

**Homi Bhabha Centre for Science Education (HBCSE)  
Tata Institute of Fundamental Research (TIFR)**

**A Vision of Future HBCSE**

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**A view of the past**

The Homi Bhabha Centre for Science Education (HBCSE) arose out of, and was nurtured as a constituent unit of, TIFR, a premier institute of science research in the country. From the time of HBCSE's genesis in 1974, this fact has shaped our vision and our priorities.

The first fundamental insight, from our founder-Director (1974-94), V. G. Kulkarni and his co-workers, was to locate the root of the problem of science education in the inequities existing in Indian society. This insight led to HBCSE's early work with first generation learners in rural and municipal schools, and to the focus on language: as a reflection of social inequality, and also as tool to challenge it.

In a remarkably prescient manner these early projects aimed to integrate field work with research. The projects were collaborative in nature; they served to build a team spirit and a shared value of social commitment. However they had some major shortcomings: 1. documentation of field work and critical self-assessment were lacking, 2. research in the projects rarely attained the rigour and quality required for internationally peer-reviewed publications, and 3. the component of material development remained weak. As a result, when the time came and expectations grew for large-scale implementation, HBCSE did not have ready a "package" to hand over to the government for universalisation.

The second insight, which came from our next Director (1994-2008), Arvind Kumar, was more directly inspired by the priorities of science research. During this period the science content of our work, which had been relatively neglected in the earlier field work phase, was sought to be strengthened. Research was firmly discontinued, and field work was gradually phased out. In their stead the Olympiad and NIUS programs were initiated and nurtured. Materials development was encouraged, leading to the preparation of some remarkable exhibitions and curricula.

By the time these materials came into existence the momentum of collaborative field work, and the possibility of large-scale implementation that came with it, were past. However these materials did set a benchmark and, over time, they had a perceptible impact on the discourse of science and maths education in the country, including the National Curriculum Framework of 2005 and some National and State level textbooks.

HBCSE now acquired a credibility for quality work in science education. The Olympiad and NIUS programs raised HBCSE's profile nationally. With the granting of Deemed University status to TIFR in 2002, research in science, maths and now, technology education, got a second chance. This time around it was able to aspire to international standards, and even international impact.

## **HBCSE's unique position today**

Education is an area of interest to several distinct communities of people. We have educationists in university departments and colleges of education, who teach professional courses for pre-service teachers, and also carry out research in education. Educational studies are also part of social science departments, where the concerns are often exclusively theoretical. Science or maths content expertise is not prominent in either of these communities of practitioners and scholars.

On the other hand there are groups of scientists and mathematicians from research institutes and universities who are passionate about improving education. Though they are experts in content, it is a challenge for them to look at their favourite subject areas from the viewpoint of a learner, and of an educator. The content experts may presume to know already the best and desirable practices, while in actual fact these practices need to be discovered and invented through intensive processes of research and reflective teaching.

HBCSE today has the unique distinction of being at the crossroads of all these communities, with their different expertises and ways of thought. What we need now is a sense of shared purpose, and a coherence of action. If we achieve that, we will be able to make an impact on science and maths education in the country.

## **A vision for the future**

The mandate of HBCSE, I believe, is to bring about a change in science and maths education, to influence students, teachers and policy, and to build expertise, resources and opinion that are conducive to good education at all levels.

There are three major ways in which we can (often do implicitly) work towards this mandate. These are phrased here in terms of what I see as the role of HBCSE in the National context:

The first is to generate new ideas for the system; the second is to translate these ideas into practicable and usable forms; and the third is to implement, or help implement, some of these ideas on a small or large scale. The three roles can be fulfilled, respectively, through 1. research and innovation, 2. development, and 3. outreach.

To ensure that we progress towards fulfilling our mandate, quality considerations should be paramount. I discuss these in some detail.

## **How do we assess and ensure quality?**

Common terms often evolve to take on specific meanings in a given context. I therefore begin by defining the key terms I have used above.

- "Research" is peer-reviewed educational research.
- "Development" is the process of producing educational materials and methods in print or electronic form.

- "Practice / Field work / Outreach / Remediation / Talent nurture" all refer to sustained programs of teaching and interacting with students, teachers, teacher educators or the public, using a variety of media.

The quality parameters for these categories are distinct, and complex in themselves. Quality of research is assessed by well-established parameters and based on peer review; but additionally, there is a "significance" aspect of research, which is assessable only over a longer term. Quality of development of materials and methods apparently has no established norms for assessment, but in practice it is often simpler to judge, and obvious even to a lay user of the material. Quality of outreach is what needs the most complex assessments, and often it remains subjective. It is at this point that proximity to high quality science research and direct participation of scientists in education contributes positively. This has been the learning from HBCSE's Olympiad and NIUS programs.

I believe, based on the experience of HBCSE, that an interaction between research, development and outreach leads to high quality work in education. Educational outreach provides a natural context and opportunities for studying the processes of learning and teaching; development of educational materials requires trials on groups of students and teachers to get feedback; and the resulting research and materials feed back to enhance outreach and teaching activities. This is an idealised view, but one that has been amply validated in HBCSE's work.

Those of us who experienced the field work phase of HBCSE found that it contributed essentially to our understanding of education. HBCSE's popular science writings, its curricula, its research and its outreach programs (e.g. the maths lab and "Yes, You Can Do it!"), have all been enriched by field experiences. Yet the kind of intensive outreach of the early years perhaps left little space for development and research.

Today the Olympiads and NIUS are in a similar position. While they are enriching our experiences at the higher secondary and undergraduate levels (at the same time giving us some feeling for talent nurture), there is little development or research accompanying them, hence that learning is not yet systematised, or available in tangible forms. We are today more aware of the value of documenting our experiences, but we have a long way to go before our learning from these programs can be translated into forms that students, teachers, developers, researchers and policy makers, can use. That should be the goal that we work towards.

HBCSE's research programs today still retain some of the legacy of our early ideals - but institutional memories also fade, experiences need to be re-lived, and learning has to be re-invented by every new generation. The linkages between research, development and outreach need to be realised explicitly. We must therefore build in institutional mechanisms that will ensure that collaborative forms of learning continue, and field contacts add that critical authenticity to our research.

## Some specifics

The above are some general ideas. Setting the specific goals and translating them into action will need to be done through a process of dialogue, in a ground-up manner. Here are some suggestions: some of these are already being done in some form; they need to be done now

with a clearer institutional sense of purpose.

- Build strategic partnerships with institutions: government and ngos at the school level, and academic institutes and professional academies at the undergraduate level.
- Through such partnerships ensure that **a.** we get the benefit of field experiences, and **b.** we feed back into the system the ideas and materials that we develop.
- Link our outreach and research programs crucially with development. It will ensure both quality and impact.
- Target rural, government and less-endowed schools; at the college level focus on non-metropolitan areas. This is where our inputs are the most valued, and most needed.

Currently we have numerous minor programs, some of which may have to be pruned and some re-worked so that they cohere and mutually reinforce each other.

Our faculty strength should be strategically enhanced with the help of a strong national and international visitors' program.

I refrain from suggesting major changes of direction or major new programs to be taken up. I believe that any change should come from the bottom up and should be motivated and driven by the faculty.

I believe, and have suggested here, that we have all the components in hand. What we need are: a well-defined mandate, clarity of thought, and an institutional sense of purpose. HBCSE will then do the country proud.

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March, 2011

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**On the NIUS XII Plan Proposal**

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**This note**

These are some thoughts that I venture to express as a long-time faculty member and at present Dean of HBCSE Faculty. Through this note I aim to place the NIUS Project, and the XII Plan proposal as I understand it, within the overall context of HBCSE. The NIUS PIs may take these ideas into consideration as and if they wish.

**Role of HBCSE in the National context**

1. To generate new ideas for the system (*research and innovation*)
2. To translate these ideas into practicable and usable forms (*development*)
3. To implement, or help implement, some of these ideas on a small or large scale (*Outreach / Talent Nurture / other projects*)

**NIUS in the X-XII Plans**

NIUS began in the middle of the X Plan with an idea - that of proto-research as a means to attract and initiate undergraduate students to careers in science. The idea was translated into a national project which, in the XI Plan, we are implementing.

Today we are largely doing 3. above. This is a service function, which is valuable and valued by its beneficiaries. But, for the program to sustain in the longer term we need to do more of 2. and 1..

When NIUS was proposed, undergraduate research was a new idea in India. Today all IITs, IISERs, NISER, CBS, etc. are doing it. The Indian Academy of Sciences, I understand, has a national program which selects students and assigns them to research institutes for UG research.

We should identify (and strengthen) NIUS's unique features (please add any features I may have missed):

- The component of training and motivation
- A large number of students and teachers exposed to good science teaching and frontier areas of research

- Many of these from non-metropolitan areas
- **A long-term commitment of academics from HBCSE - hence development of materials like lecture notes, novel experiments and curricula**
- Science education research as one area
- Higher quality or quantity of its proto-research as compared to the others?

## National role of NIUS

NIUS should be seen as a major national program to which the other programs look for leadership.

Hence we should have something to offer to the others, which will come out of a critical reflection on what we are doing. To take just one example, look at what we are trying to give to students:

- Depth of understanding of the subject
- Exposure to current research
- Training in computational and other techniques

Where we are succeeding, and where do we need more work?

The projection of our achievements should include, not simply, “We did this”, but, “This is how you could shape your own undergraduate (research) programs”, “Here are some materials you could use to enhance the quality of your programs”, and “Here are some lessons or ideas for undergraduate education in India”.

We are already partnering with individual scientists. We could expand the national reach of our program through strategic partnerships with other Institutes, which may become, say, NIUS nodal centres.

We should give a truly national flavour to our contacts with non-Metropolitan colleges and universities. Have good regional representation in such programs.

**(Two subsections on specific issues related to HBCSE’s XII Plan proposal are not included in this copy.)**

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28 March, 2011