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Building a new discipline

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I was born in Mumbai in 1954 and first went to St. Thomas' School in Delhi. My earliest "aha!" memory is when in Montessori school I was smitten by a set of shining golden unit beads, in rows of ten strung on a wire, ten perfect squares of a hundred, and one cube of a thousand glittering beads. I was extremely privileged, for, experiences of hands-on exploration are all too rare in Indian schools. Beautifully crafted equipment might come expensive, but even simple resources available locally are spurned in favour of rote learning from dry texts.

My other pleasant memory is when Ms. Wilson, our English teacher, got us to write rhymes and limericks. In our final exam, we had to construct a limerick, which I enjoyed greatly. At home we spoke Marathi, and my mother passed on to me her love of colloquial language and playful idiom. All of these came together in my later work with primary science teaching.

Grade seven was at the American School in Baghdad, where my father, a telecommunications engineer, was posted on a U.N. assignment. My parents held that this school opened up my interest in academics, but I recall it as a year of profound adolescent angst and anxiety. Among physically strong, sexually aware and racially confident kids, the only time I felt welcome was in the

weekly mental math event, when all of the students vied for me to be on their team. Our science and math teacher Mr. Berndt got us to do a lot of project work which I enjoyed.

When the American School closed down after the six-day Arab–Israeli War my mother brought me back and got me admitted to St. Helena's boarding school in Pune. Here, I found good science and math teachers, Ms. Joseph and Mr. Jog, and an interesting textbook of physics, by Gregory, Dhond and Ingle. Learning was dependent on reading a single textbook, with some rare demos – I remember an astounding one in which a little water was boiled in a ten-litre empty kerosene can which, on capping and cooling, loudly and spectacularly crumpled into a heap.

I loved physics and I was intrigued by psychology - partly due to the influence of my paternal aunt who was in social work. So after completing school I considered both science and arts, and opted for science at Fergusson College, Pune. Though biology was traumatic, I greatly enjoyed solid geometry taught by the very disorganised Mr. Inamdar, with a book by Wrangler Mahajani. Mr. Pathak, who taught chemistry, once gave a memorable home assignment to draw the structures of some linear hydrocarbons, into which list he smuggled the formula C_6H_6. Innocent of aromatic compounds, the pleasure that I got in figuring out the structure of benzene remained with me for years.

At the Indian Institute of Technology, Kanpur, Profs A. P. Shukla, H.S. Mani and others taught us wonderful physics, yet in those years I felt accelerated beyond my capacity. The summer after M. Sc. I made up for this, with a leisurely reading of the Berkeley Series on Electricity and Magnetism by Purcell. In college I used to look critically at the textbooks and tell my friends that one day I would write better ones. My interest in science, psychology and pedagogy came together when in 1976 I joined the Homi Bhabha Centre for Science Education, T.I.F.R.

Since mine was probably the first thesis in science education in India, I had to go through a slow process of defining the field based on information I came across in print. I was fortunate being at H.B.C.S.E. surrounded by the research at T.I.F.R., to have access to resources that would have been impossible elsewhere

in the country; and isolation from international research trends left me free to follow my own interests.

H.B.C.S.E. gave me a view of school science from the top – with a state-wide survey of schools and teachers – and from the bottom – sifting through and analysing a few hundred science lessons in rural schools in Jalgaon district of Maharashtra, and weekends teaching in a Bombay slum. This and later work in the Nonformal Education Programme of the Indian Institute of Education in Pune made me realise how rich were the experiences of rural children in their natural environment, and how completely wasted they were in the formal structure of the school and the curriculum. Prof. V. G. Kulkarni, founder-director of H.B.C.S.E., used to emphasise the role of language in science learning; much later I understood the significance of his remarks. Language being inseparable from thought, our failure to develop basic literacy and numeracy is intimately connected with the culture of rote-learning that is the bane of our school science.

As a struggling graduate student thrust into the role of teacher-educator at H.B.C.S.E., I got interested in students' ways of thinking about science concepts, because I could the teach the teachers something they could directly apply in their classroom. Around the same time, such investigations were going on elsewhere too, and their results were named "students' alternative conceptions". I learnt more about this field during post-doctoral work at Leeds with Prof. Rosalind Driver and at Chelsea College with Prof. Paul Black and others.

Some years later I was stimulated by the intellectual ambience that Prof. Seymour Papert created at the Massachusetts Institute of Technology with young engineers, computer scientists and psychologists, along with artists and designers, at the Learning and Epistemology Group in the Media Lab. In U.K. and the U.S., I worked in rural and inner-city schools, one of which was fitted with a metal-detector at the entrance. This was quite an experience. My interest in children's conceptions and their understanding of diagrams was sustained by these interactions.

A peer group was lacking, in India and internationally. That has been my major difficulty in doing science education re-

search. Due to a lack of critical mass, research at H.B.C.S.E. remained a low priority for many years. In the 1990s, the Centre Director Prof. Arvind Kumar advised me to take up curriculum development, a decision that I have never regretted. It was a unique opportunity to develop a curriculum based on research and field work, unconstrained by syllabus requirements. Teachers' and parents' warm appreciation has more than sustained the effort.

In the meanwhile, a core research group has emerged at H.B.C.S.E. I believe that a healthy interaction between research, curriculum and practice will enable it to grow. My early work on students' drawings and schematic diagrams finds resonance with current research – in developmental psychology, cognitive science, history of science and science education – on visual-spatial models of understanding science. I anticipate more action here. The epiSTEME series of conferences started by H.B.C.S.E. helps create links across the country as well as internationally. H.B.C.S.E.'s primary science curriculum is known and cited in India and abroad. My personal struggles in this have been closely tied with institutional struggles and those of a new research discipline.

I could not have done without the contribution of two other women: Mrs. Bapat, herself the wife of a scientist, who affectionately looked after our two children, and Kala, a highly capable woman who gave up her own childhood to work as a domestic help in the T.I.F.R. colony. And yes, my husband and children have definitely helped sustain me in my career.

Do I now wish I had done anything differently? First, as a school and college student I ought to have actively sought out good books instead of depending on what was handed over to me. Second, early on, I might have taken the trouble to learn to express myself coherently in speech – something that a science student is rarely taught to do. Third, as a junior researcher I might have cultivated more harmonious relationships with my bosses. I however, realize that some aspects of personality are hard to change. Fourth, I should have been proactive in dealing with child labour, a callous practice that still keeps the majority of our girls and boys from achieving their potential.