Education and technology education within the gender perspective

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Abstract

The function of education is socialization. It reproduces the societal values along with the existing biases and schisms through direct and hidden aspects of curriculum, teaching, discipline and interaction. The elitist educational system became universal to meet the requirements of the Industrial and technical revolution. Debates in the fields of technology and education have had some startling parallels, centring on topics of determinism and value neutrality.

Throughout history, women had limited access to education and were almost excluded from the technological community. Few women even today, are entering fields of education or work explicitly labelled science and technology. Any technology is the product of social relations and forces and choices are shaped by social arrangements. The education system plays an important role in the formation of gender identity. Today science and technology are viewed as masculine and engineering culture according to Wajcman (1995) epitomizes the masculinity of technology.

The gendered practices of technology should be challenged in schools. India, has recently introduced technology as a subject of school education. But it has earlier had a chequered history with entry in the guises of vocational education and Socially Useful and Productive Work that were stereotyped on the basis of gender.

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Placing technology and education in the historical context

Explicating technology: According to Mackenzie and Wajcman, (1985) the problem with the term technology is two-fold: it is a slippery term, and its boundaries with science, arts and the economy are unclear. Besides, these boundaries keep changing with time and the term has different layers of meanings. The problem is compounded by the English language, in which there is only one word for technology while in some other languages, like, the German and Slavic languages, more than one word is used. At the most basic level, the term technology refers to physical objects, such as, the computer and other artefacts. However, this is a narrow "hardware" definition. A second layer of meaning focuses on human activities. Technology thus refers to what people do. According to this second layer of meaning, an object becomes technology only when it is used. This layer of meaning highlights the social aspects of technology to a great extent. A third definition equates technology with knowledge. It focuses on what people know as well as what they do. This "know-how" relating to use, repair design and making of objects gives meaning to objects. This "know-how" may not necessarily be communicable in words.

This leads to the problem of terminology of and within technology. Aspects of theory, praxis and knowledge included in technology are determined by socio-cultural settings of practice. Technology is embodied within a culture, forms a part of the shared/ distributed cognition and is also transmitted through culture. According to Staudenmaier (1989), the contextual aspect of technology suggests that a socio-historical approach to technology and its implications is of critical importance.

Explicating education: Education is often defined as involving deliberate organized instruction with the aim of transmission of cultural values. Humans are distinguished from other species on the basis of learning, as most of human behaviour is learned rather that instinctive. Socialization is the process by which humans learn to live in social groups. Formal education, which is a part of the process of socialization, was available to only small elite groups a few centuries ago. After the industrial revolution, education began to spread to wider sections of society, with the tacit aim of providing the minimum skills

of literacy and numeracy. Slowly education differentiated itself from other processes of socialization and has become a complex organisation. According to Dias, diverse and complex forces have shaped present day education – especially with regard to what is considered as valid and valued. The idea of the 3 R's has pushed several areas of human skills and knowledge out of education. There is no place for, or even tolerance of, different forms of human expressions including skill-based expressions within education.

Technology education: The precursors of present day education were aimed at developing the needed skills for living or for making a livelihood. Thus most early education was technology based, and involved learning of crafts. Apprenticeship learning was one of these forms of learning. However, there existed a stream of education in the ancient times that was elitist and theory based. Examples include Plato's Academy, the Brahminical tradition, classical and later church based education. The tension between mental and manual activities has long existed in education. Archimedes (287-212 BC) offers an example of this tension. He was reluctant to call attention to his accomplishments as a designer of war machines as the act of designing worldly objects was beneath the dignity of an intellectual! Regardless, "vocational" education did make its place in formal education, to the extent that some people have described general education as becoming vocationalised, while lamenting that vocational education is being generalized.

As it has evolved, technology education refers to a study that provides opportunity for students to learn about the processes and knowledge that are needed to solve problems and extend human capabilities. Of the various levels at which technology education is introduced into the education stream, higher education has been the most preferred level in the Indian context, example the Indian Institutes of Technology (IIT's) and Indian Technical Institutes (ITI's) in terms of resource allocation. However introduction of technology education as late as at the tertiary level is cited as an important reason for gender stereotyping of professions and for stereotypical distribution of students at the intake. The alternative would be technology education at the school level, with its own accompanying set of complexities.

Technology education at school

According to Layton (1993) many stakeholders have played an important role in placing technology education within the general school curriculum. These stakeholders are motivated by;

1. Economic concerns: of the instrumentalists who aim at national economic competitiveness and wealth creation.
2. Concerns about the standards of engineering: held by professional technologists who argue that technology is a distinct "third culture".
3. Social concerns: that education should empower students with knowledge, skills and values needed to control and undertake technological developments and have the focus of sustainability.
4. Political concerns: arising out of a desire to have participatory democracy and enhancing people's control over technology
5. Internal educational and epistemological concerns: which considers the very nature of technology as the justification for inclusion in school curriculum (technological activity involves distinct forms of cognition).
6. Gender concerns: to counter gender biases in representations of technology.

Most school subjects in the present day have been defined in their scope and content over the last few centuries, though they may still be evolving in some ways. However, technology does not have such an established definition either in society or in school education. Thus, school technology tends to be a mix of diverse specific technologies (e.g. food technology, textile technology) including various branches of engineering (civil, chemical, electrical, electronic, mechanical, etc.). Besides being a relatively new school subject, it lacks both a history and a coherent tradition as a component of the general education of all children. What is required may be a step towards the development of a "general technology" composed of basic concepts and principles, as well procedural aspects of technological activity, interpreted as problem solving involving design aspects, and the recognition of value considerations in the evaluation.

Thus technology education at school level would integrate several subjects already part of most school education and some others that are being sought to be included, e.g., value education and others. This requires us to look at the aspects of technology and education that have been debated over the years. These debates show many parallels and a study of these is especially useful from a socio-cultural context in general and specifically from a gender perspective.

Parallels in the debates about technology and education

Debates in the fields of technology and education have had some startling parallels. The gender perspective highlights the role of society and possibility of change in the two fields. For example, one approach states that society determines the technology or education system adopted out of a range of alternatives, while another suggests that the system of technology or education practiced determines society. Other parallels have focussed on aspects like value neutrality or lack of it in both technology and education, the role of transfer in both, and the parallels in the historical development of both. The aspects discussed include determinism, value neutrality, transfer and historical development of technology, education and technology education.

Determinism

Technological determinism versus social determinism of technology:

The term, technological determinism was coined by the American sociologist and economist Thorstein Veblen (1857-1929), and holds that technology shapes society and culture. Accordingly, social change occurs as a result of technology, which is seen as 'the prime mover' in history. In this framework, technological change is itself viewed as autonomous.

Technology is seen as the basis of change in society not merely in one time frame, but in the past, present and also the future. For instance, writing, print, television or the computer are considered to have 'changed society'. In its most extreme form, the entire form of society is seen as being determined by technology: new technologies transform society at every level, including institutions, social interaction

and individuals. This approach suggests that to some extent technology is not under human control. While people may make attempts to resist technology, the changes appear to have a force and logic of their own, which are unalterable. This is sometimes referred to as the 'technological imperative'.

While the influential role of technology cannot be denied, it is important to note that social forces can also shape technology. These social forces are, economic forces, social relations and the state. The single most important way that the State has shaped technology has been through its sponsoring of certain technology, such as, nuclear power, air transport and electronics.

Do social factors determine education or does education determine social change?

According to Tilak (1994) four major positions delineated below exist with regard to the relation between education and social change. The first position states that education is for itself and has nothing to do with social change. The second states that education is determined completely by social factors and therefore cannot bring about social change. In fact it follows social changes. The third position states that education is autonomous, or relatively autonomous, and can therefore induce social change. While the fourth states that educational and social change must take place simultaneously. It is just one of several variables and is not the prime mover of social change. The relationship is neither linear, nor isomorphic; nothing can be said about the quantum and kind of education, which will help towards even limited social change. The history of education in relation to society indicates that at times

i) Education merely reflects society and changes with it.

ii) Education reacts to social and economic developments and influences further developments.

iii) Develops contradictions and conflicts within itself and in relation to society.

Desired development in the educational sphere does not happen because of structural constraints in the society. Education in its actual practice cannot transcend the socialising agents. The desired social

change through education can take place only to the extent that the socialising agents intrinsically desire it. Thus the change must satisfy the interests and motivation of the students and the interests of larger groups in society.

Value-neutrality

Is technology neutral?

Use/practice is integral to technology, and practice involves skill and includes appropriate behaviour. Some tools may depend, for their use, on groups and therefore social organisations. Belief systems may also develop related to the technology being used. Some critics argue that technology is 'neutral' or 'value-free', and the focus is not the technology but the way in which we choose to use it. According to some theorists, we cannot merely 'use' technology without also, to some extent, being influenced or 'used by' it. Jacques Ellul dismissed the neutralist idea, namely whether technology has good or bad effects depends on how it is used usually exemplified by "a knife can be used to kill, cook or cure". Langdon Winner, a political scientist, also argues that technologies are not politically neutral in the sense that they are sometimes designed, deliberately or not, to open certain social options and to close others. Also, some technologies may be more compatible with some social patterns than with others (in MacKenzie & Wajcman 1985).

Is education value-free?

The goals and objectives of education reflect the thinking of philosophers and social reformers of the times (who may sometimes project a desirable future society). However, in practice, these goals and objectives are influenced by the dominant politico-economic structures of society. The social system is not static, and imbalances within it affect the educational system as well. Thus education reflects the values of the dominant classes, if not overtly, then in the form of the hidden curriculum.

Transfer

Transfer of technology:

Change is an essential aspect of all societies, modern and ancient.

However, the change that took place in ancient times was slow, except in the case of natural or other disasters. In recent times the process of change is rapid. According to William Ogburn, social change occurs by three processes, invention, discovery and diffusion.

Invention and discovery can be considered similar in some ways and different from diffusion, which refers to the spread of a new idea. The first two are often taken to be individual or personal acts and are viewed as a creative response to an existing state. Creativity is a mystery, and this has led to the study of inventors in terms of their personality or intellectual backgrounds. Studies of these kinds called the "great man" or "genius" studies, consider the genius to be one who has extraordinary abilities and is either different or ahead of the rest of humanity. However, the existence of "multiples" - multiple independent discovery or invention - which according to R.K. Merton (well known sociologist of science) is the norm rather than unique discoveries, suggests an important role for society. In fact this is corroborated by instances where a discovery is attributed to an entire group like a country or a specific culture.

In the technological domain, verifying the true inventor has been an aspect of concern. This is explicit in the inordinate importance assigned to patent records today. The earlier history of technology focused on merely listing inventions and inventors. According to Lynwood Bryant it is important to note that an inventor is not necessarily the one who first conceived of a concept, but also one who recognises the usefulness of a concept and communicates its importance to an audience.

That inventions do take place independently at several places at the same or different times is well known. However, people also do "borrow" technology. The "diffusion of technology" or "technology transfer" is a process that is perhaps as old as technology itself. The problems with technology transfer are manifold and include a directional flow of technology, displacement of earlier technology, the power relations involved and assimilation within cultures and mismatch.

Transfer of learning in education

In education, transfer of learning often refers to the influence of prior

learning on a new situation. If transfer did not occur then every new situation would involve starting from scratch. Transfer of learning (or training) is often from one branch of knowledge to another. Across-domain learning is generally based on analogies. Another example of transfer is from "the classroom to the job environment." Here, it is important to consider "task variation" within the classroom as well. Positive transfer of learning takes place under a variety of conditions. These include applying learning immediately to the current situation, the learning being general enough and hence applicable to different problem instances in the same domain, and to different domains.

Besides transfer of learning within individuals, one can consider the teaching situation as one in which learning skills are developed in an individual by the mediation of another. The other could be the teacher or even a student as in the case of peer teaching. Paradigms of education have been influenced by "within individual" versus between individuals view of transfer – namely the constructivist versus behaviorist views on learning and cognition.

Histories of education and technology: some similarities

Astonishingly the histories of education and technology and their course of developments have had striking similarities. Education has historically moved towards more and more formalisation from an initial or earlier informal approach. In earlier times it included elements of apprenticeship, and learning on the job, vocationalisation of education however has involved artificially bringing these elements into the school system. The Industrial revolution made education move from an elitist base towards a more universal form.

The earlier education focussed on "content" or what materials knowledge that student should have such as, topics in science that should be known by the learners. Slowly the focus has shifted from the content of science to the "processes" of science and the development of problem solving and other skills in education. In India, as in the West there have been attempts at changing both the nature and practice of science as well as the teaching of science as part of general education. The efforts at reforming science teaching have often been too restricted in scope and have focused mainly on updating the science content in textbooks. Most science educators now agree that students must de-

velop an understanding of the nature of science.

Early excursions into the history of technology described inventions of artefacts in chronological narratives. The workings of specific devices, the modifications and improvements made, and the range of applications provided the grist for the historian's mill. However, such "internalist" history offered little in the way of explaining why novel artefacts came into being, and why they took the form they did. Attempts to provide answers to questions such as these obliged historians to explore the social, economic, political, legal and scientific contexts of invention, besides the psychology of inventors. In so doing, some historians such as Thomas Hughes, author of a prize-winning study of the introduction of electric light and power systems in Western society (Hughes, 1983), were led to view technology as part of a seamless web of interactive components in a complex socio-technical system. As Hughes notes, many of the technologists he studied "were no respecters of knowledge categories or professional boundaries. In his notebooks, Thomas Edison so thoroughly mixed matters commonly labelled 'economic', 'technical' and 'scientific' that his thoughts composed a seamless web." (Hughes, 1986:285)

The gender perspective

The gendered aspect of technology:

An area of concern has been the fact that women have historically had a very limited access to science and technology and are almost excluded from the technological community. Women have always been associated with nurturance, child rearing, house keeping and the prototype inventor is male. The contribution of women to technology is " hidden from history" (Wajcman, 1995). The perception that what women do is not in any sense technological persists despite their involvement in survival technology since the dawn of history. That our earliest myths and religions have often placed women as the beginners of agriculture, law, medicine and timekeeping suggests that women have played an important role in these and other science and technological areas. Many cultures retain till today, the image of the "wise woman" the healer, who has access to natural and supernatural knowledge and the deities of knowledge in various cultures, have been predominantly goddesses, example, the Greeks, (Athena) Romans

(Minerva) and the Indians (Saraswati).

Yet, presently, much of the work that women do is judged to fall outside the ambit of technology. What causes such a situation? One cause lies in the way we define technology. Activities can be defined as technology or ignored by our definition. Even the term 'work' is often reserved for those activities that result in monetary rewards or payments. Since much of what women do is unpaid, it is not even considered as work. Women's work is perceived as 'domestic', and the technological content of their activities is not appreciated or undervalued. Technology does not only mean designing new machines, it also means adaptation of that machinery to the users and their environment, and women are the users and adaptors of technology as has been the case with smokeless chullas.

Various socio-cultural factors keep women from entering fields that are overtly called technology. One such factor has been the deliberate exclusion of women from certain areas of work. Craft unions have played an active role in resisting the entry of women into trades thereby relegating women to unskilled jobs and identifying skilled work with men (Wajcman, 1995). The gender stereotyping of jobs is remarkably ubiquitous and even very young children strongly project that there are different occupations for the different sexes. One result of such all-pervading stereotypes is that women may choose to avoid areas that are hostile to them directly and which indirectly the society is hostile to as career choices for women. This is confirmed by the low percentage of women entering fields labelled science and technology. Women account for only 9% of the scientific personnel in India. (Expert group meeting on training of women graduates in the development process, Thailand, 1999).

The gendering of technology occurs since technology is the product of social relations and forces. Of all the technologies possible only some may be selected, the path of their developments can vary, and their effects on different social groups may be differing. These choices are shaped by social arrangements and are often a reflection of the power structures in society.

Gender and education

The education system plays an important role in the formation of

gender identity. Schools are instrumental in communicating gender roles and expectations from girls and boys especially with regards to the careers that they should take. A major issue has been the under-representation of women and girls in Science and Technology. Women are not only less likely to choose to study S & T or to choose a scientific/technological career than men, but within science classes they are less active than men (Jones and Wheatley 1988).

This under-representation of women 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 and research in this area has been inconclusive as the differences, if any, in ability, turn up only at ages when it is difficult to separate the effects of genetic factors from socialization. There may or may not be biological explanations for sex differences in learning but it is obvious that sociological factors such as, differing expectations play an important role.

Textbooks play a large role in formal education as teachers and students extensively use these. 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, wherein 41 language books prepared and used by the national NCERT and CBSE were analysed, 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 of women to men being 1: 3) whenever women were portrayed, they were depicted as inferior to men. Of the large number of occupations depicted in the textbooks, women were excluded from a majority of the occupations. The few occupations held by women were generally lower in income and prestige as compared to men (Kalia 1986).

Small 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, in Rosser 1993). Although adult women have learned that generic language is inclusive, some studies have shown (Thorne 1979, in Rosser 1993) that women feel excluded when such language is used. Research in relation to classroom interactions of teachers with students has increasingly shown that male students receive more of every type of

classroom interaction, that is, they receive significantly more praise and criticism than females (Jones 1989). Boys in school are asked more open-ended questions than girls and they are often given directions on how to do things themselves. On the other hand teachers often do things for the girls in the classrooms. Research has also shown that boys are more assertive in the classroom and more likely to shout out the answers, as a result of which they are more often responded to by teachers.

Teacher gender has been found to be unrelated to the differences in classroom interaction; both male and female teachers interact in similar ways with their students. An important point to note here is that teachers are not consciously discriminating between the students. They are convinced that they are being gender-neutral, despite the fact that observers notice the differential treatment. What this means is that teachers are not intentionally stereotyping students, but their behaviour reflects that they themselves are members of society and products of a biased educational system. Thus teachers reflect the values and expectations of society. But teacher expectations may affect student achievement as demonstrated by the self-fulfilling prophecy. Thus if teachers can be made to recognise biases they can make many positive changes to the classroom situation

Gender and science and technology education

According to Keller the modern view of science as masculine dates to the seventeenth Century when the British Royal Society was founded. The society's purpose was "to establish a Masculine philosophy... whereby the mind of Man may be ennobled with the knowledge of solid truths" (Haggerty, 1995). That science and technology are viewed, as masculine today is undeniable. Studies aimed at discovering attitudes to science revealed that physical science is considered more masculine than biology. Biology was considered more of a helping science and more people oriented. It is no wonder then that girls are found more often in biological science than in the physical ones (reported in Jones and Wheatley 1988). Other studies examining the traits of scientists, revealed characteristics, such as, extreme independence, apartness from others, persistence, etc., which are often associated with masculinity (reported in Jones and Wheatley 1988). Engi-

neering culture according to Wajcman epitomizes the masculinity of technology. Part of the masculine image of science and technology is the lack of role models for women.

The concept of critical mass emphasises that in any area/field a critical mass of some people are necessary before that field becomes attractive to more people. Thus it is not helpful to have a token or a small mass. If women are to enter non-traditional fields then the presence of very few role models is not enough. A considerable amount of women must join those fields before the field becomes desirable for most women to join it.

Intervention strategies aimed at improving women's participation in science and technology must tackle the question of creating awareness in teachers, changing the language of curricular material, and making S & T less male-oriented. Resistance to intervention is often founded on the grounds that intervention is politically motivated and that preference to girls would indirectly mean neglect of, or discrimination against boys. It is essential to remember that reducing gender-bias in education is not only in favour of girls. It is also helpful to boys who would prefer a more nurturing career and who are also trapped into rigid roles and stereotypes.

Conclusion

The linkages between technology and education are affected by their historical and social settings. The appropriate place to challenge the existing practices of technology, including gender aspects, is not at the higher education levels but at school. Research is one of the ways of establishing technology education at the school level.

In India, technology was not a core subject of school education till 2002. The National Council for Educational Research and Training (NCERT) has since introduced "science and technology" as a subject instead of the earlier "science". The rationale for doing so is to bring about "scientific and technological awareness". The curricular materials developed for this purpose, however, largely portray technology as applications of science.

Technology education at school level in India has had a chequered history, appearing in the guise of subjects like vocational education

and socially useful and productive work (SUPW). Besides, it has been stereotyped on the basis of gender: Technology taught to girls has been limited to food or domestic work such as sewing, embroidery, tailoring, cooking and nutrition while boys have been restricted to bookbinding, carpentry, electronics etc.

In the prevailing context in the country, it would be interesting to undertake a historical study of the technology curricula in Indian schools and the sources of gender bias in the curricula. The study of pupils' perceptions of technology is a promising area and is already under way at the Homi Bhabha Centre for Science Education. This work encompasses what students' mean by the term technology, and has a gender focus. The study also includes teachers' perceptions of technology, and has been carried out in schools with rural and urban backgrounds and different media of instruction, namely, English and Marathi, which is the State and local language.

The study has the long-term goal of action research wherein students are exposed to different technological experiences, through a variety of activities and teaching modules that could be a first step to the development of a technology based curriculum.

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