4. FOCI FOR CHANGE

— How can women's opportunities for careers in scientific and technical professions be expanded? Conversely, should women go into mathematics-related fields given the nature of the present system?

Girls and technology

The technological environment can, and does, affect student attitudes and their conceptions of what comprises desirable knowledge and understanding. In 1990, Ursula Franklin noted that the practices used in technology define its content and "when certain technologies and tools are predominantly used by men, then maleness becomes part of the definitions of those technologies". As a result, many female students do not appear to hold a worldview which includes technology as relevant to their lives or as appropriate for them.

Few educators would disagree that schools must be more responsive to the science/technology thrust of our contemporary world and to the related educational needs of all students. However, international investigations have noted consistent gender inequalities in the technological education. Important questions for educators to discuss include:

— How does the considerable and growing impact of technology on schools and its changing role affect the education of females?

— How can we foresee and influence how technology changes their education?

— Can we influence the designers and producers of technology, and hence how girls are educated, by setting technological goals (e.g. development of technical hardware for educational purposes)?

— How are the areas of computer studies and mathematics to be made more relevant/accessible to girls?

— How can the computer be used as a learning and teaching aid? What are the effects of certain implementations on the cognitive development of the learner?

— What are the epistemological changes due to the use of computers?

4. Foci for change

Curriculum

To achieve gender equality in mathematics education, educators need to look at the development, content, and presentation of the mathematics curriculum within its general educational context.

In this regard it is helpful to find examples of success in teaching mathematics to all students (and to be aware of criteria used to denote the term "success") and to learn from these successes. Some worthwhile questions for consideration are:

— Given the pattern of lower rates of female participation in elective mathematics courses, and the fact that mathematics is critical to careers at technical, professional and managerial levels, to what extent would it be appropriate to make mathematics a compulsory subject in schools?
— What would a gender neutral curriculum and pedagogy look like?
— Would single-sex education benefit students who tend to opt out of mathematics?
— Should different mathematics curricula be provided for different groups of students?
— Does the mathematics curriculum fail to deal with topics of particular concern to girls and women?
— Why do specific mathematics topics seem easier to one group of students than another?
— What are the essentials which must be contained in mathematics curricula?
— How can different components of curriculum — instructional methods, assessment programs, and resources produced by teachers and by publishers — be designed so that the development of mathematics skills and knowledge becomes a prime aim for all children?
— How can the pace and range of work in the mathematics classroom be adapted to allow for increased understanding by all students?
— Does the mathematics curriculum necessarily have to be so overloaded that the quantity tends to control the pedagogy?

ASSESSMENT

Assessment is a crucial component of mathematics education. It generally functions to provide information to assist in decision making about individual students, classes, teachers, programs, or institutions. The kind of information sought, how it is gathered, and the form in which it is reported, all have a bearing on mathematics education.

Major challenges and questions exist within the realm of assessment as it relates to gender issues. A critical question, for example, is whether mathematics is taught equally well to different groups of learners. Important queries within this larger question include:

— What is mathematical ability and how can it be measured?
— What kinds of mathematical tasks are being assessed (short technical exercises, long tasks, extended problems, etc.)?
— Are the methods of assessment used more favourable to certain groups of students?
— How can we ensure that classroom materials and exam questions properly reflect gender equity? Should they include a wider range of human activities and interests than traditional materials and examinations?
— Is the range of experiences provided in the mathematics classroom (or elsewhere in the school) biased in favour of one group of students to the possible detriment of others?
— Are there examples of assessment practices which are known to have a positive or negative influence on instruction? What aspects should be maintained and encouraged?
— Are there examples of assessment practices which negatively influence instruction; for example, by focussing instruction on assessment and tests rather than on more general goals?
— How do different assessment modes influence the social environment in the classroom?

TEACHERS AND THE SCHOOL

Teachers are one of the most important educational influences on students' learning of mathematics. The school environment or social context in which students learn mathematics is another critical factor, influencing how they learn, their expectations, their perceptions and misapprehension of mathematics and of schooling in general. More research is needed on how the ethos of the school and individual teachers shape or alter student attitudes towards mathematics.

With respect to teacher education, the general question remains of how to make teachers at all levels aware of, and hence how to eliminate, any gender bias in their current practices. More specifically, we need to ask the following questions:

— Do we need to improve in-service training? Should we increase incentives to groups to participate and the amount of time we spend on the topic of gender awareness?
— Should more research be focussed on teachers — their conceptions of their roles both in the classroom and in society, their understanding of the educational process, their methods and teaching aids?

Research has been done on the critical factors in the school environment which reduce retention of females in mathematics courses. We need to continue to ask:

— How can pupils' (particularly girls') self-confidence in mathematics be increased?
— How can the learning climate for girls be improved?
— Does the learning climate for girls improve within single-sex settings?
— How can modes of classroom organization and teacher-pupil interactions be encouraged and developed which would benefit all children?

Working with parents

Sex-role stereotyping begins at birth, a fact alluded to in the earlier discussion of attitudes and the different socialization patterns of girls and boys in our culture. This stereotyping is reinforced as the child progresses through school by the differential expectations and treatment of boys and girls by teachers, counsellors, parents, peers, and also through instructional materials and the media. It is known that parents and educators can intervene to modify the influence of sex-role stereotyping and to provide an equitable education for all students.

As well as working at the gender factor, researchers have studied how parental educational and occupational level affects their children's mathematics learning. And so the basic public and community issues pertain to how the dual disadvantage of sex-role stereotyping and social class can be overcome. More specific questions include:

— How can parents be sensitized to ways they can encourage and support their children in mathematics/science fields?
— How can public awareness be increased, especially among parents, teachers, counsellors, of the advantages of mathematics-related careers for women and their achievements in mathematics?
— How can schools take responsibility for informing the community about the importance of girls' participation in mathematics?
— How can the commitment of national and local governments to supporting mathematics education for girls and women be increased?

5. Call for papers

The ICMI Study on Gender and Mathematics Education will consist of two components, a *conference,* and a *publication* to appear in the ICMI Study series and based on the contributions to and the outcomes of the conference.