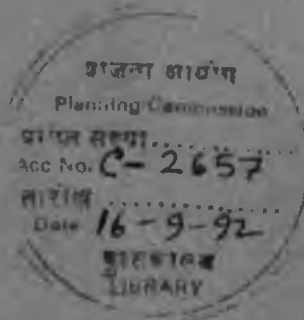


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**REPORT OF THE
WORKING GROUP TO SUGGEST WAYS
AND MEANS TO IMPROVE
UNDERGRADUATE COURSES
IN SCIENCE
AT INDIAN UNIVERSITIES/COLLEGES**



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C O N T E N T S

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1.	Foreword	1
2.	Forwarding letter of Prof. Bhide	2
3.	Report of the Working Group	4
4.	Annexures :	
	Annexure-I : Staff Paper	26
	Annexure II : Proposal for Integrated Science Programme of Talented Students prepared in U.G.C.	32
	Annexure III : Minutes of the meeting held on 10 March 1989	35
	Annexure IV : Planning Commission Order No.P-11061/2/89-Edn. dated 24th April, 1989	42
	Annexure V : Comments of Education Division	44

Gratis

FOREWORD

There is a countrywide concern among all those concerned with socio-economic development and human resource development about the deteriorating standard of Education and particularly the science Education in the country. This concern was articulated and projected to Planning Commission in the context of Eight Five Year Plan by the Scientific Advisory Council to the Prime Minister presided over by Prof. C.N.R. Rao. University Grants Commission had also formulated a proposal for Integrated Science Programme of Talented Students (ISPOTS) and also referred to a separate proposal for New Science Programme (NSP) sent by Prof. Bambah (Vice Chancellor, Punjab University).

It was in this context that the former Member, Planning Commission, Prof. P.N. Srivastava held a Meeting on the subject on 10.3.1989. As recommended by the meeting a Working Group was constituted under the Chairmanship of Prof. V.G. Bhide, Deptt. of Physics, University of Poona, (Then vice Chancellor, University of Poona).

Planning Commission is glad to make available the report of the Working Group as an input to the thinking on the subject. The report is in draft form and owing to unavoidable circumstances it could not be circulated earlier.

As clarified elsewhere the Report does not reflect the views of Planning Commission nor do the proposals contained therein have the approval of the Planning Commission. Staff comments on the Report have been extracted in an appendix to make the record complete.

Planning Commission is thankful to Prof. V.G. Bhide and his team for this useful report.

FORWARDING LETTER OF PROF. BHIDE

UNIVERSITY OF POONA

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Date:

PHY/VGB/
17th August, 1989

Dear Professor Srivastava,

You may kindly recall that at a meeting convened by you on 10th March, 1989, under your Chairmanship, a Working Group was constituted under my Chairmanship to suggest ways and means to improve undergraduate science education at the Indian Universities/Colleges.

I have great pleasure in submitting herewith a report of the Working Group. The Working Group has suggested a three tier approach to tackle this problem. At the first level, it has suggested that we should organize a programme for highly talented and motivated students to be conducted at some very select seven institutions. The institutions could be selected by the University Grants Commission in the light of their track record. At the second level, the Working Group has suggested that we should identify 2/3 colleges per state, roughly 100 colleges in the country. They should be given a liberal financial assistance to improve library, laboratories and other infrastructure and also to recruit qualified and motivated teachers for the purpose of training students at the undergraduate level. These colleges should be autonomous colleges or even should enjoy the status of deemed university.

The first two levels will cater to roughly 16% of students undergoing science education at the undergraduate level. The remaining 84% students study in affiliated colleges. It has been suggested that these colleges be provided with a library of video tapes on various science subjects prepared by eminent teachers and researchers in the subject. These tapes should be addressed to the syllabi of the undergraduate courses. Indeed this programme has already been initiated in a small measure by the University Grants Commission.

- 3 -

In order to coordinate the efforts at the three levels, the working group has suggested a Coordination Council chaired by the Chairman, University Grants Commission. The Council should be served by a separate Cell constituted in the UGC as detailed in the report.

The Working Group would like to express its grave concern at the deterioration of standards of science education at the undergraduate level and the urgent need to take steps to improve science education at the undergraduate level. The Working Group would like to emphasize that the matter is very urgent and the programme suggested in the document should be initiated without any further delay, say, from the next academic session. I do hope you will find the recommendations of the working group useful in your endeavour to improve science education at the undergraduate level in Indian Universities.

With kind regards,

Yours sincerely,

(V. G. Bhide)

Encl: as above

Professor P.N. Srivastava,
Member, Planning Commission,
Yojana Bhavan,
Sansad Marg,
NEW DELHI 110001

-4 -
REPORT OF THE WORKING GROUP

REPORT OF THE WORKING GROUP CONSTITUTED BY THE PLANNING COMMISSION
TO SUGGEST WAYS AND MEANS TO IMPROVE UNDERGRADUATE COURSES
IN SCIENCE AT INDIAN UNIVERSITIES

1. A meeting was held on 10th March, 89, under the Chairmanship of Prof. P.N. Srivastava, Member Planning Commission to discuss ways and means to improve undergraduate science education at Indian Universities/Colleges. This meeting was attended among others by Prof. M. G.K. Menon, Prof. C.N.R. Rao, Prof. Yash Pal, Prof. R.P. Bhabha, Prof. P.L. Mahlotra, Prof. A. Gnanam, Prof. V. G. Bhide. The meeting considered the present status of undergraduate education in science and expressed its deep concern at the continual decline in the standard of undergraduate education in Science. It was recognised that this continual decline in the standard of science education at the undergraduate level has led to non availability of suitably qualified and motivated students to carry out basic research in science, to man the various science departments of the Government of India, to meet the requirements of industry and has affected the overall development of science and technology in the country. The situation has assumed serious proportions and is causing grave concern. The meeting also broadly considered the approaches to improve the quality of science education at the undergraduate level and appointed a working group under the chairmanship of Prof. V.G. Bhide to work out the details of the various approaches that may be adopted to improve science education.

2. The composition of the working group was as under:

1.	Prof. V.G. Bhide	-	Chairman
2.	Prof. T.V. Ramakrishnan	-	Member
3.	Shri P. Natarajan	-	Member
4.	Prof. S.V. Kessar	-	Member
5.	Prof. Rais Ahmed	-	Member
6.	Prof. P.K. Mahanty	-	Member
7.	Dr. Arvind Kumar	-	Member
8.	Prof. H.S. Srivastava	-	Member
9.	Adviser (Education)	-	Member
10.	Secretary UGC	-	Member

The working group met on 6th and 7th June at Delhi and discussed various aspects relating to the question of undergraduate science education and the ways and means of improving the quality and standard of science education at the undergraduate level.

3. In the contemporary world, science and technology have become powerful instruments of economic development and social transformation. In discovery of India, Pandit Jawahar Lal Nehru emphasised that, "It was science alone that could solve the problems of hunger and poverty, of insanitation and illiteracy of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving millions". Presenting the Government of India Scientific Policy resolution to the Parliament in 1958, Pandit Nehru stated, "It is an inherent obligations of a great country like India with its tradition of scholarship and original thinking and its great cultural heritage to participate fully in the march of science, which is probably mankind's greatest enterprise today". C.V. Raman, one of our greatest scientists stated, "There is only one solution for India's economic problems and that is science, and more science and still more science". Homi Bhabha, the father of Indian Atomic Energy Programme, in his address to the International Council of Scientific Unions remarked, what the developed countries have and the underdeveloped lack is modern science and an economy based on modern technology. The problem of developing and underdeveloping countries is therefore the problem of establishing modern science and transforming their economy to one based on modern science and technology. An important question we must consider is whether it is possible to transform the economy to one based on modern technology developed elsewhere without at the same time establishing modern science in the country as a live and vital force. If the answer to the question is in the negative and I believe our experience will show that it is- then the problem of establishing science as a live and vital force in society is an inseparable part of the problem of transforming an industrially underdeveloped to a developed country. While these statements are as relevant today as they were when they were first made, problems of national development and the nature of science itself have assumed greater dimensions and complexity and call for not only a restatement of our conviction but also pose a challenge for appropriate and effective action.

4. In the context of establishing modern science and technology in the country as a live and vital force, the importance of science education can not be overemphasised. The primary role of science education as a means to national development was recognized in the country after independence. Indeed, the Scientific Policy Resolution of the Government of India comits the Government inter alia to, (1) ensure and adequate supply, within the country of research scientists of the highest quality, and to recognize their work as an important component of the strength of the nation and (2) encourage and initiate with all possible speed programmes for the training of scientific and technical personnel on a scale adequate to fulfil the country's needs in science and education, agriculture and industry and Defence. Subsequently, Radhakrishnan and Kothari Commissions have emphasized the importance of establishing a sound base for science education so that this country will contribute to the advancement of scientific knowledge

commensurate with its size, resources and manpower and apply scientific knowledge for its economic development. The National Policy on Education approved by the Parliament in 1986 restates the pivotal role of science education in the context of development of scientific temper and economic development. There can not be two opinions as to the need for establishing highly efficient and stimulating science education programmes so that the growing need of highly qualified and motivated scientists and technologists can be met effectively.

5. Since independence, there has been a phenomenal growth in the number of universities and colleges imparting science education and in the enrolment of students, in the science stream. The enrolment in the science stream was about 1,27,168 in 1950-51. This increased to 4,34,925 in 1963-64 to attain the level of 7,25,328 in 1986-87. Thus there is about six fold increase in the enrolment during 35 years after 1950-51. The enrolment during the preceding five years as per the data available from the UGC was as under

Year	enrolment in science stream (figure in the bracket indicates the percentage of total enrolment)
1982-83	6,23,545 (19.9)
1983-84	6,53,092 (19.7)
1984-85	6,69,563 (19.7)
1985-86	7,03,467 (17.7)
1986-87	7,25,328 (19.7)

Though the actual enrolment has steadily increased over the years, there has been a decline in the percentage of students opting for science. In 1950-51, 32.1% students who passed the higher secondary examination, enrolled in the science stream. However, this percentage decreased to 19.7 in 1986-87.

It is not only the decrease in the percentage that should concern us but the fact that the students offering science today are perhaps the lower middle level 19.9% in contrast to upper 32% students who offered science in 1950-51. Both these facts show that students particularly the bright students shy away from science.

The reasons for this decline in percentage and the decrease in the quality of students opting for science are not far to seek. Unlike in 1950-51 the facilities for technical education such as engineering and medical have increased considerably siphoning brighter boys and girls to the technical and professional streams leaving only mediocores to opt for science. The preference of the students for the technical stream is because of the better employment opportunities for a technically trained graduates as compared to those available for science graduates. In small measure, the migration of the students away from science is due

to the dull and drab teaching of science in our schools. The dismal fact is that persons who do not get admission in professional schools, namely, medical and engineering schools gravitate towards science education- not because they are interested or motivated but because they must do something and they do not know what else to do. The brighter ones out of those also appear in the competitive examinations like IAS, Banks and other secure professions. It is the distilled "left over residue" which forms the major input of our higher science education. The above inference is further supported by the follow up studies of the National Talent Students. In this connection, it must be mentioned that National Science Talent Search awards were instituted in 1964 to attract bright and motivated students to the science stream. These nationally selected students were given these awards only if they pursued a career in science. However, subsequently this restriction was removed and the National Science Talent Search transformed in to National Talent Search. With this change, the input in the science stream suffered qualitatively. The following table gives the total number of awards and those who opted for science.

Year	No. of Awards	No. of Awards opting for Science
1984	375	55
1985	750	121
1986	750	87

The number of Talent Search awardees pursuing higher science courses is still revealing.

	1984	1985	1986	1987	1988
1. B.Sc.Part-I	-	63	39	102	69
2. M.Sc. Previous	31	36	13	13	-

Thus one finds that out of 750 awardees only 13 went up to the M.Sc. level and others opted for professional career in 1986-87.

This clearly presents two related problems. A large number of talented students today simply do not opt for a career in science because they do not see it as a rewarding career. At the same time a large number of unmotivated and uninterested students seek a career in science, but they are often not fit for it. Ideally one would like a situation where a large number of talented people are motivated naturally to seek a career in science and then one selectively chooses a smaller number namely those who demonstrate a creative bent of mind so essential for higher science education and career in scientific research.

6. To make matters further worse, most of the students who after having passed the higher secondary examination opt for science education are taught for their undergraduate course in affiliated colleges. In fact recent UGC report shows that nearly 88% of the undergraduate science students are taught in affiliated

Colleges numbering over 1800. Many of these colleges are under-equipped, over crowded, and poorly staffed. Laboratory and library facilities are generally inadequate, proper text books are not available. In such an environment, it is almost impossible for a student to experience excitement of doing science and to get motivated to take to science as a career.

Any person faced with a choice of career will typically ask two questions, namely (1) is a career in science going to give me a comfortable life ? and (2) is a career in science going to be sufficiently challenging and fulfilling as my life's work? The second question is very important and we should not underestimate its value in moulding and influencing young minds. If our kids see our working scientists fulfilled lives with a high degree of job satisfaction, many of them will be motivated to take up careers in science. If not even the motivated few will be repelled by such a choice. When our kids look at our working scientists, they should not see people plodding away like cogs in the wheel, frustrated because they are not getting anywhere, indulging in escapism and ego gratification in the form of frequent attendance of meetings, symposia etc. They should see fulfilment of an honest variety resulting from solid contributions made to the development of science, technology etc. within the country. They should see sparks of creativity in action. They should feel inspired by the dedication literally oozing out of such peers. The situation in affiliated colleges is far from what should be and is indeed such that even those who are fascinated by science in the school days will be repelled by a career in science.

Land 7. Thus the present system has neither the desired selectivity nor the atmosphere conducive to motivation. The consequence of all this is obvious unmistakable. There has been a continual decline in the standard of our first degree in science. The level attained by our B.Sc. today is very much inferior to that of a graduate in advanced countries. It is at the undergraduate level that we see a sudden and steep fall in the quality of education. The science graduates, as a result of their undergraduate education lack curiosity are devoid of creativity and innovativeness, lack confidence in themselves and are almost toally unmotivated. The examination system, laying as it does more emphasis on memory than on analytical ability and innovativeness further deteriorates the situation. The situation is almost alarming. Weaker undergraduate science programme implies weaker post graduate and research programmes. It is becoming increasingly difficult to find adequate numbers to award the scholarships and offer placements. The Department of Atomic Energy initiated a scheme to select some 300 trainees and yet they found that from amongst 3835 applications, only 207 were suitable. This is also the experience of many other agencies.

8. It may not be out of place to mention a few other drawbacks of our present undergraduate science education programme.

Undergraduate curricula are rigid even in the best of places. Combinations such as PCM and CBZ do not provide the necessary breadth or depth. The absence of flexibility has made it impossible for a good student to obtain sound training. For example, a physics student can never study biology just as biology student can never study mathematics or physics.

Undergraduate science education programme depends entirely on chalk-talk concept, doling out uncorrelated information without bringing out basic concepts and the unity of the subject. Demonstrations, class room open ended experimentation have disappeared from the undergraduate programmes. Although science is experiment based, it is taught as prose or poetry.

A teacher who teaches at the undergraduate level has hardly any say in formulating curricula or in evaluating his own students. This results in the lack of attachment of a teacher to his teaching and the taught.

The most disturbing feature in our education system is that of examination. While most undergraduate education is imparted in colleges, examinations are conducted by the universities who have no direct interest or control over the educational process itself. These examinations lay tremendous premium on memory and fail to test the ability of the students to, (a) critically analyse situations, (b) reason and logic, (c) comprehension, (d) innovativeness or model building capacity and, (e) communication skill.

9. It is now well recognized that our first degree science education programme is very weak and is unable to attract good students or to produce talented and motivated young science graduates. It is also recognized that weaker undergraduate science programme would mean in the long run poor scientific research, inability to generate technology, inadequate to man the industries etc. This explains the paradox namely inspite of having the "third largest scientific community" in the world, the impact of this manpower on the world scene in basic sciences is not very significant on the whole. In the context of exponential increase in knowledge connected with science and technology and increase in the importance of science and technology for national development, with a consequent decrease in the time of adolescence and the continued decrease in the time gap between a major discovery and its applications, it will be at our peril if we do not take urgent and effective steps to stem the rot and make undergraduate science programmes productive, exciting and capable of turning out highly talented, dynamic and motivated young boys and girls who would contribute to the advancement of science and to the application of science for national development.

It is no denying that modern India is brimming with young people full of vitality, talent, enthusiasm and aspirations. This is our most precious resource. It is a fundamental right of these young boys and girls to go through an educational system which motivates them in the right direction, trains them and prepares them for life to come and help them in unfolding their potential to the limit of their capabilities. It is our duty to provide them with such a system.

10. The task of improving science education programme is stupendous. As mentioned earlier, the yearly enrolment in the undergraduate science programme is about 2,00,000. These students as per the UGC data take their training in about 1500 colleges. It is this large number of science colleges and the number of students enrolled in undergraduate science course that makes the task of improving science education at the degree level formidable. Such a stupendous task can not even be attempted unless one adopts some selectivity and novel approaches. The working group considered all aspects of this stupendous task and decided to recommend a three tier approach. Before we describe these approaches, it may perhaps be worthwhile to mention the steps already taken by the UGC to improve the quality of science education at the undergraduate and post graduate level.

11. University Grants Commission initiated a scheme called college Science Improvement Programme (COSIP) in 1970-71. The objective of the programme was to bring about qualitative improvement in the teaching of science at the undergraduate level. The programme is implemented at two levels, namely, (a) in selected colleges to include the entire faculty. (b) in one subject in all the colleges affiliated to a University-called the University Leadership Programme. As on 31st March, 1987 COSIP was implemented in 265 colleges and 40 university departments. The emphasis in the programme was to improve the curricula, teaching methods, laboratory exercises, etc. The review committee appointed to review these programmes concluded that the performance widely varied depending upon personal local leadership and administrative support. The committee noted the positive impact in the matter of preparation and production of text books, laboratory kits and other educational material. The committee also noted that in the ULP there was lack of full involvement on the part of students and teachers and in COSIP, administrative support. In the absence of bench mark survey, the assessment of the impact of these programmes in terms of their objectives is not possible.

University Grants Commission at the instance of the Scientific Advisory Committee initiated a COSIST programme to strengthen the infrastructure in highly selected science departments in Indian Universities. Till now 99 departments spread over all the subjects and all the universities have been selected for COSIST support. This COSIST programme has made a qualitative improvement in the infrastructure of these departments enabling them to attract larger funding from different funding agencies for their teaching and research programmes. Being highly selective, COSIST programme has made an impact.

12. Another measure taken to improve science education was the introduction of science talent search in Delhi in 1963 and in the entire country in 1964. As stated earlier, in 1977, these awards were also extended to students going in even for professional course. The effect of this change has been referred to earlier. Although through science talent search an attempt was made to identify talent, precious little was done to nurture and nourish talent. The awardees went to the same institutions, were taught by the same teachers etc. Except that they got a scholarship nothing positive was done to nurture and nourish them. In our opinion, it is not only necessary to identify talent, but perhaps more important it is to nurture and nourish the identified talent so that it can flower to its full potential.

13. The working group considered the genesis of the problem, the magnitude of the problem and the efforts already taken to redress the situation. Taking all these into consideration, the working group decided to recommend the three tier approach to tackle this stupendous problem. This approach has been guided by the need not only to raise the general level of science education at the undergraduate level but to deliberately and consciously attempt to develop peaks of excellence.

14. Programme for the highly talented:

The first part of the programme deals with highly talented students. It should be restricted to the chosen few who demonstrate competence in creative pursuit. On completion of their training, these are the young boys and girls who will lead the creative efforts in various research groups, R and D labs of Govt., educational institutions, defence, industry etc. The actual number needed should be determined by careful manpower planning. We strongly believe that it is not only important to identify talent but perhaps it is more important to nurture and nourish this talent. This part of the programme is aimed at producing peaks of excellence, creating leaders in science, attracting and stimulating bright young students from all over the country.

14(a) Objectives:

The objectives of this programme are, (a) to devise a five year programme for producing highly trained and motivated scientists confident of tackling problems in the rapidly advancing frontiers of their chosen disciplines and, (2) A product of this programme should be a through disciplined professional with detailed knowledge and understanding of his own subject and having an awareness of current and future trends in other disciplines. He should appreciate and understand the social milieu in which he would practice, its socio-political structure, resources and growth problems and their solutions.

14 (b) : Broad features of the programme:

1. This will be an integrated science education programme leading to the M.Sc. degree. An attempt will be made to integrate the programme in time and in terms of disciplines. Emphasis will be laid on the unified structure of science as man's quest for an understanding of nature and natural laws and the utilization of this understanding for the benefit of the people.
2. Strong foundation in Mathematics, Physics and Chemistry as they are essential for further development of any branch of science.
3. An awareness of the nature and significance of life processes, their complexity and vast technological potential.
4. Emphasis on both intellectual ability and manual skills.
5. Exposure to, (a) unifying concepts in science, (b) history, philosophy, methodology of science, (c) computer and computer graphics, (d) basic electronics, (e) interaction between science, technology and society, (f) planning and designing an experiment, modelling and simulation, including hobby workshops, (g) research experience through seminar, project and participation in research programmes, (h) promotion of entrepreneurship etc.
6. A rigorous semester education with periodic and continuous assessment. Interaction between instruction and assessment.
7. Common course to students in the first year exposing every student to the basic concepts of physical sciences, mathematical sciences, life sciences, earth sciences and social sciences.

14(c) : Input to the Programme:

The input to this programme should be highly selective based on performance in the well designed national competitive examination. Admission to this programme should be based on no consideration other than merit and merit alone and will be open to the students who passed the higher secondary examination from any place in the country. Initially, admission to this programme would be limited to 700 students. When the programme becomes full operational, i.e. after five year, there would be in all 3500 students. This number 700 constitutes roughly 0.5% of the students seeking admission to the science stream presently. We strongly feel that going beyond this number at this stage will not be advisable. We would once again like to emphasize that this programme is meant for highly talented and motivated students and this essential character of the programme must not be diluted.

Based on the experience of running this programme for a period of five years, one may consider gradual expansion of the programme to cater to 1% of the students namely 1500 students.

The programme should be widely advertised in national media regional newspapers, in schools and colleges and radio and TV so that a student of merit even in the remotest place can take advantage.

14 (d) : Places where the programme should be pursued:

Having ensured selectivity and having identified talented students, we feel that these students should be nurtured and nourished so that they flower out and perform to the maximum of their capabilities. It is, therefore, essential to place them in creative atmosphere and in contact with highly creative, eminent and dedicated persons. They should see sparks of creativity in action, they should feel inspired and excited by scholarship and dedication.

In order to provide a creative environment of the type mentioned above, we considered two possibilities. One of the obvious possibilities could be to set up a couple of institutes of higher learning in the country which are entirely devoted to creative activities. The faculty of such institutes will have to be carefully chosen, for example, they would be drawn from some very active groups in research laboratories/universities, who are not only doing front ranking research work but are also committed to teaching. These institutes should have entire administrative structure fairly flexible, responsive and conducive to creative academic activity. With less centralization and department's enjoying a great degree of autonomy, these institutes will have to be funded liberally.

The other possibility was to use the existing infrastructure. In India, there are a few institutes and a few departments in the universities which can satisfy the above requirements. The University Grants Commission could certainly identify two centres per each of three streams namely, (1) Physical Science, (2) Life Sciences, and (3) Mathematical Sciences which have established themselves and meet the requirements mentioned earlier.

After carefully considering the advantages and disadvantages of the two possibilities, we feel that setting up of separate institutes will take certain amount of time and even longer to set up healthy traditions. Conversely, the existing centres (selected by the UGC) with established record can start functioning immediately. Secondly, utilizing the existing infrastructure would entail minimum additional investment.

It is, therefore, suggested that UGC should identify three centres for Physical Sciences, two centres for Life and Mathematical sciences each. Thus there would be seven centres, each centre admitting 100 students. The selection of the centres would be dependant on the attainment, competence and dedication of the staff in concerned departments and the willingness of the management authorities of the universities to undertake this programme. Obviously, these centres will have to be provided some additional funds for recurring and non-recurring expenditure.

14 (a) : Academic course structure:

Seven hundred students selected through national competitive examination will be allocated to seven centres, (3) in Physical Sciences, (2) in Life Sciences and (2) in Mathematical Sciences. Allocation of students to streams and centre location should be done following the IIF admission procedure.

Physical Sciences stream shall consist of mainly the following subjects: Physics, Chemistry, Geology, Life Sciences stream shall include Botany, Zoology, Biochemistry, Microbiology and Biophysics. The Mathematical Sciences would comprise of Mathematics, Statistics Computers.

All the seven hundred students would be exposed to the basics of all the three streams in the first year. Taking into consideration the existing practise of some students taking mathematics and no biology and some other taking biology but no mathematics at the higher secondary level, the first year course for students opting for physical and Mathematical Sciences stream and for students opting for life sciences could be different only in relation to the relative emphasis on mathematics or biology. This first year course should be designed keeping in mind, (a) Mathematics, Physics and Chemistry are basic to all sciences and every student should be conversant with mathematical tools and physical concepts, and (b) that many challenging and technologically important research areas of future lie in the domain of life sciences. This implies,

- (1) the students in Mathematical Science Stream should be given enough awareness of the physical and life sciences.
- (2) the students in the Physical Sciences stream must acquire considerable competence in Mathematics and be aware of basic concepts in life sciences and excitement therein.
- (3) the students in the life sciences stream must acquire considerable competence in Mathematics and be conversant with Physical concepts.

After completion of the first year course, the students will go to the allotted centres of their choice and discipline. These university centres will be selected by the UGC objectively depending solely on the performance of the universities in the respective areas and the willingness of the universities to participate in the programme. We would not favour a single university to have more than one stream. Secondly, we would strongly recommend that this selection of the universities should be strictly on the basis of merit and accomplishment and other considerations such as region, state etc. should not influence the decision.

At the end of the first year, a student who has opted for one stream could migrate to the other depending upon his performance and the available vacancies in the stream to which he wishes to migrate. Similarly, at the end of first year, the student will opt for a particular subject in the stream of his choice, namely, say Physics in Physical Sciences, Mathematics in Mathematical Sciences etc. These admissions will be regulated as per seats available and his performance in the first year. Alternately, it was suggested that at the point of entry in the programme itself a student should not only opt for the stream but also for the subject in the stream.

The next two years course structure will resemble the Hons course structure with the subject of his choice as the Principal subject and two other subsidiary subjects. There would be enough flexibility available in relation to the choice of the subsidiary subject. This will be provided by offering choice of courses rather than subjects. The Principal subject course should form a part of the integrated course leading to M.Sc. in that subject. In addition, some compulsory and some optional subsidiary courses will be prescribed.

We strongly feel that whatever stream and subject a student offers, every student must necessarily have certain minimum courses in mathematics, computers, electronics and communication skills. Each student will be encouraged to do workshop practice, glass blowing, certain basic electronic circuitry and programming on computers. Similarly, in the integrated course in a given subject leading to M.Sc. degree he may be permitted to offer certain courses in other related subjects of his choice in the same stream.

At the end of third year, a student may be awarded the B.Sc. degree and those who wish to leave at this stage may be permitted to leave or those whose performance is not satisfactory, they may be discontinued. This terminal stage will also provide an opportunity for a student to migrate to other subject if vacancy in that subject exists and he satisfies the basic requirements through a test. Thus a student who opted for physics at the end of first year wishes to migrate to Chemistry at the end of third year, he will be permitted to do so if vacancy exists in Chemistry and if he satisfies a test that may be prescribed. The students in the fourth and fifth year will also be provided with an opportunity to participate in research programme in the department during vacations, Similarly his experimental work will include open ended exploratory experiments, project work etc.

14(f) : Incentives for attracting talented students to the Programme:

We considered the question of attracting students of requisite calibre to this programme at length. At present, due to complex socio-economic reasons, many talented students with inclination for science opt for professional courses. This is essentially because of the job opportunities and career prospects in professional stream. We sincerely feel that those who pass the

National Competitive Test which is aimed at selecting top 0.50% of the students at the higher secondary level and who are exposed to the creative atmosphere and flexibility of courses and who do well will not find it difficult to obtain a job comparable to that in professional stream and should therefore be naturally attracted to the programme. However, the problem is more psychological than real. The prospective bright students and more so their parents need to be assured of good career prospects. In this context, we feel that it is not enough to give imaginative publicity bringing out the challenges and the excitement of a creative scientific career but we feel that Science Agencies such as BARC, CSIR, DRDO, ISRO etc. should give these boys an assurance that they would be absorbed in these agencies subject to the satisfactory performance throughout five years programme. In this, the agencies will get cream of the young boys and girls suitably trained in creative academic atmosphere and in turn such an assurance will remove psychological barrier and allay the apprehensions of the students and more particularly of their parents about their career prospect. We feel confident that the students who have gone through this programme will come up to the requirements of the scientific agencies and would get absorbed. If for some reason, a few of them do not get absorbed, we recommend that the UGC should absorb them in teaching positions in various universities and/or their research scientists programme. We suggest that the basic minimum that can be done is to assure them JRF after completion of the five years programme for doing their PH.D. research. The above suggestion may sound unconventional but is not unreasonable and we hope it is in the national interest.

Just as we considered the question of providing incentive to attract students to the programme we also considered the question of students dropping out or failing badly or going abroad. Although it is our conviction that very very few students will drop out or fare badly, there is considerable chance of these students going abroad after their five year integrated course. We considered at great length the question of providing for some prohibitive provisions but in the end we felt that providing for a bond etc. would be counter productive at this stage.

We must of course mention that since students in this programme will be drawn from all over the country and will learn at places other than their own, they must be provided with fellowship adequate enough to take care of their board, lodging and other expenses. A suggestion was made that they may be given fellowship on par with the IIT students, i.e. Rs. 400/- p.m. we felt that the situation here is different. IITs do not have any difficulty in attracting good students. Secondly, hostel accommodation in IIT is assured. In this programme at least initially we felt that we must provide them fellowship which should be adequate enough to meet all his expenses. We arrived at a figure of Rs. 1000/- p.m. for a period of 10 months but this can vary depending upon the facilities which the universities can provide.

14 (g): Organizational Structure:

The operation of this programme will need an organizational structure which should be autonomous. We suggest that there should be a coordination council as the apex body which will take policy decisions in all matters concerning this programme. It would have been advantageous if an organization like TIFR, Indian Institute of Science were to manage this programme. However, in case they are unable to do so or it is not practicable, we recommend that UGC should operate this programme with a coordination council as an apex body. The coordination council should be chaired by the Chairman UGC and should have representatives of participating universities, institutions such as TIFR, IISc etc. science agencies such as BARC, CSIR, DRDO, ISRO, DST etc. and five eminent scientists and representatives of industries.

The coordination council should be serviced by a special cell created in the UGC for this programme. This cell should be headed by a Director of a rank of a Professor in the University. The cell should have professional scientific staff with barest minimum of non technical personnel. The Director shall be the Member Secretary of the Coordination Council,

FINANCIAL IMPLICATIONS

This programme will entail recurring and non recurring expenditure. The recurring expenditure shall include, (a) fellowship; (b) recurring expenditure of the seven centres, (c) recurring expenditure on the coordination council. We suggest that each of the seven centres be given a financial assistance of 1.5 crores for upgradation of teaching complexes, practical halls, purchase of equipment and facilities such as computers, books and journals etc.

The financial outlay during the 8th five year plan period is as under:

1. Non-Recurring: Financial Assistance Rs. 10.5 crores
to seven centres at
Rs. 1.5 crores

2. Recurring

	1990-91	1991-92	1992-93	1993-94	1994-
1. Fellowships for 10 months	70	140	210	280	350
2. Recurring exp. for seven centres	70	70	70	70	70
3. Recurring exp. on coordination council	10	10	10	10	10
	150	220	290	360	430

Total expenditure during five years plan period:

1. Non Recurring - Rs. 10.5 crores
2. Recurring - Rs. 14.50 crores
- Total Rs. 24.50 Crores

15. It is strongly suggested that this programme should commence from the Academic Year, 1990.

16. SECOND COMPONENT OF THE PROGRAMME

The programme described above is highly selective and caters to only 0.5% of the students, and is designed to generate peaks of excellence. We strongly feel that in addition to generating peaks of excellence, it is necessary to raise the general level of undergraduate science teaching.

The Education Commission (1964-66) had recommended that selected colleges should be given autonomous status so that they could initiate experiments and innovations in designing courses, determining the contents of courses, developing new teaching methods, evolving new evaluation procedures etc. In pursuance of this recommendation, the UGC formulated a scheme of Autonomous colleges in the fourth five year plan. The scheme of autonomous colleges has considerable merit because it provides for delinking of good colleges from the monolithic and rigid affiliating system and enables these colleges to experiment and innovate new courses, teaching methods and evaluation procedures. The grant of autonomy to colleges requires amendment to the statutes of the universities to which they are affiliated. Most of the state governments have not been convinced about the desirability of granting autonomy to colleges and in spite of academic novelty of the scheme only few colleges and that too in only few states have been granted autonomy.

In line with the reasoning behind the selectivity involved in granting autonomous status to colleges we feel that the UGC should select roughly 2-3 colleges per state depending upon the student population in the science stream in the state for the second component of the programme concerning improving science education at the undergraduate level. There would thus roughly 100 colleges spread all over the country.

These colleges should be selected on the basis of their track record and performance over the last ten years. These colleges should be given a financial assistance of Rs. 1 lakh over the 8th five year plan period to equip their libraries, laboratories, recruit qualified staff and to improve the infrastructure.

These colleges should be given autonomous status or status of deemed university whichever is easier and practicable. This will provide them enough freedom and flexibility and delink them from the monolithic and rigid affiliating system that is prevalent in the country. These colleges should be helped to design courses improve teaching methods and to evolve evaluation procedure.

The admission to these colleges should be again on the basis of merit and merit alone. Merit can be ascertained by a public examination conducted in the state or on the basis of performance at the higher secondary level.

The colleges should provide a large menu of courses and flexibility for a student to offer courses of his choice. The colleges should attempt to give a common course to all the students in the first year exposing them to mathematical techniques, physical concepts and fascination in live sciences. Every student must necessarily be made to do workshop practice, glass blowing, electronic circuitry and computer programming. At the end of first year, student will opt for his principle subject. The courses in the principle subject should be supplemented by relevant course in the subsidiary subjects. In designing courses, care should be taken to see that students opting for any subject in live sciences has enough grounding in physical concepts and mathematical techniques. Similarly, a student opting for mathematics should be exposed to the areas of application of mathematics and so on.

This programme in these colleges should be closely monitored to see that the objectives of the programme are adhered to. It is suggested that the coordination council and coordination cell recommended for the first component of the programme designed to improve science education should not only provide the policy frame but would also monitor and evaluate the programme in these colleges.

17. Phasing of the Programme and Financial Implications

The process of selection of 100 colleges over the entire country will take some time. We strongly feel that the colleges should not only be very carefully selected but enough guidance and counselling should be made available to these colleges. We suggest that 20 colleges should be identified every year over the next five years. The colleges should be given a period of one year to prepare themselves.

The financial implication of this programme is as under

	1990-91	1991-92	1992-93	1993-94	1994-95
Funding to 20 Colleges.	20	20	20	20	20
Funding to another 20 Colleges.	-	20	20	20	20
Funding to third batch of 20 colleges	-	-	20	20	20
Funding to the fourth batch of 20 colleges	-	-	-	20	20
Funding to the fifth batch of 20 colleges	-	-	-	-	20
Selection, counselling 10 guidance, mentoring	10	10	10	10	10
TOTAL:	30	50	70	90	110

GRANT TOTAL Rs. 350 LAKHS

At the end of five year period, there will be 100 colleges catering to a student enrolment in the first year of 24,000 (240 students to be admitted in each college at the first year).

18. THIRD COMPONENT OF THE PROGRAMME

The first component of the programme would cater to an enrolment of 700 students to the first year of the undergraduate course. The second component will provide for nearly 24,000 students at the end of five years i.e. in 1994-95. By that time the total number seeking admission to the undergraduate science course will mount to more than 1,50,000. Thus the first two components of the programme would cater to roughly 16% of the students seeking enrolment in the first year of the 3 year undergraduate science course. This leaves about 84% of the students. Most of these students as stated earlier would seek admissions to affiliated colleges in mofousil and rural areas. Although it would be necessary to improve the infrastructure in these colleges, we feel that because of severe resource constraint and the numbers involved, it would be impossible to bring about qualitative change in the standard of education in these colleges following the conventional system of education. Some imaginative steps need to be taken in this regard. Before we discuss these, it may not perhaps be out of place to comment on two related problems, one concerning the quality of students seeking enrolment and the other concerning the opening of science colleges without adequate staff, infrastructure and facilities.

Alongwith an increase in enrolment for higher education, there has been a steeper increase in educated unemployed. We have almost reached a staggering figure of 20 million educated unemployed out of which science graduates account for a substantial fraction. There is no proper manpower Planning which has resulted in a serious mismatch between the output of higher education and the demand for these people. Although it is recognised that education is vital for development, it is not realised that unrestricted growth of higher education itself can bring a ruin of a nation unless education and production processes are related. We have reached a paradox that we have a large number of educated unemployed, but we do not find enough well trained and skilled, masons, welders, fitters and other tradesmen. Boys and girls after having passed higher secondary examination knock at the doors of the university to seek admission to degree courses irrespective of the fact whether they are qualified and fit for the course. In fact, they enrol themselves for graduate courses in science and social sciences and arts not because they are interested in them but because they have nothing else to do. It is time, we consider this problem in all the seriousness it deserves and open out new channels and diversify our education system. If social pressure is for a degree, the least one can do is to provide for short term technical courses such as that of electrician, plumber, radio and TV

course, one could provide that every student takes every year during his stay of three years, a diploma course of three months duration in one of the trades, so that when he goes out of the college with a graduate degree, he has also three diplomas with training in three trades. Thus even if he does not get a job, he can be self-employed. Apart from the fact that this will reduce the pressure of unemployment, working with hands and obtaining training in some trades will generate confidence in himself.

The second question which also needs careful consideration concerns opening of new science colleges. There has been mushroom growth of this sector. Colleges are started because of social and political pressures without adequate preparation and infrastructure. Such colleges do more harm to younger generation than the service which they profess to perform. It should be incumbent on college management to satisfy some basic minimum in terms of space, buildings, staff, library, laboratory etc. to be laid down by the UGC. Any infringement of this requirement should attract severe punitive action.

19. As stated earlier, the first two components take care of nearly 16% of the students at the undergraduate level leaving 84% of the students who study mostly in affiliated colleges. These colleges seldom have adequate number of teachers and even if they are there, they are not suitably qualified and experienced. These colleges do not have adequate laboratory, library facilities and necessary infrastructure. The students in these colleges are not exposed to the fascination and excitement in science. Far worse is the fact that because of inexperienced teachers even the basic concepts are not clearly explained.

Considering the large numbers involved and the power of electronic media, we consider it necessary and advantageous to recommend the greater use of electronic media particularly the video in imparting education. It is suggested that eminent researchers and experienced teachers be invited to prepare video tapes of lectures addressed to a national syllabus for the undergraduate courses in various science subjects. The video system will also be suited to demonstrate experiments which the students in mofussil colleges never hope to see. These lecture tapes would be duplicated and each college should be supplied with a library of video tapes and a video projection system.

This approach has several advantages. First of all, through this process, one effectively takes a best teacher in the country to a student in the remotest place. It is hoped that a lecture from an experienced and eminent teacher will provide the necessary excitement and arouse the curiosity of children. We would suggest the use of video system not in the transmission mode but in the non transmission mode so that a given lecture if not understood in the first viewing can be repeatedly shown on the screen. We suggest a system of a counsellor in every subject and in every college, so that a student after seeing a video

lecture on the screen can go to a counsellor to get his questions answered or his doubts clarified. We realize that it is not possible to replace a good teacher but we must stress that there are no good teachers to replace. This system is of course supplementary to the existing system and is indeed meant to enrich the present system. These lectures should be of the type and standard of Feynmann lectures or lectures by Sir William Bragg. There is yet another advantage of the proposed system and that is that these series of lectures can also be used for non formal education. Far more important than both these, the system has an inbuilt teacher training component. An inexperienced teacher in a College after seeing a video lecture would understand how a certain concept is handled by an experienced teacher.

This system, therefore, has the potentiality of (a) enriching the formal system of education (b) providing opportunity of non-formal education and (c) teacher training.

We recommend that the UGC should embark on this programme with vigour and speed so that the whole set of video tapes for the undergraduate science education is made available within a span of two years or so. The system is highly cost effective and amenable to updating without substantial additional inputs.

20. FINANCIAL IMPLICATIONS AND OPERATIONAL STRATEGY

UGC should entrust the task of recording these lectures to the EMRC's and AVRC's that have already been established during the last five years. These may be provided with marginal financial assistance for some equipment and staff.

UGC should nominate one full time coordinator for this programme whose responsibility it will be to monitor the programme and to see that entire set of video tapes for the science subjects at undergraduate level are available within two years.

It is necessary to keep the spontaniety of lectures and consequently they should be recorded in a classroom situation. The lectures should also include questions and answers as a part of the lecture to give it a live character. There has been some debate about the duration of these lectures. One view is that these lectures should be of 45 minutes duration as normal college lecture is. The other view is that the duration of this lecture should be 25-30 min. and rest of the time should be used by the classroom teacher to clarify the students doubts and answer students questions. There should be forty lectures per paper per semester.

The introduction of the system in affiliated colleges should be done in phases. A College should be provided with a whole library of lecture tapes and as many video projection systems as are the subjects taught in a College.

FINANCIAL IMPLICATIONS

Rs. in lakhs

- | | | |
|----|---|---|
| 1. | Equipment, editing table, video cameras, etc. at five places (This will supplement the facilities already available in EMRC's) | 50.00 |
| 2. | 240 lectures per year
720 lectures for three years course at the rate of Rs. 5000/- per lecture
In all eight subjects,
1. Physics, 2. Chemistry,
3. Botany, 4. Zoology,
5. Mathematics, 6. Geology,
7. Statistics, 8. Computers | 720x5000x8
28800000
288.80 |
| 3. | Honorarium to lecturers at the rate of Rs. 10,000 per course of 40 lectures | 6x 3 x8x10000
= Rs. 1440000
14.40 |
| 4. | Duplication of lecture tapes for 100 colleges + video projection systems | 300.00 |

TOTAL Rs. 652.40 Lakhs

Based on the experience of its operation in 100 Colleges, the programme be expanded to include another 100 Colleges in the IX Five Year Plan. This would entail an expenditure of Rs.300 lakhs.

21. Miscellaneous Supporting Programmes

Besides, the above programme, we feel that an affiliating university should be helped to set up Science Education Centre at its headquarters. These science education centres should perform a variety of things. It could with the help of Academic Staff Colleges already set up in several universities organize systematically teacher training programmes. The Science Education Centres, with the help of Department of Special Assistance and the University Leadership Programme provide leadership to the affiliated colleges to improve the teaching methods and evaluating systems. The Science Education Centre with the help of University Science Instrumentation Centres design and fabricate laboratory kits and demonstration experiments. The fabrication of the laboratory kits should be got done through the teachers drawn from the colleges. The Regional Instrumentation Centre should play a pivotal role in this component of the programme. We believe that it is necessary to take the modernization of laboratory and laboratory exercises on a war footing. The WRIC should draw up a coordinate plan and get it implemented through the USIC's.

We recommend that UGC should undertake one or two schemes to specially motivate the teachers. The existing scheme of faculty improvement programme should be pursued with vigour. Secondly, we feel that UGC may establish some five awards in each of the science subjects to be awarded to teachers who have designed a good laboratory experiment or a demonstration experiment. These awards in addition to providing incentives would generate some healthy competition.

We also feel that science students should be given a remedial course in English so that the student who passes out can express himself reasonably well in English.

Finally, we believe that the greatest scourge of our education system is the examination. Instead of evaluation being an aid to education, it has tended to exercise severe constraint on education. Examination Reforms are the urgent need if we want to save our education system from a total collapse. The barest minimum that one can do is to introduce National Testing Services. The performance at this examination will help normalization of standards of education in various universities. Although the appearances at NTS examination may be optional, we feel that some benefits should go along with this examination. Thus for example, we may link up scholarships with the performance at this examination or the admissions to the advanced courses may be linked.

The UGC has already established Curriculum Development Centres in various subjects. This programme should be pursued with vigour and the curriculum thus developed through national consensus be introduced in various universities with some modification and with persuasion.

All these miscellaneous, though very important programmes would involve some financial burden. This is indicated as below:

1.	Science Education Centres at 40 Universities	Rs. 20 crores
2.	Regional Instrumentation Centre	1 Crores
3.	N-tional Awards for Teachers Rs. 10,000 per award 5 Awards in eight subjects per year	4 lakhs a year (for five years)
TOTAL Rs.		21.20 crores

TOTAL FINANCIAL IMPLICATIONS

Component	Students	Financial Outlay
1. Highly Talented students	700 students	24.50 crores
2. Selected Colleges	2400 students	3.50 crores
3. Video Lecture Tapes	Rest of the Students	6.52 crores
4. Science Education Centres and other Misc. programmes	All the students	21.20 crores
		<hr/> 55.12 crores. <hr/>

22. CONCLUSION

In conclusion, we would like to emphasize that immediate action is called for, for the improvement of science education at the undergraduate level. We have suggested a three tier approach which in our opinion meets all the requirements of the situation viz. for deliberately and consciously promoting peaks of excellence and for raising the general level of science education at the undergraduate level. We would strongly recommend that this programme be introduced from the Academic year from 1990-91. However, in order to do this immediate action in relation to the constitution of coordination council should be immediately undertaken.

We would like to very strongly emphasize that the whole programme should be Centrally funded leaving no financial liability on the States concerned. Experience has shown that States are unwilling to shoulder the financial responsibility after an initial period of five years. If this happens in relation to this particular programme, the whole programme will collapse. It is, therefore, necessary that the entire programme should be funded totally by the Central Government.

Annexure-I : Staff Paper *

PLANNING COMMISSION
(Education Division)

Subject: Ways and means to improve undergraduate Science Education at Indian Universities/Colleges.

The importance of science education in the process of national development is well recognised. The Scientific Policy Resolution of the Government of India commits the Government to the pursuit, inter-alia, of the following purposes:

- (i) to ensure an adequate supply, within the country, of research scientists of the highest quality, and to recognise their work as an important component of the strength of the nation; and
- (ii) to encourage and initiate, with all possible speed, programmes for the training of scientific and technical personnel on a scale adequate to fulfil the country's needs in science and education, agriculture and industry, and defence;

As stated in paras 1.6 and 3.4 of NPE (1986) science and mathematics will remain as core subjects in the first ten years of school education. Para 2.2 of the Policy refers to the role of education in development of scientific temper. The chapter on Higher Education specifically emphasises the need for development of science and technology curricula and material, research and teacher-orientation (para 5.31). Whatever is stated in other paragraphs relating to protecting the system from degradation (para 5.27) redesigning of courses and programmes (para 5.29), provision of minimum facilities and transformation of teaching methods (para 5.31) also applies to science education at this level.

According to UGC Report for 1986-87, student enrolment in science courses in successive years has increased as below:-

* by Adviser (Education) Shri M.R. Kolhatkar

Year	Enrolment	(Figures in brackets give percentage to enrolment)
1982-83	6,23,545	(19.9)
1983-84	6,53,092	(19.7)
1984-85	6,69,563	(19.7)
1985-86	7,03,467	(17.7)
1986-87	7,25,328	(19.7)

△ and

In percentage terms, the enrolment in science courses appears to have declined from 32.1% in 1950-51 to 31.3% in 1963-64/to 19.7% in 1986-87. However, the absolute enrolment has increased from 1,27,168 in 1950-51 to 4,34,925 in 1963-64, to 7,25,328 in 1986-87. It may be clarified that the above numbers include the students in under-graduate as well as post-graduate courses and in colleges and universities. The UGC report shows that in 1986-87 87.7% of the students were in affiliated colleges and 88.0% were under-graduate students. On this basis and keeping in view the fact that the enrolment covers 3 years and only about 50% of the students appearing- pass the final examination, it can be concluded that about 2 lakh students appear for B.Sc/B.Sc(Hons) examinations every year of whom about 1 lakh students pass. This order of magnitude is also confirmed by data relating to out-turn which for the latest year (1979-80) was 97,000 B.Sc.s. when we are considering measures for improvement in undergraduate science education, it is this large annual number that we have to keep in mind.

1. Standards of Science Education

There has been a feeling that standards of education in general and science education, in particular, in Indian universities/colleges are going down. In this connection, UGC Report on standards of University Education, although it is 24 years old, still retains relevance. According to a study of the Department of Atomic Energy based on its experience of training programmes, scholarships, research grants, fellowships etc. the Department had initiated a scheme for selection of 300 trainees for which 207 applications were being found suitable out of 3,825. The careful record kept showed that "the proportion of candidates suitable for training has steadily gone d-down and the proportion of applicants of very poor quality has steadily gone up, although the standard of requirements in the selection has certainly not risen. There does not seem to be very much difference between a B.Sc. and an M.Sc. student and there is

..../-

some indication in recent years to show that the 3-year B.Sc. course produce students of lesser calibre than the original system. In any case experimental work done by these students prior to coming to the training school seems to be extremely weak. The possible reasons for declining standards of Science teaching in most cases are attributed to the poor quality of the teachers, the dominance of the purely memory examination and the extremely outmoded syllabi. Practical examinations in their present form in universities have absolutely no value.

The above mentioned report also quotes the views of Indian and foreign Scientists regarding the poor quality of Indian science degree-holders.

Among the factors identified by the Report for the poor quality are as below:-

1. Lack of diversity in selection of subjects- stereo-typed combination of subjects;
2. Lack of fresh outlook in techniques of teaching science- tendency to perform routine experiments in a routine manner;
3. Lack of research facilities;
4. Absence of inter-action between University institutions, and non-university scientific laboratories engaged in applied research; and
5. Talented students being attracted towards professional courses, such as, medical, engineering and technology.

2. Remedial measures taken:

(i) University Grants Commission, which is concerned with standards of education in Indian universities/colleges initiated a scheme called College Science Improvement Programme (COSIP) in 1970-71. The objective of the programme was to bring about qualitative improvement in the teaching of science at the under-graduate level, through development of science capabilities of under-graduate students and by initiating the process of continuous self-renewal. This is brought about through an integrated approach and simultaneous improvement in the subject matter, methods of instruction, syllabi, curricula laboratory exercises, workshops, library and teaching material etc. The programme is implemented at two levels; namely, (a) in selected colleges to include the entire faculty: and (b) in one subject in all the colleges

affiliated to university—University Leadership Project (ULP). As on 31st March, 1987 COSIP was implemented in 265 colleges and 40 university Departments. The UGC Report mentions that the programme is under review. However, the Report of the Review Committee on UGC Programmes (1981)—(Chairman—Prof. Satish Chandra) had, on the basis of 10 years' experience, concluded that the performance has varied widely depending upon local leadership and the support lent by the administrative set-up. The Committee noted the positive impact in the matter of preparation and production of text-books, laboratory manuals and other educational materials and proper utilisation by some colleges of the assistance given by the commission. The Committee also noted that in the ULP there was lack of full involvement on the part of students and teachers and in the COSIP, administrative difficulties and lack of interaction between ULP and COSIP etc. Incidentally, the amount of assistance under this programme is rather limited (maximum Rs. 1 lakhs under COSIP and 15 to 20% of the overall budget under ULP). The Committee also noted that the absence of bench-mark survey made the assessment of improvements under various items of the programme difficult. There was also a tendency to divert funds under the programme to other schemes.

(ii) Another measure taken for improvement of science education was introduction of National Talent Research Scholarships through NCERT. These scholarships were introduced in the Union Territory of Delhi in 1963 and all over the country in 1964. In 1977 these scholarships were also extended to students pursuing medicine and engineering courses. A destination study of the NTS scholars as to how many scholarship holders went in for science career, is not available. In 1986, 750 scholarships were awarded of which roughly 95% were for science subjects. As, however, many students taking up science subjects at higher secondary stage opt for medicine and engineering the number of students going in for science (B.Sc/M.Sc) is likely to be much less. While the overall number is not available, out of 4,511 scholars on the roll in 1986, 223 were pursuing under-graduate courses, 227 were pursuing post-graduate courses and 50 were pursuing Ph.D. Thus, only about 500 out of 4,511 were pursuing a specifically Science career. The total amount of scholarships disbursed in 1986 was Rs. 75 lakhs.

We have not developed and built-up the data relating to quantitative measures for assessing quality of education over a number of years. However, the general impression is that inspite of above mentioned measures, the standards of science education in India have deteriorated further since the Report on Standards of University Education (1963).

3. Science Education at School level and Post-Graduate/ Research level.

There is a feeling that in 1980s certain measures have been taken which would go a long way in improving science education at lower level (School education) and at higher level (post-graduate/research level) as compared with under-graduate science education. In particular, reference may be made to the emphasis given in the New Education Policy on Improvement of Science and Maths in schools. A new scheme for strengthening of science Teaching in schools, has been introduced. The salient features of the scheme are as below:

- Provision of science kits to 90,000 Upper primary schools.
- Assistance to 22,500 Secondary and Higher Secondary schools, having laboratory room and science teachers to acquire science equipment (cost of total equipment) for a schools is assessed at Rs.75,000/-
- A one-time assistance of Rs.15,000/- per Secondary/ Higher Secondary School for 40,000 Secondary and Higher Secondary Schools each to procure about 500 books relating to Science and Mathematics.
- Identification of an educational institution or Voluntary agency in each district to act as resource cent to help science teachers. Each resource centre will be given equipment of Rs. 1 lakh;
- Conducting in-service training in the form of summer institutes in institutions of Higher Education, Courses in Secondary Teacher Training Colleges, Courses in DIETs and through voluntary organisations having expertise;
- Assistance on 100% basis to voluntary organisations having expertise to promote scientific temper and science education;

So far as Science education at Post-graduate level and science research are concerned, apart from old scheme of the UGC for Centres of Advanced Study, Departments of Special Assistance and Departmental Research Support Projects in science subjects (there were 25 Centres of Advanced Study, 72 Departments of Special Assistance and 51 Departmental Research Support projects in 1987), the Commission in 1983-84 launched a new scheme called "strengthening of Infrastructure of Science & Technology (COS IST)" on the recommendations of the Science Advisory Committee of the Cabinet. The aim of COS IST is to achieve higher quality performance in research and post-graduate teaching and to raise selected institutions to a level of excellence comparable to other developed countries. So far, 62 Departments have been identified and supported under COS IST programmes. (10 in Chemistry, 7 in Physics, 18 in Bio-sciences and Life Science, 8 in Earth Sciences, 2 in Maths and 17 in Engineering and Technology)

4. Future Directions :

In the background of the above review, and keeping in view the fact that inspite of substantial investments, through several schemes apart from COSIP, referred to above, the feeling of standards being low and deteriorating progressively persists, it may be considered as to what needs to be done to achieve the objectives of the Scientific Policy Resolution, NPE, and the objectives of planned development. Some of the suggestions are as below:

- 1) Revamping of the COSIP scheme with increased funding and with strict monitoring based on benchmark survey;
- 2) Modification of the National Talent Search examination so that the courses, which are otherwise popular are not further subsidised by way of scholarships;
- 3) Linkage of a programme of Science Education Improvement with the scheme of autonomous colleges;
- 4) Identification of institutions spread all over the country which were specifically established for improvement of science education but which have now fallen on bad days because of under-investment and lack of leadership; for example, Institute of Science Bombay and similar institutions which have been established by several State Government;
- 5) Identification of voluntary agencies engaged in science education all over the country and their involvement in the task of improvement of science education at all college/university level. Among such agencies may be mentioned Vikram Sarabhai Community Science Centre at Ahmedabad; Homi Bhabha Centre for Science Education at Bombay, Kishore Bharti at Hoshangabad; Vidyanam Ashram, Pabal, Eklavaya Bhopal, Kerala Shastra Sahitya Parishad, Trivandrum and several others. Many of these have done a lot of good work in relation to School science education. The need is for having voluntary agencies which can work at the college level keeping in view the difference in approach at the two levels.
- 6) In this connection, a scheme called ISPOTS (Integrated Science Programme for Talented Science Students) has been proposed by UGC for implementation in selected universities. The scheme envisages a 5 year programme for producing capable, highly trained and motivated Scientists who would be given scholarships of Rs. 1000 per month with an assurance of employment at the end of the course. A copy of the scheme is enclosed herewith. The scheme appears to be based on an earlier scheme called PUPILS (Punjab University programme for Integrated Learning Sciences).

The meeting may consider the above scheme as well as other measures for improvement of under-graduate science education in India.

Annexure-II Proposal for Integrated Science Programme of Talented Students (I.S.P.U.T.S.) by U.G.C.

A. Preamble

In spite of having the "third largest scientific manpower" in the world the impact of this manpower on the technological development of our country as well as on the world scene in basic sciences is not very significant as principal reasons for this apparent paradox are lack of highly talented students as well as antiquated, fragmented and uninspiring science education programmes in our universities. It has also become apparent that the increasingly one-sided migration of highly talented science students to professional courses, including non-scientific ones, is going to be disastrous for our country's future development. Clearly, this downward drift in sciences must be arrested by devising an imaginative, rigorous and flexible educational programme in basic sciences capable of attracting and stimulating bright young students from all over the country.

B. Objectives

1. To devise a five year programme for producing capable, highly trained and motivated scientists confident of tackling problems in the rapidly advancing frontiers of their chosen disciplines.
2. A product of this programme should be a thorough, disciplined professional with detailed knowledge about his own subject and having an awareness of current/future trends in other sciences. He should learn the social milieu in which he would practise his profession, in particular its socio-political structure, resource and growth problems, various strains and their possible amelioration as well as the impact of his profession on the society at large.

C. Broad Principles

1. An integrated science education, broad-based and liberal, emphasis on the unified structure of science as man's search for an understanding of nature and the Utilization of this understanding for the benefit of his people.
2. Strong foundations in Mathematics, Physics and Chemistry, since these are essential for further development of any branch of science.

3. An awareness of the significance of life process, their great complexity and vast technological potential.
4. Emphasis on both intellectual and manual skills.
5. Exposure to (a) unifying concepts in science, (b) history/philosophy/methodology of science, (c) computer programming and computer graphics, (d) basic electronics, (e) impact of science on Indian society, (f) self-Planning and self-designing of experiments in the laboratory (including a hobby laboratory), (g) research experience; through seminars and a project (h) entrepreneurship and future challenges to Indian scientists.
6. A rigorous semester of education, with periodic/continuous assessment. Interaction between instruction and assessment.
7. Common courses to students in the first year. Branchings into various disciplines from the second year.

D. The Quality of Student Input

This would be a special programme for a limited number of talented science students selected on the basis of an all-India entrance test. Since many brilliant students have not been opting for a science career, it would be necessary to attract them to this programme by means of the following:

1. Wide publicity in mass media and in schools (especially rural areas) to create an awareness in students, and their parents, about good career prospects in science for capable students. Bring out the adventure and satisfaction in a creative scientific career.
2. Institute scholarships (to cover fees, boarding, lodging, purchase of books, pocket expenses) for all the students in the programme (continuation of this scholarship will be strictly subject to a predetermined high level of performance throughout the programme). The maximum number of students entering every year will be 300 (100 per university) so that in the 5th year there will be about 1500 students.
3. Obtain employment assurance from agencies such as UGC, CSIR, DAE, ICAR, ICMR, ISRO, DRDO, DST, Ministry of HRD etc.

E. Governance of the Programme

Initially, the programme will be carried out at 3 Universities, viz. Panjab University, Poona University and Madurai Kamraj University. All the three universities need

not start the programme for awarding degree in all the sciences. However, a department not awarding a degree under this programme may be required to provide instruction in that discipline to the students. There will be an all-India Coordination Council with members from the participating universities, employment agencies (including industry) and leading scientific institutions, e.g. (TIFR Bombay) and IISc. (Bangalore). One of these two institutions may take up the responsibility of operating the office of the Council. Faculty members from these institutions may also participate in the teaching programme at any of the universities.

The Coordinating Council will look after the conduct of all-India entrance test, approve the curricula and ensure high standards in the development and execution of this programme. It will also deal with policy matters, the media publicity and employment prospects.

F. Finance Required

Unlike some other countries, we do not envisage setting up separate institutions for educating talented students. The existing infrastructures with improvements will be deployed effectively for this purpose.

1. Fellowships
100x3 @Rs. 1000/-p.m.

1st year	Rs. 36.00 lakhs
2nd year	Rs. 72.00 lakhs
3rd year	Rs. 108.00 lakhs
4th year	Rs. 144.00 lakhs
5th year	Rs. 180.00 lakhs
and thereafter	

2. Recurring expenditure (Council, entrance examination publicity, office, etc.) Rs. 320.00 lakhs p.a.

3. One time initial grant of Rs. one crore per University for upgrading their infrastructure Rs. 3.00 crores

Certain assurance may be sought from the students of this programme so that we do not lose them to other countries.

The allocation is required to be enhanced proportionately in case more universities are covered under the programme.

G. Target Date for Beginning

The first academic session should begin from July, 1989.

H. Commitment sought From Government and Employment Agencies

1. Financial support.
2. Employment assurance.

Annexure III : Minutes of the Meeting held on 10th March 1989

Planning Commission
(Education Division)

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MINUTES OF THE MEETING HELD ON 10TH MARCH 1989 TO DISCUSS
THE WAYS AND MEANS TO IMPROVE THE UNDER-GRADUATE SCIENCE EDUCATION
AT INDIAN UNIVERSITIES/COLLEGES UNDER THE CHAIRMANSHIP OF
MEMBER(S)

The list of participants is enclosed.

Welcoming the participants, the Chairman stated that concern had been expressed in many quarters and very rightly that the quality of science education was deteriorating in our country. The scientific manpower produced in the country was very large but its impact on the country's development and on the world scene in sciences was not very encouraging. Efforts had been made in the past for improvement of quality of science education. In schools there had been some change but it was not very satisfactory. Funds were provided by UGC for under-graduate science education under COSIP etc. The impact of this was negligible. Large number of B.Sc's were produced every year but because most of them were not of a good standard training effort and investment on them can be regarded by and large as a waste. This was because the training was miserable. Putting in steel and cement structure and spending money on the system was not enough. Something must be done to strengthen the under-graduate education. It was true that there were problems in implementing the programmes, there was rigidity in the university system, rules, and statutes, ordinances etc. Something should be done to reduce these bottlenecks and let the system develop and improve. There was one subject for Honours system. The subsidiaries were neglected. There was no proper integration of subjects at the under-graduate level in the Honours system. We would have to consider all these issues.

/" ISPOTS "

The U.G.C. had sent a proposal acronymed (Integrated Science Programme of Talented Students) for consideration of the Planning Commission. The U.G.C. could, of course consider the proposal but it was thought that views of other experts like those present would be very useful, Hence the proposal has been circulated with a background note prepared in Education Division of the Planning Commission.

Referring to National Talent Search Scheme, Chairman pointed out that Scholars turned out by this scheme were very good, but many of them after completing M.Sc or Ph.D went abroad because they could not get jobs here.

Prof. Menon also expressed concern about the quality of the product of the Universities and Colleges in Sciences. He stressed that some thing should be done to improve the situation. In this meeting, we should agree to do few things and do them rightly. There were many issues needing consideration but there was immediate issue of B.Sc. course. A proposal was sent by Prof. Bambah, Vice Chancellor, Punjab University for a new Science Programme for talent/students at Indian Universities. The programme was called PUPILS (Punjab University Programme for Integrated Learning in Science). This was discussed with Prof. Bambah. The U.G.C. also considered that and then came up with this proposal of ISPOTS. The U.G.C. also had a programme of autonomous colleges under which established colleges were being given autonomy. There were problems of rigidity in the university system. The universities were most of the time busy in conducting the undergraduate exams. He wondered why Universities should conduct these exams. They should concentrate on quality teaching. The State Boards, which conduct secondary schools exams, could also conduct these exams. There should be flexibility in the system. Established colleges should be made autonomous. They could conduct their exams and award the degrees as in Western Countries. These issues need consideration at the highest level. This meeting could also recommend solutions to these problems.

Prof. YASHPAL: also agreed with the Chairman about the quality of science education. He stated the out of the whole lot at under-graduate level, a small fraction was learning science and a large fraction of those learning science were not learning well. Situation is very difficult at the B.Sc. level. He informed that the Working Group on Higher Education constituted for the formulation of the Eighth Plan was recommending the setting up of 600 new colleges and strengthening of many existing colleges. When a new college was started, there was no laboratories, funds provided were not enough. Most of the funds were spent on salaries. The development of the colleges and the quality of teaching was effected.

He was of the opinion that in order to improve the situation 100 colleges could be taken up and made autonomous, provided additional Rs. 1 crore per college during the Plan. He was not in favour of setting up any centrally funded institution for this purpose.

About the 5-year integrated courses, he stated that the product was very very good. Why was this experience not replicated. If 4 to 6 Universities took up this programme, students could be selected for admission from all over the country. They would be provided hostel facilities and scholarships. In case of State Universities, problems of local reservation and other restriction would come up. In that case institutions would have to be centrally funded and autonomous. At present U.G.C. had 100 autonomous colleges,

70 more were waiting to become autonomous. University Acts were to be amended for this purpose. This should made a good impact at the under-graduate level. Some Working Group should be set up to decide how to go about this.

PROF. C.N.R. RAD: stated that there was urgency to start the programme to improve under-graduate science education. Products of the Universities were not good enough for taking up research work. Something should be done on a war footing. A few institutions should take up quality education which should be among the best in the world. One way was the integrated M.Sc. course for which existing institutions could be utilised. This would solve the problem to some extent. Secondly special science colleges, about fifty or so could be taken up for specialisation. They should be autonomous with flexibility of teaching, examinations etc. The admission should be like IITs. These programmes could be taken up in the Eighth Plan.

PROF. GNANAM: also supported the 5-year Integrated M.Sc. Course. He informed that the University at Trichy had started 5-year integrated Master of Science degree from 1985. Madras University also started such a course in Chemistry from 1988. Such courses were already running at BITS, Pilani and other centres. Those courses were popular and much sought after for which entrance tests were conducted.

For talent search and promotion, students were identified on the basis of merit (about 100) and supported for attachment of 6-8 weeks in R & D laboratories, by spending Rs. 1,000/- per student for each summer for two years. The funds could be derived from endowment specially created for this purpose. He also stated that the COSIP ULP should be strengthened. The proposal on ISPOTS should be further discussed specially in respect of expenditure on council and fellowships. The number of 300 students to be taken up initially was very small. The Universities/Institutions could be funded on prorata basis (per student). The details could be further worked out.

Prof. Menon was of the view that we could agree here to take up integrated courses, the details of the courses could be worked out later on.

PROF. BAMBAH: expressed concern about science education. He stated that good students of 17-18 years were attracted towards engineering and medicine courses. Left overs only came to science courses. In IITs, the integrated M.Sc. courses were the last choices. Efforts should be made to identify leaders in pure Sciences, put them in the inspiring atmosphere, give them incentives and impart good training and offer them good jobs so that they remain in the country.

Among the scholars of the Talent Search Scheme, very few study science at the college level. Many of them, after graduation, go abroad. They should not be left alone. They had to be inspired so that they did not lose interest in science. They could be sent to other institutions for better exposure. The National Talent Search Scheme could be utilised to identify the students for taking up science in the college. They should be assured jobs. The existing institutions could be provided inputs to impart education in science to these talented students.

PROF. CHAKRAVARTY: also supported the concept. He stated that good students could be taught by researchers at the age of 16-17 years after school education. This type of experience was necessary to motivate the students. He expressed concern about the present university system which was catering only to the mass education. The one subject Honour System did not serve the purpose. Subsidiaries were not taken seriously and therefore there was so much waste of time. There was therefore a need to create infrastructure for quality education. Three institutions proposed would not be enough. Large number of institutions should be taken up and graduate education in Science should be strengthened.

Prof. Yashpal was of the view that these institutions should have only special types of course in Science and not a mix of all subjects as at present. Scholarships should be provided at the level they were provided in IITs. Good institutions could be promoted to take up this programme. Upgrading of present type of colleges was not going to succeed.

PROF. RAIS AHMED stated that the issue involved in this were:

- (i) Raising the Standard of Science Education in all colleges. Minimum facilities must be provided.
- (ii) The innovations talked here were not new. A number of universities in Sixties introduced this but after 5 to 6 years, reverted back to conventional system. Even examinations were a problem and if one wanted to leave after three years, the equivalence was a problem.
- (iii) The proposals for innovation should come from the universities.
- (iv) Introducing innovations in existing universities was problematic.
- (v) Jobs could be ensured. It might be possible if the number of the students was small.

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All these issues should be sorted out.

PROF. BHIDE : was of the view that the programme should be centrally administered. Leaving the matter to States would create problems and adversely affect the programme. A few universities should be selected for this purpose. Other universities could take up the same later on.

Video cassetts and other audio and visual aids could be prepared and utilised for teaching purposes. This would help in achieving the purpose with less expenditure.

PROF. SANKAR SEN informed that Jadavpur University had already started 5- years integrated courses in 1987. Admission was done on the basis of Joint Entrance Examination conducted for courses in engineering and medicine. He felt that the level of attainment of the students would not be equal to B.Sc. if they were to leave after three years of education in this programme.

Prof. JALALUDDIN : said that this innovation would require talented teachers and they would be difficult to find. Secondly atmosphere would have to be created so that these students were accepted and absorbed.

Some system could be designed so that the programme could be implemented with optimal expenditure which could be achieved by net-working of facilities of libraries, resource centres and other facilities created for this purpose. A group of people could be requested to think over it and work out the details for implementation.

PROF. H.S. SRIVASTAVA informed that the National Talent Search scheme had produced scholars who had attained high positions in the society. They were brilliant people. This scheme, when started, was for search of talent in pure sciences only. Later on, when the response for pursuing these courses declined that scheme was diversified to include courses in engineering, medicine etc. The students were attracted for courses in engineering and medicine. The response for pure science courses was very low. The system of identifying scholars for National Talent Search Scheme could however be utilised for identifying students for this programme.

The proposal for this innovation should come from the universities because they would have to make changes in their rules, statues, ordinances etc. Mobility of students from one institution to another should be allowed. Net working of facilities created in various institutions should be done.

PROF. GNANAM: suggested that the institutions should be provided Rs. 1 crore each - Rs. 50 lakhs for construction of hostels and Rs. 50 lakhs as endowment fund. The interest on this amount could be used for developing facilities for courses.

MEMBER (S) in his concluding remarks stated that concern had been expressed here about the quality of the under-graduate courses in science and there was a consensus for 5-year integrated courses in sciences. A number of suggestions were made here for improvement of quality which were very valuable. These had to be given concrete shape. He suggested that a working Group should be constituted to work out the details. The group should submit its report in 4-6 weeks. Prof. Bhide was requested to chair this group. Other names suggested for the working group were :-

- (1) Prof. H.D. Kesar - Punjab University, Chandigarh
- (2) Prof. T.V. Ramakrishna - I.I.Sc., Bangalore,
- (3) Shri P. Natrajan, Development officer - Madras University, Madras.
- (4) Prof. Rais Ahmed.
- (5) Prof. H.S. Srivastava - NCERT
- (6) Prof. Asis Datta - School of Life Sciences, Jawaharlal Nehru University, New Delhi.
- (7) Adviser (Edn.) Planning Commission / or his nominee.
- (8) Secretary UGC or his nominee.

LIST OF PARTICIPANTS

1. Prof. P.N. Srivastava
Member, Planning Commission, -- in the Chair
2. Prof. M.G.K. Menon,
Member, Planning Commission
3. Prof. Yash Pal,
Chairman, U.G.C.
4. Prof. S. Chakravarty,
Chairman, EAC
5. Prof. C.N.R. Rao,
Director, IISc, Bangalore,
6. Prof. R.P. Bambah,
Vice-Chancellor, Punjab University
7. Prof. A. Gnanam,
Vice-Chancellor, Madras University
8. Prof. M.S. Agwani,
Vice-Chancellor, J.N.U.
9. Prof. S.K. Sen,
Vice-Chancellor, Jadavpur University
10. Prof. Rais Ahmed
11. Prof. P.L. Malhotra,
Director, NCERT
12. Prof. V.G. Bhide,
Head of the Physics Department
Poona University, Pune.
13. Prof. A.K. Jalluddin,
Joint Director, NCERT
14. Prof. H.S. Srivastava,
DEAN (Academic), NCERT
15. Prof. (Mrs.) Archana Sharma,
Calcutta University,
16. Shri S.R. Chopra,
S.R.O., Planning Commission.

Note :- Shri M.R. Kolhatkar, Adviser (Education) Planning
Commission could not attend as he was on tour.

Annexure IV: Planning Commission Order No.P-11061/2/89-Edn.
Dated 24th April, 1989 as amended by Order dated
11th May, 1989.

No.P-11061/2/89-Edn.
Government of India
Planning Commission
(Education Division)

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Yojana Bhavan,
Sansad Marg,
New Delhi.
Dt. 24.4.89.

ORDER

Subject: Ways & Means to Improve Under-Graduate Science
Education at Indian Universities/Colleges.

In a meeting held on 10th March, 1989 under the
Chairmanship of Prof. P.N. Srivastava, Member, Planning
Commission to discuss the ways and means to improve under-
graduate Science Education at Indian Universities/Colleges,
it was decided to constitute a Working Group to work out the
details for implementation of the recommendations made in this
meeting.

2. The composition of the Working Group is given below:-

1. Prof. V.G. Bhide, - Chairman
Head of the Physics Department,
Poona University, Pune.
2. Prof. T.V. Ramakrishna, - Member
I.I.Sc., Bangalore.
3. Sh. P. Natarajan, - Member
Development Officer,
Madras University, Madras
4. Prof. H.D. Kesar, - Member
Punjab University, Chandigarh
5. Prof. Rais Ahmed, - Member
C-27, Ranjit Singh Block,
Asiad Village, New Delhi.
6. Prof. P.K. Mohanty * - Member
School of Life Sciences,
Jawaharlal Nehru University,
New Delhi.
7. Prof. H.S. Srivastava, - Member
N.C.E.R.T., New Delhi

8. Prof. Arvind Kumar, *
Member Secretary of the
Homi Bhabha Centre
for Science Education, Bombay. - Member
9. Adviser (Education),
Planning Commission
New Delhi or his nominee - Member
10. Secretary, U.G.C.
or his nominee - Member

3. The Working Group will submit its report to the
Planning Commission latest by 31st July, 1989.

Sd/-

(J. C. Dangwal)
Director (Administration)

Copy to:-


Sd/-

(J. C. Dangwal)
Director (Administration)

* Name of Prof. Mohanty replaced the name of Prof. Ashish
Datta and the name of Prof. Arvind Kumar was added by
Planning Commission order of even No. D/11.5.1991.

Annexure-V: Comments of Education Division

The recommendations of the report are well conceived. It does suggest a very good three-tier structure for improvement of science education. Our comments relate to the following:-

- 1) The alternative of opening new central institutions has not been examined. Its implications need to be worked out. It is recalled that Prof. Rais Ahmed had advocated this alternative in the meeting of the Steering Group and it was our expectation that this alternative will find a place in the Report. This is because just as this alternative is costly, it has also its advantages. Thus, at least part of success of IIT's is due to the fact that these were new institutions. New institutions mean new 'Culture' also.
- 2) The distribution of streams in the scheme for highly talented students-3 for physical science, 2 for life science and 2 for maths needs consideration. Could we not have equal number of streams in life science?
3. The organisational arrangement for the scheme for highly talented students- 2 alternatives are given-administration through TIFR/IISc or administrated through UGC. It is felt that former alternative is preferable.
4.  does not deal with reserving NTS non-professional streams only this important financial consideration.
C2657
PLANNING COMMISSION
LIBRARY
5. The recommendation that the Central Govt. should permanently fund the scheme including colleges is not in order. At the most, it can be for 10 years instead of usual 5 years corresponding to 5 year Plan.
6. The report deal with restructuring of 3 year degree programme (~~3-2-5~~). It would be better to have a separate section on this in the context of science education-suggest new courses with application orientation.
7. The report should deal with the problem of recruiting and retaining science teachers in greater details. New organisational arrangements for the faculty development & improvement need to be dealt with.

