Australia and the United States where mathematics is a gender neutral domain (Forgasz et al. 2004). Forgasz (2002) previously observed that gender stereotyping of mathematics belief is strongest among students from high SES school communities and weakest or not evident in middle class and low SES school communities. The secondary schooling system in Germany is stratified according to student achievement; this is highly likely to correlate with socio-economic status since, like Australia, German achievement in mathematics is more strongly correlated with socio-economic status than for other European and Asian countries (OECD 2004). It would be interesting to know whether male stereotyping relating to socio-economic status is also evident in the German data. The sample used for this study was dominated by students from "higher type secondary schools" (48.3%). It would be possible to conduct further analyses of these

data to determine whether the male stereotyped view pervaded all school types for both age groups. Such analysis would be important as gender stereotyping of mathematics has the potential to impact differently on girls' and boys' participation and achievement according to socio-economic status (Teese 2000).

2 Impact of Affective Factors

So what is the impact of these affective factors, that is, perceptions of mathematics, self-concept, confidence and self-efficacy in mathematics, on participation, engagement and learning, and achievement in mathematics? Intrinsic and extrinsic theories of motivation, along with socio-cultural and feminist theories, have been used when exploring these affective factors (Fennema and Peterson 1983; Forgasz 1995; Leder 1982; Thomson et al. 2004; Watt 2006). These studies reveal the complex gendered relationships between affect and cultural factors including learning behaviours, achievement, and participation.

Kaiser et al. found that students believed that girls achieve well in mathematics when they work hard, are conscientious, and ambitious, whereas they believe that boys are more likely to achieve well in mathematics because they are more interested and have better reasoning capability; findings not dissimilar to those reported in an earlier study by Leder (1982). In this study, and others, there is an assumption that participation and success in mathematics follow for students who don't "get the wrong answers", don't need "help in mathematics," don't have to "work hard to do well at mathematics" and who think "mathematics is interesting" and "will be important in his/her life." Yet the authors of this chapter concede that stereotyping of mathematics as a male domain and girls' lower self perception are "in sharp contrast to the general better achievements of German girls in school." Failure among students to appreciate that constructive learning behaviours such as persistence, diligence, autonomy, and respectful and productive relationships between students are related to success in mathematics may explain these findings and others reporting gender neutral perceptions of mathematics and the closing of the gender gap in mathematics achievement over time around the world (Boaler 2008; Fennema and Peterson 1983; Forgasz et al. 2004).

Thomson et al. (2004) argued that participation of females in tertiary mathematics and related disciplines could be increased if teachers attended to girls' attitudes, while Watt (2006) claimed that we need to find out why girls who perform as well as or better than boys regard themselves as lacking talent. Both of these views imply that girls are the problem. Shannon (2004) on the other hand argued that teachers need to change their practice so that girls come to enjoy mathematics, not feel alienated, and see it as relevant. Kaiser et al. argue that parents and teachers need to be much more aware of how gender stereotyping of mathematics in the community and schools is affecting girls' self concept with regard to mathematics. Their position sits well alongside critical theorists who call for deeper understanding of gendered subjectivity in order to implement strategies and approaches to develop the agency of young women in mathematics (Hirschmann 2003; Walls 2010). Researchers of

gender and mathematics need to continue to investigate approaches that promote productive learning behaviours and relationships with peers, teachers, and parents and positive self-concept and interest in mathematics especially for students, both girls and boys, who are most disadvantaged by the stereotyping of mathematics as a male domain.

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