AN INCLUSIVE SCIENCE AND TECHNOLOGY EDUCATION CURRICULUM AT SCHOOL LEVEL

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With increasing dependence of humans on science and technology (S&T) the question of gender in the context of (S&T) is assuming greater relevance than in earlier times. Today it is needed that people contribute to the growth of S&T, but more importantly there is a need that people understand impact of S&T on our lives and use its products effectively.

Across the world there has been a disturbing trend that few women participate in the growth of S&T, which is become a more and more exclusive male domain. Efforts have been undertaken at various levels to change this scenario, and very often education has been targeted as the solution to the problem highlighted above. Education can be the instrument of changing the existing status-quo, yet we see that while we have emphasised educational reforms in India the gendered picture of S&T in society has not changed much. A reason for this lack of change could be that research from across the world has demonstrated that education itself is gendered.

Science as a subject has been a part of school curriculum for over a century and in India, presently it is a mandatory subject. Hence the under-representation of women in S&T education is a concern. While both science and technology are human endeavours with a long history, they also emerge as a result of social relations, which explains their gendered nature. The involvement of women at all levels of S&T tends to be skewed the contribution of women in S&T is not visible. Thus writers have suggested that the contributions of women to technology is 'hidden from history' (Wajcman 1991) and that often the prototype inventor is male. A perception is created that what women do is not science or has any technological inputs and this perception is long-lasting despite the fact that women have been involvement technology since the beginning of human history.

While we have been talking about science and technology together as S&T it is necessary to emphasise that while technology, is universal and a part of all cultures and groups, science is a specialized form of knowledge, that has a formal language and method. Philosophical debates about what constitutes science have occurred over long periods of time and have their

own history. There is presently consensus on the nature of science. According to Keller, the modern view of science as masculine can be traced to the seventeenth century with the establishment of the British Royal Society. That science is viewed as masculine today cannot be denied. Studies aimed at discovering attitudes to science reveal that the physical sciences are considered more masculine than the biological sciences which are viewed as a helping science, more people oriented, and is often considered a 'soft' science. According to Jones and Wheatley (1988) it is not surprising then that more girls are found in biological disciplines as compared to physical sciences.

What other factors from our social environment are responsible for gender stereotyping? Our families, the media and peer interactions promote gender stereotypes; often the school itself is an institution where gender identities are established. Factors within the school, which have been identified as resulting in gender differences are: language of textbooks/curricular material, classroom interactions and the image of science and technology presented to students.

The under-representation of women in science is often 'explained' by suggesting that there are biological differences in cognitive ability between men and women. The issue of sex differences in learning falls into the classic argument of nature versus nurture. The research in this area has been inconclusive as the differences in ability, if any, appear only at ages when it is difficult to separate the effects of genetic factors from socialization. Thus there may or may not be biological explanations for sex differences in learning but research has highlighted the role of sociological factors, such as differing expectations, differences in learning and attitudes of school boys and girls and the fact that different aspects of the educational system play an important role in building gender identities.

Let us look at some of these factors closely: Textbooks, used extensively by teachers and students, play a large role in formal education. In India, there is a great dependence on textbooks mainly because of a lack of other educational materials. A study of textbooks by Narendra Nath Kalia in 1979-80, indicated widespread and extensive gender bias in the textbooks. Not only were women portrayed in very few of the lessons as compared to men, (the ratio being 1:3) whenever women were portrayed, they were depicted as inferior to men.

Regarding the use of masculine pronouns like ‘he’ ‘his’ or words like ‘mankind’ ‘man’, it is often argued that these are merely semantics and children understand that these words refer to both men and women. However, various studies have shown that young children, given information of generic language such as ‘mankind’ and ‘he’, draw pictures of men and boys

when asked to visually present the information or story they had heard (Martyna 1978, cited in Rosser 1992).

Gender- based subject choices of boys and girls may also be influenced by visual depiction of gender in school science texts. An analysis of illustrations and texts in Indian science textbooks of classes 3-10, revealed gender biases by omission and commission (Chunawala, Vinisha and Patel 2009). There were significantly fewer female figures and often these were stereotypical images depicted in non-remunerative occupations limited to the domestic space. Women were rarely shown as contributing to historical or present day events related to S&T. This evident lack of female role-models in the textbooks sets a poor example for young girls who may aspire to be scientists and may discourage the pursuit of science.

In comparison to science, technology has not been universally accepted as part of school curricula. At present, technology is largely introduced at higher levels and is a subject at the school level only in some countries. Even so, it has always been gendered and perhaps more so than science (Layton, 1993: 33). Technology is often perceived as complicated and engineering is seen as a masculine profession (similar to science). The technological content of women's activities is not appreciated or is undervalued. For instance, in the case of women's traditional technologies, such as horticulture, cooking, sewing and childcare.

In higher education, few women enter technological fields – this is a reflection of the nature of these fields and gender relations in society. In India, women form a small part (about 22 % at graduate level) of the technology/engineering community (INSA 2004); and of those women who do clear the engineering examination, over 30 percent remain unemployed (Parikh and Sukhatme 2004).

Gendered perceptions of s&t across the world and in India

Images do change with time and place and in human history the images of men and women and their gender roles have not only changed but have been justified differently. How do students view science and scientists? Can this perception be important for us to learn about as science educators? Mead and Metraux (1957) administered questionnaires to high school students in the United States wherein they found that a majority of students tended to view science as natural science, and a scientist as 'a man who wears a white coat and works in a laboratory, is elderly or middle aged and wears glasses'. Newton and Newton (1992) found that children acquired such stereotypical images of scientists, as early as six years of age.

A study was undertaken in Mumbai with eighth standard students (about 13 years old) as part of an international collaborative effort (Chunawala&Ladage 1998) found that students had an overly positive image of science and scientists, but a stereotypical one. It was mainly that of a young, intelligent, hard working male, a solitary person engaged in laboratory work, most often chemistry. Biologists were viewed as neater, more caring, social and kinder than physicists, who were viewed as more intelligent, imaginative, hard-working, interesting and democratic. There were no gender differences in the above perceptions.

Technology education in the general school curriculum

Technology education at the school level in India has emerged in several forms like vocational education and socially useful and productive work (SUPW). Broadly defined, technology has the potential to be a component of some existing school subjects (NCF 2000) but if these are not assessed or given due weightage the exercise is futile.

The National Curricular Framework 2005 (NCF 2005), for the first time referred to design and technology as part of teaching and learning science at the school level. Its Position Paper of the National Focus Group on Teaching of Science (NFG-ToS 2006: 2), recognized that '*Technology as a discipline has its own autonomy and should not be regarded as a mere extension of science. . . . Technological solutions are guided as much by design, aesthetic, economic and other practical considerations as by scientific principles*'. Besides, the Position Paper of the National Focus Group on Work and Education, 2007 (NFG-W and E 2007: 30) linked the role of productive work and design opportunities in education: 'A systematic study of design and technology can provide opportunities for learning a broad spectrum of generic skills and competences'.

As it has evolved, technology education provides opportunity for students to learn about the processes and knowledge needed to solve problems and extend human capabilities. Of the various levels at which technology education is introduced into education, in India higher education has been the most preferred level in terms of resource allocation, as in the Indian Institutes of Technology (IIT's) and the Industrial Technical Institutes (ITIs). Yet, as already mentioned there are very few women at this level in engineering and technology (Parikh and Sukhatme 2004).

Along with other socio-cultural reasons that prevent women's employment in technological occupations, the introduction of technology at the tertiary stage rather than in school could be an important reason for the skewed participation of women in technology. By the tertiary

level, the gender stereotyping of professions and stereotypical distribution of students at intake is already in place. Thus I strongly believe that the appropriate place to challenge the existing practices of technology, including gender aspects, is not at the higher education levels but at school.

Technology education has not only failed girls, but has also failed other marginalized groups: students from rural areas, tribal communities, the poor and those who drop out of school due to a variety of reasons. One of the reasons for dropping out of school is the alienation of school knowledge from everyday life, which happens at various levels.

Most members of marginalized groups are creative in designing a sustenance for themselves and their families from the limited resources available to them. Technology education that begins only at the tertiary stages leaves out of its range a large group of students who are already disenchanted with the process of getting an education that does not address everyday problem-solving and their own sustenance. Besides, technology, as defined hierarchically from vocational to engineering education, fails to recognize the technologies created by the marginalized. Introduction of technology at school has the potential to meet the concerns of equity in access to technological knowledge, processes and activities. For this to happen, it is also imperative that technology education be introduced early in school, be inclusive and collaborative, and allow different forms of communication.

Attempts in the direction of making technology education inclusive have been made by our research group at HBCSE and we feel that technology education has to be introduced in schools and it has to be completely restructured so as to make it inclusive. The 'add women/marginalized groups and stir' methods are not successful. Technology education activities also offer opportunities to visualize and creatively redesign the environment in ways that can be meaningful to all. By its very nature technology is diverse and provides possibilities for students to engage in a wide variety of tasks depending on their choice and aptitudes and is ideal to reach out to girls and marginalised students.

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