Prof. Vijay A. Singh

National Initiative on Undergraduate Science (NIUS)

(2004 – 2010)

Prof. Vijay A. Singh (HBCSE, TIFR)

The National Initiative on Undergraduate Science was launched in the summer of 2004. Over 400 undergraduate students have been exposed to this programme. The program includes initiating and guiding students for proto-research, preparing and editing lecture notes, and promoting undergraduate research. The administrative aspects involve co-ordinating with scientists and students and purchase of equipments among others. Another aspect has been to assist college teachers in setting up modest research programs who in turn would then locally mentor students.

NIUS Camps:

The NIUS is an extended nurture program for undergraduate students. A typical student attends three to four camps each of two to four weeks duration. The first camp is an exposure and enrichment camp for students. In this camp, experts lecture on topics of frontline research. Some of the more pedagogical lectures have been written up and edited, and will assist in Curriculum Development at the undergraduate level. Some of these have already been widely disseminated and constitute valuable resource material.

Six batches of undergraduate students from across the nation have been exposed to this program. A fair fraction to the students was from non-metropolitan colleges.

Biology:

In biology the following areas were covered: Cell Biology, Microbiology, Biochemistry, Bioinformatics, and Molecular Biology. Resource Persons were drawn from HBCSE, IIT-Bombay, Pune University and the colleges of Mumbai University.

Sr. No.	**Batches**	**Year**	**Students Enrolled**
1.	Batch I	2004-2005	29
2.	Batch II	2005-2006	15
3.	Batch III	2006-2007	10
4.	Batch IV	2007-2008	14
5.	Batch V	2008-2009	12
6.	Batch VI	2009-2010	07
7.	Batch VII	2010-2011	20
		Total	**107**

Chemistry:

In chemistry the following areas were covered: Computational Chemistry, Organic Chemistry, and Interfacial Chemistry. Resource Persons were drawn from HBCSE, BARC, Colleges of Mumbai University, Pune University, NCL Pune, Hindustan Lever and IIT-Bombay.

Sr. No.	Batches	Year	Students Enrolled
1.	Batch I	2004-2005	31
2.	Batch II	2005-2006	18
3.	Batch III	2006-2007	07
4.	Batch IV	2007-2008	25
5.	Batch V	2008-2009	14
6.	Batch VI	2009-2010	39
7.	Batch VII	2010-2011	40
		Total	**134**

In physics the areas covered were: quantum computing, astrophysics, neutrino physics, semiconductor nanostructures, instrumentation and optical measurements, and the application of the techniques of statistical mechanics to cognitive science and science education. Resource persons were drawn from HBCSE, BARC, TIFR, IISERs, as well as from a number of colleges in the non-metropolitan areas of the nation. A happy outcome of this has been that several students have raised the level of their proto-research work to international research standards. They have presented their work in International Conferences and their publications have appeared in National and International Journals.

Physics*:*

Sr. No.	Batches	Year	Students Enrolled
1.	Batch I	2004-2005	27
2.	Batch II	2005-2006	40
3.	Batch III	2006-2007	35
4.	Batch IV	2007-2008	43
5.	Batch V	2008-2009	49
6.	Batch VI	2009-2010	51
7.	Batch VII	2010-2011	67
		Total	**312**

After the first camp in each subject, students are selected for subsequent camps and focus on their chosen area of proto-research. Approximately one-third of the enrolled students successfully complete their projects. IT may however be noted that first camp itself provides guidance, enrichment and tremendous motivation to the students.

To summarize,

1. **Camps for students:** **Seventy eight (78)**
2. **Lectures notes prepared:** **Thirty (30)**
3. **Refereed Research Publications and Conferences Proceedings with Undergraduate Students:** **Forty four (44)**

[See website http://nius.hbcse.tifr.res.in/subjects/physics/publications **for details of publication].**

PROMOTING UNDERGRADUATE RESEARCH IN NON- METROPOLITAN COLLEGES

The task of identifying**,** encouraging and working with faculty in Non-Metropolitan colleges has been initiated. This had been done in half a dozen places in India notably in Christ Church College, Kanpur (Kanpur University); Science College, Patna (Patna University); Jagdam College, Chapra (Jaiprakash Narayan University); B S. College, Danapur (Magadh University), DAV PG College, Rishikesh (Tehri-Garhwal University), Physics Dept., H. S. Gour University, Sagar, MP and Saran Basaveshwara College of Science, Gulbarga University.

Our perspective is to enable the teachers to set up a modest research effort so that they in turn will mentor the undergraduate students. In the places mentioned above the plan has been put in place and is operative. The research areas are nanophysics (both theoretical and experimental) and quantum chaos.

Promotion of Undergraduate research in Non-Metropolitan Colleges: **over six (6)**

NIUS WORKSHOPS

NIUS Workshops were conducted in nanoscience, classroom demonstrations and in statistical physics. The aim of these workshops were (i) to orient these college teachers towards statistical mechanics, an area not touched upon in undergraduate physics; (ii) to assist in the preparation of pedagogical lecture notes introducing undergraduate students and college teachers to the Physics of Second Order Phase Transitions; (iii) Development of undergraduate physics laboratory. Over 100 participants from across the nation have attended these workshops.
With the inauguration of the NIUS facility, this activity will receive a fillip.

Workshops for College Teachers from Non - Metropolitan area: **over five (5).**

PROMOTING UNDERGRADUATE LABORATORY WORK AT NEWLY ESTABLISHED SCIENCE INSTITUTES

NIUS greatly expanded its scope of work with the establishment of Department of Atomic Energy (DAE) aided institutions: National Institute of Science Education and Research (NISER), Bhubaneshwar and University of Mumbai- Department of Atomic Energy for excellence in Basics Science (UM-DAE CBS). As part of NIUS, HBCSE was proactively involved in the initial curriculum design of these institutes as well as IISER Pune and development of its first year laboratories in all the three subject. In physics the entire experimental set-up was first assembled at (HBCSE) and then transferred to NISER and CBS. In chemistry, the first year laboratory activity of CBS students in 2008 – 2009 was carried out entirely at HBCSE. Besides, NIUS members were also actively involved in carrying out the first year physics teaching programme of CBS, Mumbai. HBCSE also conducted the national Entrance Screening test (NEST 2007) for these institutes, and its members played an active role in the subsequent interviews for admission to them.

MAJOR EXPERIMENTAL FACILITIES & SET-UPS

A large number of facilities were set- up in each discipline*:*
In Biology: UV Visible spectrophotometer, Documentation System, Cold Centrifuge, Deep Freezer, Poly Acrylamide Gel Electrophoresis Apparatus, Western Blotting.

Using the above facilities a number of important projects could be initiated. For example the DNA profiling of various tissues that differed metabolically could be carried out and studies of protein denaturation could be monitored.

In Chemistry: Gas Chromatography, UV-visible Spectrophotometers, FT-IR, pH meters (advanced models), Refractometer, Surface tensiometers for crude as well as for surface and interphase measurement. In addition a computational chemistry facility was set-up and advanced software (Gaussian) was acquired.

Using the above facilities a number of important projects could be initiated. For example the vibrational and electronic spectra of complex molecules and nanostructures could be studied. Calculations for the same could also be carried out in the computational chemistry facility. The identification of functional groups in organic compounds could be effected.

In Physics: Fibre Optic Spectrometer (Ocean Optics make), He-Ne Laser Sources, Optical Bread Boards, EPROM Programmer, Microprocessor Kit and Sensors for Velocity, Acceleration, Magnetic Field and Temperature.

Using the above facilities a number of important projects could be initiated. These included the study of emission, transmission and reflectance spectra as well as photoluminescence. The study of ophthalmic lenses could be carried out in a systematic way.

POSTSCRIPT

It maybe noted that the tradition of introducing undergraduate students to research in western countries is not new. Caltech (USA) for example has run the SURGE project since 1919. The Indian Institute of Technology (IITs) in India have initiated similar projects with IIT – Kanpur tying up with Caltech. The Kishore Vaigyanik Protasahan Yojana (KVPY) and the Jagdis Bose National Science Talent Search (JBNSTS) schemes also encourage its scholars to carry out research projects in summer. In contrast to these schemes the budget outlay of NIUS is modest. It must also be noted that for the past five years since NIUS has been operational there was no hostel, laboratory space and dedicated staff. The Olympiad cells of biology, chemistry and physics were asked to take up this task. They have taken up this challenge and, although a great deal needs to be done, they have delivered. At least eight NIUS scholars are pursuing research at the TIFR main campus. Several students have been encouraged to pursue science as a career. A case in point is Raghu Mahajan the IIT all India rank one (AIR -1) who left the IIT Delhi computer science program midway to pursue a career in physics research at MIT. He has publicly acknowledged the positive influence of the NIUS program in his decision making. Another NIUS scholar (Akash Kamra) was honoured by his host institution, in this case IIT Kanpur, with a cash award of Rs. 20,000/ for the international publications he authored under NIUS. The research work on quantum teleportation of another NIUS scholar Sreeram Murlidharan from Loyala College, Chennai was singled out for special mention by the renowned journal Nature. He secured the 2009 Erasmus Mundus scholarship for Masters in Europe and is currently at KTH Sweden. A measure of the success of the NIUS program is the presence of undergraduate students at national and international conferences and the scientific publications. The first national conference to showcase undergraduate research was held in IIT-Kanpur March 26-28, 2010 (ICARUS). Over 25% of the talks presented at this conference were by NIUS students and an additional session was earmarked where Prof. Vijay A. Singh presented the NIUS programme. The research output by undergraduate students under NIUS is unprecedented in our nation.

FUTURE WORK:

Students camps are in place. Now the NIUS facility is nearing completion. We plan to hold a larger number of workshops for college teachers. The workshops will have mixed approach and will include both; 1) Slandered undergraduate topics but with a solid pedagogical fashion. 2) Topics which are at the frontiers of the research. A substantial Financial outlay is needed for holding camps for students and college teachers.

REFERENCES

For details including publications and conference proceedings see http://nius.hbcse.tifr.res.in/