Women's Role in Shaping Future Directions in Statistical Education

Shyamala Nagaraj
Department of Applied Statistics
University of Malaya
50603 Kuala Lumpur, Malaysia
g7shyn@umcsd.um.edu.my

This paper briefly considers the role of women in shaping future directions in statistical education. First, we discuss the need for statistics in a global-information world, and then look at women's participation in this new world. This is followed by a review of the role of women in statistics, as students, teachers, workers and professionals. Some suggestions for improving the position of women in statistics are then considered. The paper concludes with some implications for the future role of women.

1. The Global-Information Economy

Future directions in statistical education are likely to be governed by the needs of the global economy that is increasingly technology and communication-based (Ottaviani 1999). The high productivity work organization of a global-information economy demands effective thinking, problem-solving and communication skills, and thus requires education that develops the capacity to learn (Lee 1996). These skills are similar to those recommended for a well-grounded program in statistics (Curriculum Guidelines for Undergraduate Programs in Statistical Science, *Amstat News* February 2001: 24-25), and are perhaps fundamental to the process of statistical inquiry (Deming Lecture [by George Box] at JSM Focuses on Discovery, *Amstat News*, October 2000: 15).

To prepare a workforce that can play an effective role at all levels in promoting a competitive economy, statistical education should concomitantly be available at all levels and in all fields. At the minimum, the secondary school curriculum should provide for the development of skills (such as summarizing data and understanding variation) for simple inquiry, analysis and presentation of findings. Undergraduate education for non-statistical majors should, as proposed (Curriculum Guidelines for Undergraduate Programs in Statistical Science, *Amstat News* February 2001: 24-25), focus on the understanding the use of appropriate statistical methods including their limitations, while undergraduate majors in statistics should learn about the theoretical underpinnings of various statistical methods in at least one major area of application. Post-graduate education in statistics should broaden skills for new developments in statistics, including its effective integration in new areas of application.

2. Women in Statistics and the Global-information Economy

Are women in statistics in a position to respond to the new demands of the global-information economy? The answer to this question is evaluated for four areas in statistics: women as students, women as teachers, women as workers and women in research and other professional activities.

To provide a global (albeit incomplete) perspective, data for four countries are examined: United States (US), Norway, Malaysia and India. The US and Norway rank highly on the Human

Development Index, which is based on life expectancy, educational attainment and GDP per capita (HDR 2000: 269), while Malaysia ranks in the middle and India lower. The US and Norway remain in a high position on the Gender-related Development Index (GDI), which is based on the same variables as the HDI, but adjusted for the disparities in male and female achievements (HDR 2000: 270). However, in terms of the Gender Empowerment Measure (GEM), which uses variables constructed explicitly to measure economic participation and decision-making, political participation and decision-making and power over economic resources (HDR 2000: 271), Norway ranks way ahead of the US, and is in fact ranked first among the 70 countries for which the index is computed.

Although information on female students, educators and workers in statistics cannot be obtained directly, gross enrolment ratios and employment in relevant sectors can be used to assess women's participation on the basis of the linkages through the various stages of education that impact on the number of women in statistics. It is likely that in most cases, the study of statistics is available to science and mathematics students at the secondary level. In both the US and especially Norway, almost all secondary school age girls are in school; the percentage drops to 68.5 per cent for Malaysia and 48.5 per cent for India. Despite the almost universal access to secondary education in Norway, its percentage of female tertiary students in science enrolment is slightly lower than that for India, although the value is less than a third for both countries. In employment, among professional and technical workers, the group in which statisticians are likely to belong, the proportion female is highest for Norway, and lowest for India. The emerging pattern suggests a strong link between development and the education of women, but not between development and the number of women scientists.

The data for vocational and polytechnic education for Malaysia suggests that while female participation is low, that in engineering is even lower. The current Malaysian scene then suggests that while women are in the sciences, they are less visible in engineering fields. To the extent that statistics is part of the undergraduate science and social science curriculum, it would appear that women are reasonably well represented in Malaysia in statistics, especially in fields of application that are not related to engineering. Women statisticians are not uncommon among teaching staff, government statisticians, and market researchers.

The lowest rates of female participation rate in statistics can be seen in terms of professional recognition. Between 1914 and 1999, only 12 per cent of American Statistical Association (ASA) Fellows were female, although the proportion increased to about 23 per cent for the 1990s (Table 1). Female participation in professional statistical activities is also low. Recent data shows that 26 per cent of ASA members are female, and the rate is much lower at 9.9 per cent for membership of the International Statistical Institute (ISI).

4. Addressing Gender Diversity

Why is it important to be concerned about gender diversity in statistics? The most important reason would be the argument that everyone deserves the right to realize his or her full potential, and women should not be denied that right. Gender diversity in the workplace is important as women have a positive contribution to make, especially in understanding women-related issues. The latter becomes increasingly important with increasing female participation and even domination in some

industries, like in electronics. Gender diversity in the classroom is important not only because it will lead to gender diversity in the workplace, but also because it will encourage greater socialization and networking across gender barriers.

Carlson (2000) suggests that one explanation for the varying female representation among ISI membership by country can be found in the national education curriculum, that is, countries that require mathematics and science at secondary school are likely to have a greater proportion of females in science, and hence greater membership. Another factor is the indirect effect of development. It appears instead that the more there are female students in tertiary education (a function of the level of development and hence access to education), and as the female proportion relative to men increases, the more likely women are to enter tertiary education in science. Carlson (2000) also noted the low participation of women in statistics, even in teaching although, as she argues, the profession is less demanding than many others. Various studies point to the inadequacies in the work and study environments for women. Fourth, the "glass ceiling", whether real or perceived, may also be a reason for not moving into jobs that are seen as male-dominated. That promotional prospects to the position of professor are still poor for women in academia is clear.

Low female participation in statistics implies a need for pro-active measures, assuming that females are equally suited to the profession. Gender diversity needs to be addressed in the two broad areas: in the classroom and in the workplace.

5. Concluding Remarks

The position of women with respect to education is improving around the world. As developmental levels improve, more women have access to primary education, then to secondary education, and then to tertiary education. This trend is concomitant with a move away from specializations in the hard sciences to the social sciences. If future tertiary enrolment is largely female, it is apparent that women will need to be encouraged to move to the sciences, and by extension, to the study of statistics. The effect of gender on education suggests that a country that does not understand it, or fails to address it, may be constrained in its development by a workforce that does not have the appropriate skills to compete in a global-information economy.

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Table 1. Some Indicators, Women In Professional Statistical Activities

Item	Percentage Female	Source
ASA Fellows, 1914-1999	12.2	Kasprzyk, c. 1999
ASA Fellows, 1990-1999	23.4	Kasprzyk, c. 1999
ASA Membership, recent, based on 60% response	26.0	ASA Customer Service
ISI membership, 1999	9.2 (n=1996)	Carlson 2000
1998 ASA JSM Meetings	18.3 n= 2274	Ayeni and Mori 1999
Chair, 1998 ASA JSM Meetings	24.4	Ayeni and Mori 1999
Organizer, 1998 ASA JSM Meetings	24.3	Ayeni and Mori 1999
Invited Paper Writers, 1998 ASA JSM Meetings	20.0	Ayeni and Mori 1999
Discussants, 1998 ASA JSM Meetings	20.0	Ayeni and Mori 1999
First Author, 1998 ASA JSM Meetings	25.0	Ayeni and Mori 1999
Posters, 1998 ASA JSM Meetings	36.4	Ayeni and Mori 1999
ISI 2001 Participants, March 27	23.0 (n=1090)	Local Program Committee, ISI 2001
ISI 2001Organizers	16.2	Bulletin 1
ISI 2001US Participants, March	13.0 (168)	website*
ISI 2001, Norway participants, March	20.0 (10)	website*
ISI2001Malaysia Participants, March	37.5 (12)	website*
ISI 2001, India participants, March	14.8 (29)	website*

* www.nso.go.kr/isi2001. There are approximate figures, since it is not easy to identify gender from the names.