

VISION OF FUTURE HBCSE

Arvind Kumar and H. C. Pradhan

Homi Bhabha Centre for Science Education
Tata Institute of Fundamental Research
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Acknowledgement

This document on future HBCSE presents our ideas which have evolved over several years through continual discussions with all our colleagues at the Centre. Several specific programmes and suggestions included here have been discussed in the group informally or otherwise on many occasions in the past. However, the responsibility for any inadequacy in the perspectives outlined here is entirely ours.

I Introduction

HBCSE has now moved to its new premises and is poised for major qualitative and quantitative growth. This is a most critical juncture in time for this institution. The basic paradigm that we adopt today and the particular choices (academic and otherwise) that we make now are going to determine the shape and orientation of future HBCSE.

Any vision of future HBCSE must evidently be based on three things: HBCSE's past and current programmes, a critical appraisal of our strengths and weaknesses, and our long-term perspective of what we want HBCSE to be like, when in about a decade or so it grows to its nearly full scale of operations. We turn to these things one by one.

II HBCSE's Present Activity Profile

(1) School Science and Mathematics Education

From its inception, HBCSE has been involved in programmes of science and mathematics education at the school level. The principal focus of these programmes has been the education of the disadvantaged sections of pupils. In particular, this entails identifying cognitive, linguistic and socio-cultural factors that hamper their education; and designing and field-testing suitable remedial measures for the same. To this end, several action research projects have been, and are currently being, undertaken. Some of the noteworthy projects are the Khiroda project, SC/ST project for BMC students, Non-formal Education project, the collaborative projects with the Govt. of Maharashtra in several educationally backward areas, and currently the Solapur project. A State-level expansion of this activity is on the cards in the near future. These different projects include a variety of service components talent-nurture of pupils, in-service teacher training, training of teacher educators and so on. More recently, a definitive thrust has been put in the area of mathematics education, and two international conferences on the subject have been already organised by HBCSE. All this has resulted in HBCSE's gaining rich and varied field experience at both primary and secondary levels of education in rural, semi-urban and urban areas.

This whole range of field activity has never operated in a conceptual vacuum. A certain intellectual outlook underlies the whole work. Two of the main planks of this outlook have been constructivism and the intimate role of language in cognition. Pedagogic research has involved development of quantitative evaluation tools, investigating the effect of language simplification on cognition and instruction; identification of educational hurdles, and development and field-testing of remedial measures for underprivileged (SC/ST) students; and more recently, diagnosing and remedying learning barriers of pupils in particular topics of chemistry, and research in mathematics education. The research component has been further augmented by recent professional sociological studies on career aspirations of pupils. There has been considerable production of materials also. Instructional packages, remedial mathematics books, teachers' handbooks, dictionaries of scientific and technical terms (for school students) have been, and are currently being, brought out. A modest level of CBL package development has also been undertaken at HBCSE.

A comprehensive package of orientation and remedial materials at the primary and secondary levels of science education is intended to be completed in due course. Such a package, when completed, will be an invaluable contribution towards wide - scale dissemination of innovative educational ideas in the country.

(2) Higher Education

This new dimension has been added to HBCSE's activity profile about eight years ago. The higher education wing is pivoted around the Homi Bhabha Study Circle a regular weekly programme of problem-solving and critical discussions with promising physics undergraduates. Several of the outgoing students of the Circle have joined' prestigious institutions in India (TIFR, I.I.Sc., MaT Science, I.I.T's, etc.) and abroad.

The Study Circle over the years has stimulated substantial activity on different fronts research, materials and teachers' orientation. Several papers on instructional protoresearch problems have been published in Physics Education - the

U.G.C. journal whose Problems and Book Review Section is also looked after by HBCSE staff. More recently, on the research front, detailed work has been carried out on students' alternative conceptions in Galilean relativity, leading to some three research papers, one of which is due to appear shortly in an International journal and the others are being submitted. The materials generated by the Circle is especially worth noting. A total of 1200 innovative exercises at the 'plus two' level in physics have been designed (now included in the new NCERT texts). A comprehensive compendium of over 400 tutorial problems at the B.Sc. level has been accepted by U.G.C. as part of its national curriculum. More recently, two volumes of an interrogative series How and Why in Physics have been brought out. These materials have been invaluable in several 'plus two' teachers' orientation courses held at different places in the country, which HBCSE staff contributed to or directed.

Due to the particular specializations of the staff associated with this wing, the activity has so far focused on advanced physics education only. The Circle is now being extended down to the plus two level, and will incorporate other disciplines also, especially mathematics. Development of a laboratory dimension is also envisioned. In short, a full-fledged senior secondary wing of HBCSE is now in the offing.

(3) Research in Cognitive Science; and Mathematical Modelling

Cognitive science is the broad interdisciplinary area that is witnessing increasing research activity the world over. It is fundamental to all of HBCSE's work in education, and the development of in-house expertise in this area is a necessary prerequisite for safeguarding the status of HBCSE as a research institution in science education.

For several years, work has been going on at HBCSE in this area, thanks to consistent and sustained efforts by one, or two staff members. Investigations on children's alternative frameworks in regard to motion, ray optics, digestive systems etc. have been and are being carried out. A year-long graduate course on this emerging new discipline has considerably enhanced professional awareness of its need within the group.

One off-shoot of this has been the recent comprehensive work on alternative frame-works in advanced physics done in collaboration with the higher education wing. (see(2)).

Another fertile area of research developed at HBCSE over the last several years is : mathematical modelling of educational processes. This activity in a relatively short time has led to half a dozen publications in national and international journals.

(4) Graduate Courses

An important in-house activity that has come up well over the last few years consists in offering graduate courses to research scholars and project assistants on research methodology of behavioural sciences; cognitive science; and statistical techniques. These courses have enhanced the level of professional expertise in the group and are intended to be a regular activity of HBCSE in future.

(5) General Science Dissemination

From the beginning, HBCSE has been involved in general science popularization through different media (print, radio and TV). It contributed notably to the SITE programme in its, early years. More recently, collaboration with S.I.E.T. Pune in producing educational television programmes has shown encouraging results. HBCSE staff frequently produce or contribute to expository programmes in science broadcast by AIR.

HBCSE's question-answer activity spanning over so many years, with regular contributions to Kishore and Science Today is particularly note-worthy. The books based on this activity (How and Why in Science) brought out by Oxford Publications have received much acclaim.

III Appraisal

(A) General

A critical and objective appraisal of HBCSE's work so far must be prefaced by two important observations:

Firstly, the basic thrusts and directions of HBCSE's work are already well laid out. Any modest-sized institution cannot possibly cover science education in all its aspects and dimensions. It must choose a few broad directions which are socially desirable and urgent, and also feasible for the staff to pursue. For school science and mathematics education, HBCSE's conscious choice of work on the education of the underprivileged is undebatable, and this focus of its activities should never be compromised. This is what has given HBCSE a unique status among the institutions of science education in the country. Likewise, for its higher education activity, emphasis on promoting excellence among motivated sections of students is equally justified, and again this is what will give HBCSE a distinctiveness that will set it apart from other institutions of science education. This bifocal social perspective is wholly consistent with the basic tenets of the National Education Policy universalisation up to school level for ensuring social equity, and excellence promotion in higher education for ensuring professional manpower for the country. These twin foci should not be regarded in opposition to each other; they are complementary and mutually reinforcing. To sum up, the basic social paradigm adopted by HBCSE is eminently sensible and hardly merits a debate.

Secondly, an appraisal of HBCSE's work so far must take into account one fact. The Centre's entire gamut of activity has been carried out by a very small number of people under physical conditions and infrastructural facilities which, until recently, were far from comfortable. Thus, at best, not more than half a dozen or so (often less) of core staff members have been involved in the whole range of activity in school science and mathematics education including the substantial science dissemination work. Many of the large scale projects have been literally carried through on the shoulders of 3 or 4 core members. The cognitive science research activity has been sustained through consistent efforts by only one person. The entire higher education activity was carried out nearly

single-handed for about five to six years, with just one or two additional persons joining in over the last two or three years. Research in mathematical modelling was also confined to only two persons. Our appraisal of HBCSE's work here is thus by no means an evaluation of HBCSE staff who unquestionably are exceptionally dedicated. (No exaggeration is meant). Our aim is to identify the principal limitations of the work so far and to suggest some practical ways to overcome them.

(B) Limitations and Ways Out

In our view there are two major limitations of HBCSE's activities so far, one concerned with its work in school science and mathematics education and the other in regard to its higher education activity.

(1) As remarked earlier, HBCSE's field activity is more than a mere service-oriented work typical of a voluntary social organization. It also entails development of a conceptual paradigm and carrying out specific pedagogic and curricular research. Despite these sound professional objectives, the extensive nature of field work and materials production coupled with the circumstance of very limited staff have had one consequence. Detailed pedagogic research at HBCSE in school education has not yet reached the scale and rigour expected of a quality research institution. No doubt, some promising research investigations have been carried out as mentioned in **II(1)**; yet, overall there is clearly a need for much greater professionalization of its R and D work in order for it to conform to international standards and the standards of its parent institution TIFR. Also, professional research in mathematics education is still in its embryonic stage and needs to be further nurtured.

How do we ensure and sustain international standards and norms of research work without compromising the outstanding features of HBCSE's field activity? The foremost thing needed is, of course, to attract increasing number of young and competent people to join HBCSE. But a mere increase in staff strength cannot guarantee the

required research ethos in the group. What is required is a strong promotion of academic values. Comprehensive graduate courses in educational theory and methods, research methodology of behavioural sciences, statistical techniques etc. must become an integral part of HBCSE's activity year after year. In addition, the broad discipline of cognitive science basic to HBCSE's work must be vigorously emphasized. A minimum level of professional awareness of this fundamental discipline must be inculcated in the entire academic staff of HBCSE. Efforts along these lines have already been initiated in the recent past.

A most important caution to observe is with respect to the Field projects are a distinctive feature of large-scale field projects. HBCSE's work, and they are indispensable for both materials writing and research. However, the basic research ethos of the group should not be allowed to be overwhelmed by rushing concurrently into many large scale projects, incommensurate with realistic estimates of present and future staff strength. HBCSE has already committed itself to a State level expansion of its orientation activities in Maharashtra. Until substantial increase in staff strength is effected, further new large scale projects should be considered with great restraint.

(2) The next major limitation concerns the higher education activity of HBCSE. Quite plainly, this activity in its present form is lopsided in many ways. First, it is confined to the discipline of physics only. Second, even within this discipline the laboratory dimension is so far missing. Third, it is a highly localized activity, confined only to the students of Bombay colleges. Clearly, a national institution cannot so localize itself indefinitely, and should not confine itself to just one area. There is an urgent need to generalize this activity and open out to the all-India level.

What is the practical way to grow out of the above limitation without sacrificing the intensive character of the higher education of future HBCSE staff, space, activity? A realistic estimate clearly of infrastructure and budget clearly reveals that development of a comprehensive university level education wing at HBCSE is impossible at least in the foreseeable future. It appears that a feasible thing to do is to focus the higher education activity at the 'plus two' level of education.

The 'plus two' stage is a most crucial stage of education. Institutionally, it is also the most neglected stage. Fortunately, discipline expertise required for handling this stage exists at HBCSE in many subjects, notably physics and mathematics. With some efforts and augmentation in staff, other disciplines can also be taken care of. It should also be feasible to develop in a few years a reasonable (if not comprehensive) laboratory up to the plus two level (but no higher). In short, the lopsidedness of present activity in higher education can be removed if HBCSE vigorously undertakes the development of a full-fledged 'plus two' wing which in due course offers all-India programmes: teachers' orientation, summer schools for talented students selected from all over India, olympiads in different subjects, and so on. Efforts in this direction are under way.

International level research on students' alternative cognitive constructs and instructional proto-research have been already carried out in physics education at HBCSE. However, the scale of this activity is still far too modest to make an impact; it must be geared up substantially by inducting additional staff.

(C) The Problem of Staff Augmentation

As already remarked, the limitations of HBCSE's work so far are primarily traceable to its very limited staff strength. Attracting young and competent people to its core staff has been so far a difficult proposition for HBCSE. Over the last decade, only 3 to 4 people have joined its core staff. Taking into account some inevitable exit rate, the core staff at HBCSE has stayed more or less unchanged in numerical strength over a full decade. Hopefully, the new building with its better infrastructure facilities will make a dent in this situation.

We envision future HBCSE staff to be a harmonious mix of professional educators, cognitive and social scientists and discipline experts in pure sciences, mathematics, etc. In order that this personnel profile actually comes through, we must think about the entry channels of these future personnel. One clear channel is the Research Scholars' channel that is already in operation. As said

before, a systematic graduate level training programme must be formulated and initiated immediately. A clear menu of research areas in science and mathematics education that HBCSE wishes to emphasize should be offered to the incoming research scholars. One possible incentive to attract more research scholars to HBCSE is to offer them M.Phil. in science education after successful completion of training. [The idea will need to be worked out with Univ. of Bombay, Univ. of Poona, YCMOU which have or are in the process of instituting M.Sc. and Ph.D. in science education.] The outstanding among the successful trainees may then be encouraged to pursue their Ph.D. for possible absorption in the academic stream of HBCSE. These research scholars will eventually become the cognitive scientists and professional educators of future HBCSE.

The Research Scholars' channel will, however, not provide the discipline experts (in physics, maths, chemistry, biology etc.) who are indispensable to the Centre for ensuring in-house high level subject expertise. How do we attract such people to HBCSE? Experience shows that discipline experts with strong interest in education nevertheless do not like to abandon association with their disciplines altogether. It is precisely for this that the higher education wing of HBCSE should never be underemphasized. It is this wing that is most likely to attract discipline experts to join HBCSE. Once they join, many of these experts will gradually extend their interests and 'work in harmony with cognitive scientists and educators, as has clearly happened at HBCSE in the recent past.

To sum up, for augmenting staff strength, efforts should be directed on two fronts. First, a comprehensive graduate level training programme leading to M.Phil. and Ph.D. in science education should be initiated with due publicity to attract young and bright M.Sc.'s to HBCSE. Second, we should begin earnestly scouting for discipline experts and offer them the challenge of developing a full-fledged senior secondary wing at HBCSE. In addition, of course, we should try to attract senior educationists, psychologists, linguists, sociologists and so on. The implementation of the vision of future HBCSE given in the next section depends on how successfully we increase the relevant core staff at HBCSE over the next few years.

IV Vision of Future HBCSE

(A) General

In terms of social commitment and goals, our fundamental vision of future HBCSE is bifocal. On the one hand, HBCSE will focus on the problem of universalisation of education up to school level for which purpose it would concentrate intensively on the science and mathematics education of the disadvantaged sections of the society; on the other hand it will vigorously promote excellence in higher education, particularly at its entering ('plus two') stage. This bifocal character of the institution will give it a healthy, balanced and stable bearing and will set it apart from all other educational institutions in the country.

The same social goals can, however, correspond to institutions of widely different ethos and identity. For instance, a common social objective of alleviating the sufferings of a community from a major disease may be shared by two very different groups. One group may consist of medical scientists researching on mass immunization against the disease or adapting and modifying the known methods to the requirements of the community; the other may simply be a voluntary service group of well-meaning people actually carrying out the treatment on a large scale through a network of its sub-agencies. These two groups must evidently have some interaction, because research on an epidemic must involve knowledge of ground reality and also field-testing. However, one group cannot and should not become the other. Each must strive to preserve its identity even as they share a common social goal.

A similar if not identical situation obtains for clarifying the identity of HBCSE. It was started by scientists already accomplished in their fields who wished to turn to the socially important area of science education. The idea was to exploit scientific expertise and intellectual maturity acquired through years of research for systematic investigations on educational problems in the country and their remedial measures. Thus its history and parentage have already given HBCSE the identity of a research institution in science education. Future HBCSE should never compromise on this basic identity. HBCSE should not allow

itself to become a non-professional service-oriented organization, no matter how well-meaning and relevant the service component may be HBCSE's social commitment lies in taking up research in socially relevant areas of science education, not in sacrificing research and taking up non-professional service.

Does it mean future HBCSE should underemphasize fieldwork? Not at all. Research in science education cannot be done in vacuum. Field projects are indispensable for suggesting directions of work, for crystallizing specific problems for investigation and for eventual field-testing of remedial measures. But the scale of field operations (vis a vis the staff strength) must be such that the service component in it does not overwhelm and undermine the basic research motivations and thrusts. The Khiroda project, the SC/ST BMC project, the Solapur project and the Homi Bhabha Study Circle are good examples of the appropriate scale of operations.

If, as suggested, the scale of field operations should be moderate, how will HBCSE's work impact the educational system on a large scale? The answer lies in a vigorous emphasis on materials production. HBCSE cannot reach out to everybody, but its materials can. All the educational insights and innovations developed by HBCSE through years of fieldwork must be condensed in the form of comprehensive remedial and orientation packages. Materials production is a laborious, time consuming and 'painful' activity. That is another reason why the scale of field operations should not become unwieldy. Field work should aid in the development and testing of materials; it should not hamper it. A high quality materials package will ensure large scale dissemination of HBCSE's work more than anything else. It will be HBCSE's most tangible and enduring contribution to the country.

There is no doubt that for actual large scale dissemination of innovative ideas and materials, a considerable amount of liaison with the State education departments is both necessary and useful. Here, HBCSE should clearly delineate its role. It should provide over-all consultation and may also take up orientation of teachers/teacher educators at appropriate stages. Great care, however, must be exercised for this collaboration not to become unwieldy. Teachers' orientation should be viewed as an outlet of HBCSE's main activity: research and materials production, and as

also something that will provide important feedback to its work. The scale of teachers' orientation activity should not be such that it stifles the main R&D and materials writing commitment of HBCSE.

In the final analysis, however, the research identity of HBCSE can be preserved only by a strong in-house promotion of academic values. We envisage HBCSE of future to have a vigorous graduate-level training programme in science education. This programme will inculcate professional competence in HBCSE staff in educational theory and methods, research methodology of behavioural sciences including good familiarity with statistical techniques. A major component of this training will be exposure to the new interdisciplinary area of cognitive science which is fundamental to HBCSE's work. Great emphasis will be placed that all the R&D findings of HBCSE are condensed properly in the form of research papers and submitted to international journals for refereeing.

For this vision to really come through, the most crucial thing is acquiring new personnel. We have already commented on this in **III (C)**. Future HBCSE will consist of professional educators, cognitive and social scientists, discipline experts and science popularisers. Cognitive scientists will help provide and clarify the conceptual paradigm underlying all of HBCSE's work; professional educators will bring their pedagogic and curricular insights to bear on all programmes, discipline experts will provide in-house subject expertise, social scientists will provide professional sociological perspective to the work, and science popularisers will use their flair for communication to disseminate science through different media. Together all these people will give substance to the research; materials writing, orientation and science dissemination activities of future HBCSE.

In summary, our vision of future HBCSE involves a symbiosis of elements in many different ways. In terms of social goals, it is a symbiosis of two basic drives universalisation for equity and excellence promotion for modernization in India. In terms of activity profile, it involves a symbiosis of research, materials writing, fieldwork and science dissemination all feeding and reinforcing one another. In terms of personnel, we envisage a group of cognitive and social scientists, educators, discipline experts

and science disseminators in symbiotic relationship with one another.

(B) Structure

We envisage future HBCSE to consist of the following main divisions:

- (1) Cognitive and Social Science Division
- (2) Integrated Science Education Division
- (3) Mathematics Education Division
- (4) Higher Education Division
- (5) Science Dissemination Division

These divisions are meant to make a subject-based categorization of HBCSE's work; they are not intended to divide HBCSE staff into water-tight compartments. Major projects of HBCSE will usually involve a number of divisions pooling their resources together. The divisions are tentative and may change as new personnel join HBCSE. The suggested, manpower given below - for each division is based on assuming a saturation level of about 30 academic staff at HBCSE in future.

(1) Cognitive and Social Science Division

The primary focus of this division will be to carry out professional research studies in cognitive, linguistic and socio-cultural aspects of science and mathematics education. There will be an emphasis on research on fundamental aspects of learning, and work of this division will help clarify the conceptual paradigm of HBCSE's activities. Some key research areas are expected to be: symbolic and schematic representations in cognition, Piagetian and neo-Piagetian studies, computer modelling of cognitive processes, cross-cultural studies, sociolinguistic variables in cognition, gender issues, etc. Interests may be further diversified if members specializing in linguistics, artificial intelligence, cognitive psychology and anthropology join HBCSE. A well-equipped laboratory for carrying out empirical cognitive studies (involving clinical interviews of students and teachers) will be an essential facility of this division.

The principal tangible output of this division is expected to be research publications in international journals. Besides, review articles and possibly textbooks on cognitive science etc. may also be brought out. This division will be mainly responsible for in-house training of all academic and scientific staff of HBCSE in basic cognitive Science, educational theory and methods, research methodology in behavioural sciences and statistical techniques. It will liaise with other divisions and run a full-fledged graduate school in science education for entering research scholars. In short, the role of this division is to lend a high degree of professionalization and intellectual maturity to all of HBCSE's work in education.

Projected Staff : (2001)

Academic staff	:	5
Post-doctoral Fellows	:	2
Research Scholars	:	2
Scientific/Technical Staff	:	3

(2) Integrated Science Education Division

This will be a major division of HBCSE. Its primary focus will be to carry out systematic pedagogic and curricular studies concerning the science education of the underprivileged at the primary and secondary school level. These studies will overlap with those in the cognitive science division; however, emphasis here will be on phenomenology diagnosis of learning difficulties and development of remedial measures. Development of a viable and low cost laboratory programme in integrated science will be one of its important commitments. Extensive field work for testing its materials and other innovations will be the hallmark of this division. Aspects of in-service training of teachers, role of voluntary organizations in implementing curricular innovations may be some of the other areas of research interest of this division.

The major responsibility of this division will be twofold one, to produce remedial and co-curricular materials for pupils, and orientation packages for teachers; two, to carry out in-service training of teachers and teacher educators. This division will greatly emphasize HBCSE's outreach to the society; it will liaise with voluntary agencies and Government departments and work out large-scale projects to disseminate educational innovations and materials developed by HBCSE. In these large-scale projects, it will provide consultation at the apex level and possibly orient the top tier of teacher educators who through successive tiers will carry out the programmes on a large scale.

Because of its extensive range of activities, this division will need greater manpower than all other divisions.

Projected Staff : (2001)

Academic staff	:	10
Post-doctoral Fellows	:	2
Research Scholars	:	2
Scientific/technical staff	:	8

(3) Mathematics Education Division

This division is similar to the Integrated Science Education Division in that it will focus on the development, of remedial and orientation materials in school mathematics with particular emphasis on the learning by the disadvantaged pupils. It will also handle the mathematics component in the large-scale orientation projects mentioned under (2). Cognition in mathematics is a basic and fertile area of research. The division will collaborate with the cognitive science division in carrying out research in this important discipline.

Mathematics Education Division will extend its activities up to the senior secondary stage. Some of the mathematicians of this division will contribute to the activities of the higher education division.

Mathematics education of the disadvantaged at school and senior secondary levels is expected to be one of the central activities of HBCSE in future.

Projected Staff : (2001)

Academic staff	:	5
Post-doctoral Fellows	:	2
Research Scholars	:	2
Scientific/ Technical staff	:	3

(4) Higher Education Division

This will be another major division of HBCSE. Its principal focus will be to promote excellence among promising sections of students at the entering (plus two) stage of higher education and motivate them towards advanced educational and research careers.

The key responsibility of this division will be to regularly carry out talent-nurture programmes of selected students from all over India at the plus two level. For these programmes to be effective, the division will bring out suitable problem-oriented and other enrichment materials in mathematics and sciences at the plus two level. These materials will also be useful for teachers' orientation at the same level, and for organizing olympiads in different subjects. An important commitment of the division is to develop innovative, concept-centred experiments at the plus two level.

Some of the research areas of interest of this division will be: cognitive constructs in advanced science, expert-novice differences, and instructional proto-research problems.

The Higher Education Division will provide in-house discipline expertise in mathematics and sciences. Besides its own

'plus two' level programmes, its discipline experts will liaise with other divisions in carrying out large scale projects.

Counting about two for each discipline, the division will need about 8 academic staff members, as indicated below.

Projected Staff : (2001)

Academic staff	:	8
Post-doctoral Fellows	:	2
Research Scholars	:	2
Scientific/Technical Staff	:	4

(5) Science Dissemination Division

This division will bring out popular, semi-popular books on science and mathematics. It will be responsible for the Question/Answer activity of HBCSE, and for the production of audio-visual materials from time to time.

Host of the HBCSE staff from other divisions are expected to be occasionally involved in this activity. Thus at a modest level of activity, about two additional persons with known flair for communication may be recruited to this division.

Projected Staff : (2001)

Academic staff	:	2
Scientific/Technical Staff	:	2

The picture of projected staff among various divisions of HBCSE of future is summarized below. (Figures are notional)

Division ↓	Staff → Academic Staff	Post-doctoral Fellows	Research Scholars	Scientific/ Technical Staff
I Cognitive and Social Science Division	5	2	2	3
II Integrated Science education Division	10	2	2	8
III Mathematics Education Division	5	2	2	3
IV Higher Education Division	8	2	2	4
V Science Dissemination Division	2	--	--	2
Total	30	8	8	20

Grand Total: 66

(C) Some Major Anticipated Projects

The general nature of activities that different divisions of HBCSE will carry out has been sketched above. However, it is important that these activities crystallize into some major projects by which HBCSE is known nationally and internationally. In the following we anticipate some of these major projects :

(1) State-level Teachers' Orientation in collaboration with Govt. of Maharashtra

This major project is already in the pipeline and is due to start any time. It involves large scale orientation of teachers all over the State, through successive tiers of teacher educators. HBCSE is expected to play an apex consultation role. To begin with, the project will concentrate on standards V to VII for which new curricula are being introduced. All the teacher colleges in the State which are involved in teacher training at this level will be covered. It is hoped that the project will develop and test a three-tier model of teacher training, which will be relevant to the whole country. The project will yield large scale field experience and give HBCSE an opportunity to test and disseminate its materials and innovations.

(2) Bhabha Curriculum

Curriculum development and text-book writing programmes are not new to the country. Indeed every decade or so, such programmes have been undertaken by NCERT and other State Bureaus, and the work done so far is quite substantial. However, experience shows that the whole process often gets embroiled in bureaucratic tangles and delays. Further, the actual writing work is carried out by a large group of people located in different parts of the country, with little or insufficient co-ordination.

Bhabha Curriculum is conceived to be a comprehensive curriculum development and model text-book writing project from Class V to X in science and mathematics. There are two distinctive features of the project that are intended to set it apart from earlier curricula. First, it will be developed by a small cohesive group of about 10 people at HBCSE working full time on the project. This group will, no doubt, consult experts all over India through periodic workshops and meetings; but the final responsibility for the implementation of the project will be confined to a small group. Secondly, the curriculum will have built in remedial components for the disadvantaged students. Text-books will be so written that their core part takes into account the educational problems of the underprivileged. The standard, levels of modern curriculum will not be compromised, but the tendency to load the curriculum with excessive information will be curbed. Additional enrichment will be

provided for those on the 'faster track'. The development of laboratory materials, learning and testing exercises, model evaluation schemes will form part of the curriculum. The possible use of computers and other media will also be explored in the project.

Bhabha curriculum is an idealistic ambitious project aimed at condensing all the experience and insights available at HBCSE in the form of tangible enduring products. Its main feature is its comprehensiveness. It should not be taken up in a patchy, half-hearted manner. We should either go for it full steam, or not take it up at all. A substantial increase in staff strength at HBCSE is a prerequisite to starting this project.

(3) Remedial Mathematics Project (Class VIII to Class XII)

This is a more focused project than (2) and narrower in its scope. Research in mathematics cognition has witnessed increased global activity recently. The principal aim of this project is to carry out research studies on cognition in mathematics among the disadvantaged students in secondary and higher secondary stages; and follow it up by writing suitable remedial materials. The project will be based on fieldwork in the neighbouring schools of HBCSE.

In scale and scope, this project seems to be more feasible than the Bhabha Curriculum, and can be taken up immediately. Some work on materials writing has already been completed, and research in mathematics education is under way.

(4) All-India Summer/Winter Schools For 'plus two' students

This will involve liaison with various Central and State agencies to select promising students from all over India at the entering junior college stage. The selected national batch of students will then undergo talent-nurture programmes at periodic summer/winter schools. The schools will emphasize critical comprehension, problem solving and open-ended laboratory experiments. The students will be encouraged to take up protoresearch projects and will be exposed to the research environment of TIFR and similar institutes. An off-shoot of this project may be the organizing of national olympiads in different

subjects. Suitable materials will be produced to make these activities effective.

The project presupposes the availability of a hostel for HBCSE. Until that materializes, the same activities will be carried out on a local level.

(5) Children's History of Science Project

Although enrichment materials on history of science exist in abundance, a comprehensive package suitable for exposing Indian school children to the fascinating history of science and mathematics from ancient to modern times does not yet exist, as far as we know. We envisage a series of about twenty small booklets covering this story written in a simple language and at a level that every secondary school pupil can comprehend. These books can also form the basis for suitable audio-visual programmes.

This is a desirable and feasible in-house project for HBCSE. Just as Bhabha Curriculum will condense the pedagogical and curricular experiences of HBCSE in concrete form, the History of Science project will condense the communication and dissemination experiences of HBCSE in a concrete lasting form.

(D) Linkages with other institutions/agencies

A substantial part of HBCSE's activities should be in-house activities. Excessive liaison with outside agencies always has a price to pay, chiefly in terms of the considerable paperwork that it needs, the manpower that it consumes and, to a lesser extent, the lack of cohesiveness of work that it engenders. A modest-sized institution must enter into collaboration with outside agencies with care, taking into account these possible effects. However, HBCSE cannot obviously operate in isolation, and some effective linkages must be sought and strengthened.

For its curricular work, HBCSE should strengthen its already existing links with NCERT, and the various SCERT's, especially the SCERT of Maharashtra. Besides periodic visits to and

from these institutes, some of the more enthusiastic members of these institutes can be encouraged to work at HBCSE on sabbatical leave. This applies also to the Regional Colleges of Education at Bhopal, Ajmer, Mysore and Bhubaneswar. HBCSE has an ongoing collaboration with the Open University in Maharashtra. We can also explore cultivating ties with Indira Gandhi National Open University, Delhi. There are several notable voluntary agencies such as Eklavya doing similar if not identical work. We should interact with these non-Govt. organizations and subject our work to their critical scrutiny and evaluation. Our collaboration with the Solapur Science Centre has been quite fruitful, and this can be further extended.

For its large scale field work HBCSE has already established excellent liaison with the Department of Human Resource Development at Delhi, and with the State Education Department. These links should be sustained and reinforced in future by HBCSE's senior staff providing consultancy and advisory roles in various Govt. programmes and bodies.

For its science dissemination work, HBCSE can profitably enter into collaboration with the Nehru Science Centre at Bombay and similar Centres at other places. It should also forge ties with various local, state and national level teachers' associations at school and college level.

Another important agency with which HBCSE should cultivate strong ties is the AEES, Bombay. Because of the proximity of its headquarters and the local schools run by AEES, collaboration with this agency will ensure ready availability of samples for research and materials testing. In addition, HBCSE can work out periodic teachers' orientation and talent-nurture programmes for schools all over India which are run by AEES.

Finally, HBCSE should forge informal but strong ties with major research institutions in the country. Besides its parent institute TIFR, it should also interact with experts from BARC, IIT's, I.I.Sc. and other major universities. There are many high quality discipline experts in the country with strong interest in

education, and HBCSE should work out informal ways of tapping this interest.

Linkages with outside agencies should be forged with clear definitive goals. HBCSE should be as willing to say no to a collaborative programme that is not viable as it should take up a programme that will truly enrich all the partners in a collaboration.

(E) Conclusion

HBCSE was founded with a vision the vision of an institution where highly qualified academics turn their professional expertise and maturity to the socially urgent area of science education, carry out research investigations into the educational problems of the Country and develop viable remedial measures for the same. This vision has been pursued with much. imaginativeness and originality in the form of a wide spectrum of specific programmes from its inception to date. The vision of HBCSE presented here is but a continuation and amplification of that of its founders. This vision will zealously guard HBCSE' s basic identity as a research institution, and insure it against becoming a mere non-professional service organization. HBCSE draws its sustenance and ethos, intellectual and otherwise, from its parent institution TIFR with its known high standards of academic values and attainments. This vital link with TIFR. is its life-line and should never be weakened; indeed it should be further strengthened and reinforced. Future HBCSE should be worthy of its illustrious parent an offspring that TIFR should look up to with pride and satisfaction.

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