

Homi Bhabha Centre for Science Education

Tata Institute of Fundamental Research

Jayashree Ramadas

Centre Director

XII Plan - mid-term review

November 20, 2014

Revised: November 25, 2014



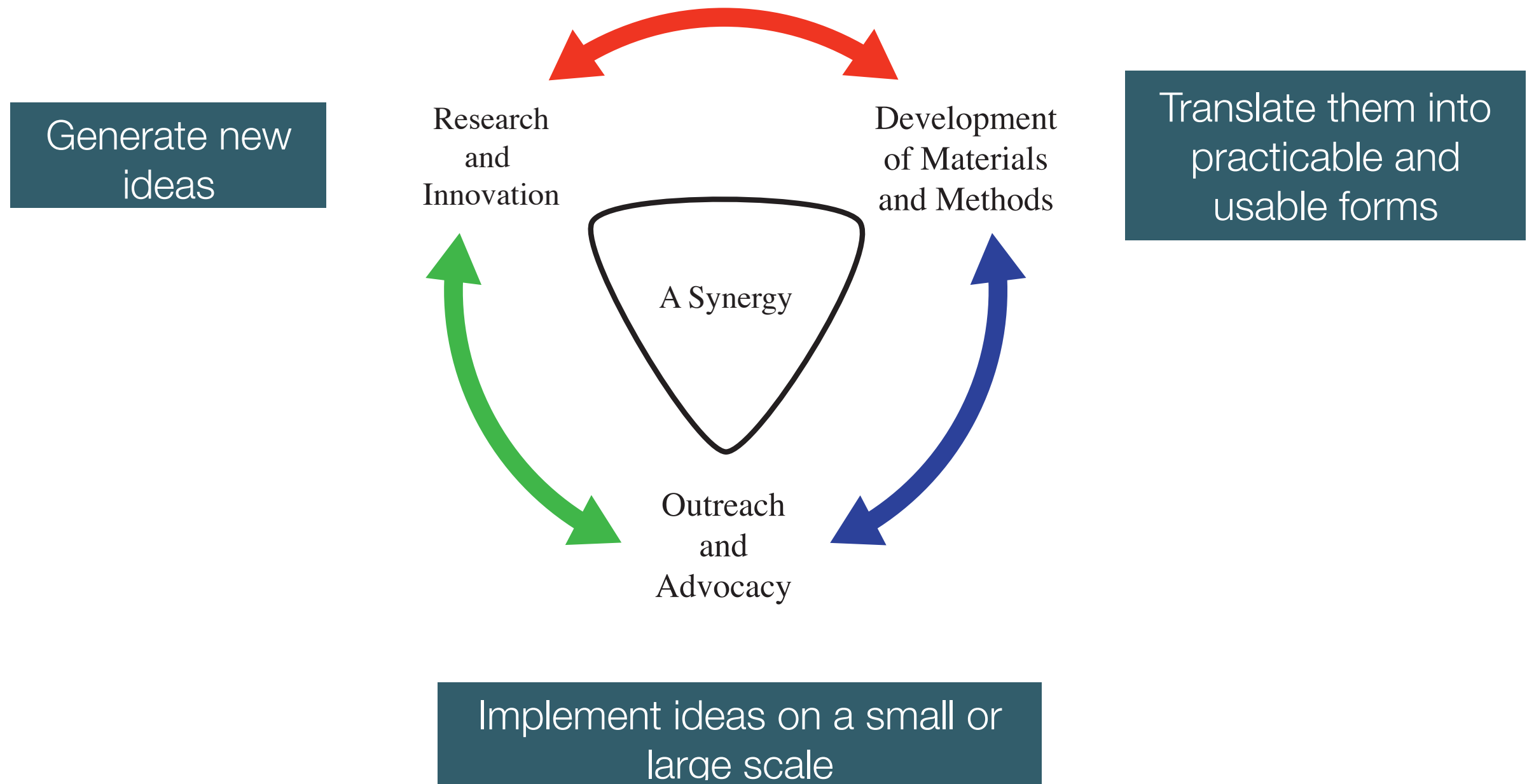
HBCSE

A synergy of research, development
and practice

Our Goals

- To carry out research and development
 - towards improving the quality of science and mathematics education
 - for all students
 - from primary school to undergraduate level

HBCSE Goals



Expenditure – 2013-2014

Non-Plan (₹) : 1,122 lakh

Plan (₹) : 274 lakh

Misc. Grants (₹) : 545 lakh

Total (₹) : 1,941 lakh

Non-Plan Expenditure

Salaries (₹) : 766 lakh

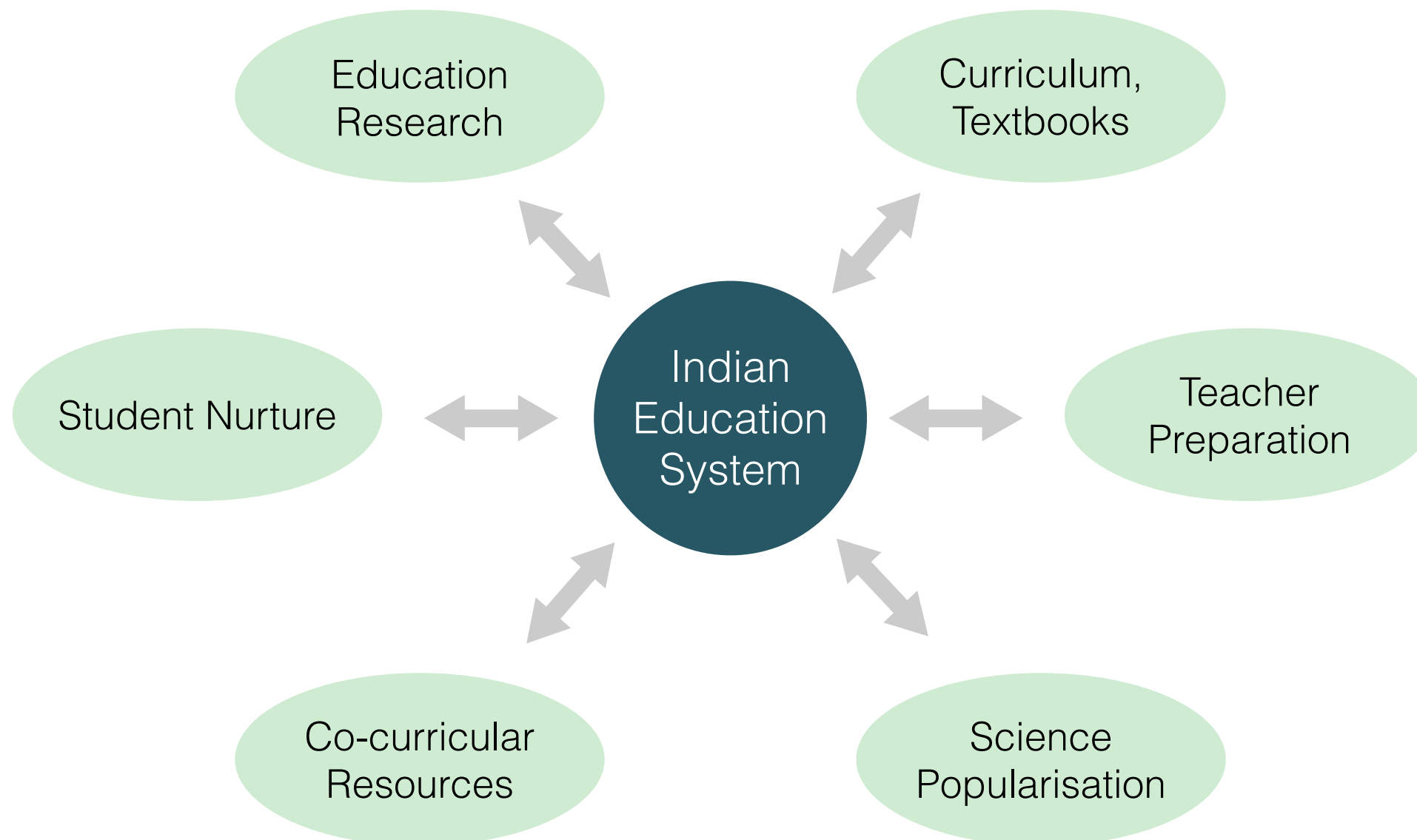
Operation & Main. (₹) : 356 lakh

Total (₹) : 1,122 lakh

Staff Strength - Now and Projected

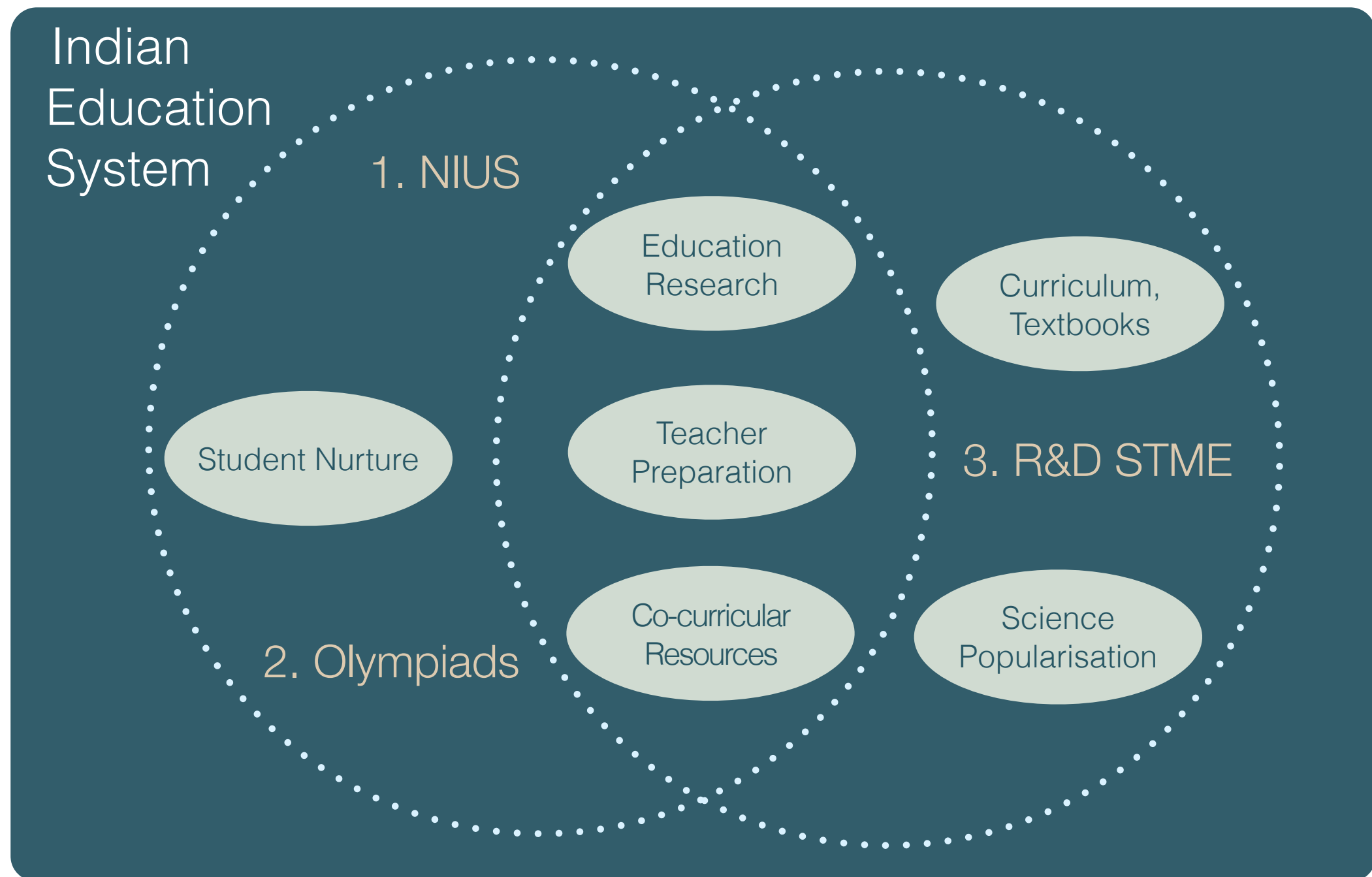
Category						No. of members		Projected nos.		
Permanent	Faculty					18	Total 69	25		Total 82
	Scientific Staff					18		22		
	Administrative & Auxiliary					26		28		
	Technical Staff					7		7		
Temporary	Research Scholars					15	Total 63	25		Total 86
	Visiting Fellows					1		5		
	Project Fellows					6		8		
	Project Assistants					30		35		
	Organisation/Technical Trainees					11		13		
Total						132		168		

Approach to Goals



http://www.hbcse.tifr.res.in/review-presentations-1/jr_hbcse-review-presentation.pdf

Approach to Goals - XII Plan



HBCSE Plans – A brief history

1992	Move from Nana Chowk to Anushaktinagar	
1993-94	VIII Plan	Plan funding begins
1997-2002	IX Plan	New campus development
2002-07	X Plan	Homi Bhabha Curriculum Olympiad block, laboratories mid-term review - NIUS proposal
2007-12	XI Plan	NIUS building, laboratories

HBCSE XII Plan Overview

- Upgradation of facilities
 - Laboratories
 - Library
 - Computers and networking
- Teacher and student camps
 - Human resource intensive
 - Human resource creating

XII Plan Projects

1. National Initiative on Undergraduate Science (NIUS)
2. Olympiads
3. R & D in Science, Technology and Mathematics Education (STME)

Budget (before cut of November 2014) Rs.1800 lakh

Project 1 – NIUS

Principal Investigators

- Vijay A. Singh (National Co-ordinator, NIUS till July 2012)
- Rajesh B. Khaparde (Physics)
- Rekha Vartak (Biology)
- Savita Ladage (Chemistry) (National Co-ordinator, NIUS since August 2012)
- Anwesh Mazumdar (Computational Science and Astronomy)
- Centre Director, HBCSE

Project 1 – NIUS (2004 -)

- Promoting learning of basic sciences through nurture camps and undergraduate research
- Target groups, motivated and meritorious
 - UG students in colleges
 - Students in professional courses, interested in basic sciences
 - College teachers

Budget (before cut of November 2014) Rs.700 lakh

NIUS - Camps, students, projects

4 camps per subject per year
(1 exposure camp ~40-60 students + 3 camps for project)

Since 2004	~1000 students have attended NIUS nurture camps and ~120 completed projects
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Since 2012	Physics	3 camps, 205 students, 23 projects, 26 publications
	Chemistry	2 camps, 94 students, 20 projects, 12 publications
	Biology	3 camps, 96 students, 2 projects, 1 publication

Student Projects

Biology: Cell Biology, Microbiology, Biochemistry, Bioinformatics and Molecular Biology.

Chemistry: Organic Chemistry (with emphasis on Green chemistry), Interfacial Chemistry (study of physico-chemical properties surfactant containing systems , Computational Chemistry

Physics: Quantum Computing, Astronomy & Neutrino Physics, Nano Science and Instrumentation

Lab upgradation - Biology

Instruments procured (April 2012 onwards)

- Poly Acrylamide Gel Electrophoresis (separation and profiling of proteins)
- Polymerase Chain Reaction (PCR) machine (for gene amplification),
- ELISA Reader (allows spectrophotometric analysis in UV range with volumes as low as 2µl)
- Western blotting apparatus (identification of specific proteins using antibodies).

Lab upgradation - Chemistry

Instruments procured (April 2012 onwards)

- UV visible spectrophotometer with peltier system, multi-cell and variable path length cells: Allows kinetic study of samples at variable temperatures, spectrophotometric titrations
- FT-IR spectrometer: Identification of functional group and their transformation in synthesis reactions
- Viscometer with peltier system: Viscosity measurements of different systems at different temperatures

Lab upgradation - Chemistry

(contd)

- Rota vapour: Removal and recovering of organic solvent in synthesis reactions
- Accessories for surface tensiometers: Density measurements, study of surface and interfacial tension as function of temperature
- Upgradation of Gaussian software and Gaussview visualiser
- Expansion of computational chemistry projects to clusters and visualisation of atomic/molecular/cluster systems

Lab upgradation - Physics

Instruments procured (April 2012 onwards)

- Fibre Optic Spectrometer (Ocean Optics make) and calibration systems for velocity, acceleration, magnetic field and temperature.
- Standardization and calibration of measurement systems and experimental setups developed at HBCSE, experimental projects involving optical characterisations



Time measurement unit

Computational Science facility

Rationale

- Unifies undergraduate science, contemporary relevance, yet not an integral part of curriculum

Hardware

- 30 machines
Intel core I-7 processors - 3.8 GHz, original Intel mother board, 16 GB RAM memory, 2 TB internal capacity and graphics card, optical DVD drive, etc.

Computational Science facility

Student projects

Biology

- Bioinformatics and ethology

Chemistry

- Electronic structure, Molecular dynamics and Statistical mechanics

Physics

- Quantum computing and Astronomy



Workshop on computational chemistry

Computational Science facility

Workshops

- NIUS chemistry: modules in computational chemistry
- Computational Science
 - Introduction to various tools of computational science, hands-on programming and problem-solving
 - Basic numerical techniques and their implementation in physics.
- Geogebra and biology Olympiad training

NIUS - future directions

- Developing pedagogical resources for students and teachers
- Research in UG science education
- Workshops for teachers (content and pedagogy)
- Upscaling the programme and increasing its reach (number, frequency, multiple entry)

Project 2 – Development of Laboratories and Library for Olympiad and Talent Nurture (Olympiads)

Principal Investigators

- Vijay Singh
(National Co-ordinator, Science Olympiads till April 2014)
- Savita Ladage
- Rekha Vartak
- Aniket Sule
- Paresh Joshi
- Centre Director (HBCSE)
- Anwesh Mazumdar
(National Co-ordinator, Science Olympiads since August 2014)

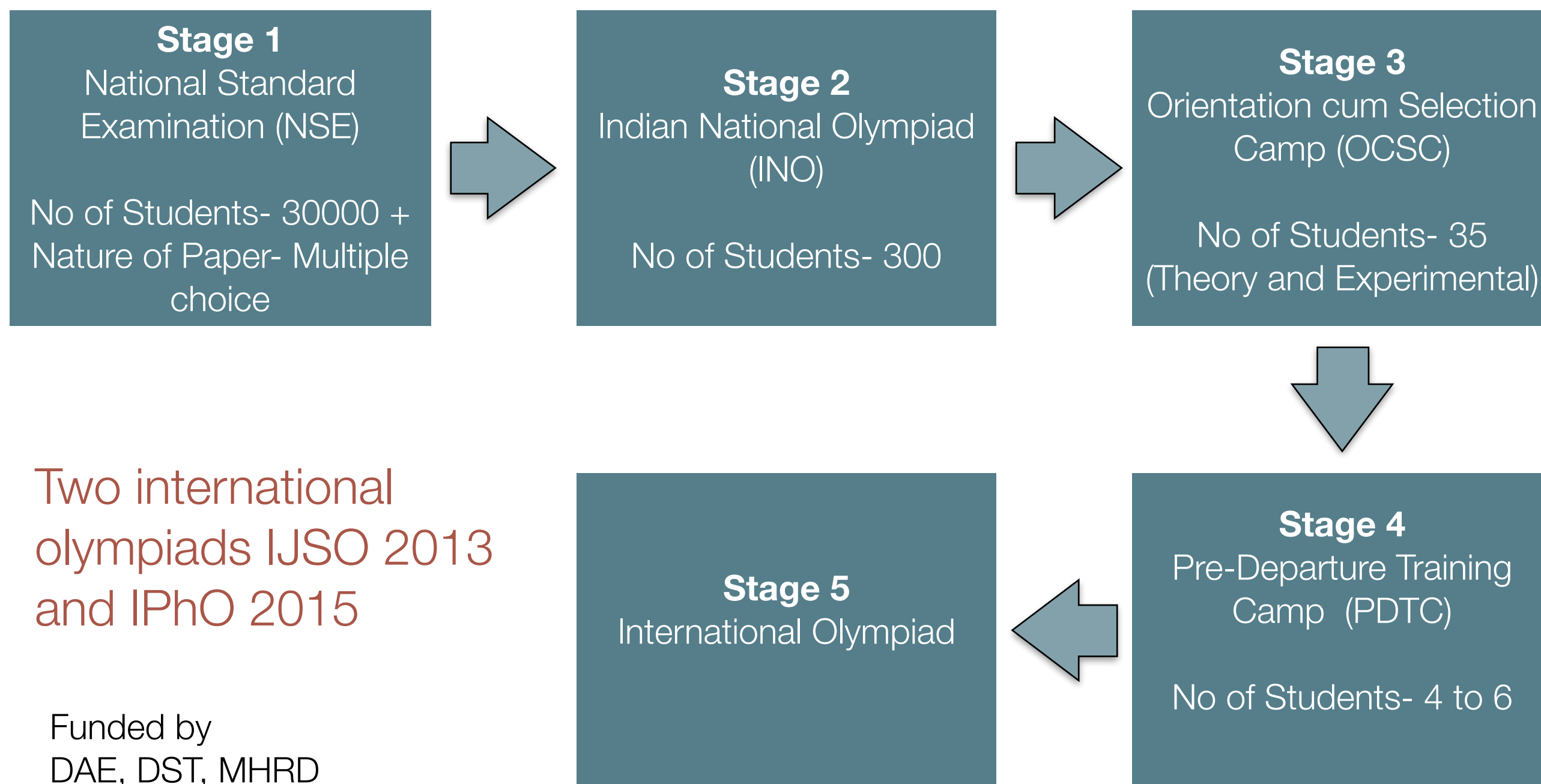
Project 2 – Olympiads

- Mathematics
- Physics
- Chemistry
- Biology
- Astronomy
- Junior Science



Budget (before cut of November 2014) Rs.425 lakh

Structure of Science Olympiads



Olympiad Exposure Camps for Teachers

3 - 4 days

- Discussions regarding content and pedagogical aspects of the subject
- Alleviating common misconceptions about subtle points among teachers, and thereby future students
- Introduction to unconventional ways of doing experiments and setting questions

Olympiad Exposure Camps (2012 onwards)

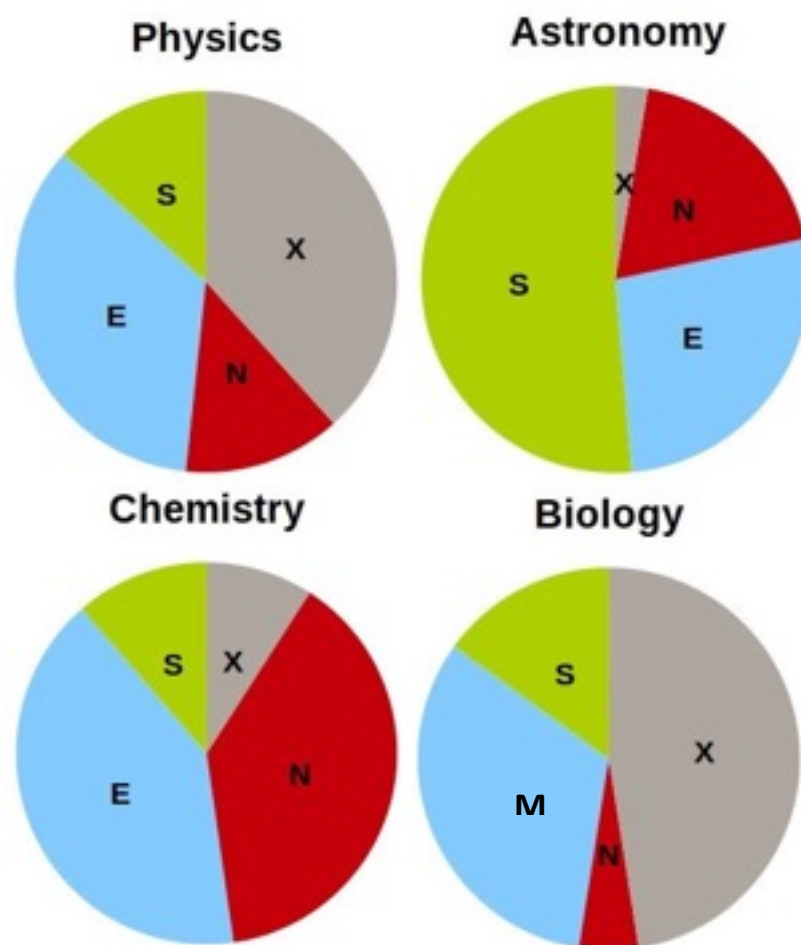
Astronomy	No. of camps	3
	No. of participants	200
Biology	No. of camps	3
	No. of participants	111
Chemistry	No. of camps	3
	No. of participants	95
Physics	No. of camps	2
	No. of participants	70

Olympiad Exposure Camps (2012 onwards)

- Teachers from different states across India
(Assam, Bihar, Chhattisgarh, Haryana, Jharkhand, Jammu and Kashmir, West Bengal, Madhya Pradesh, Kerala, Punjab, Orissa, Tamil Nadu, Telangana, Uttar Pradesh and Uttarakhand)
- More than 500 teachers have so far attended exposure camps, some even from Bangladesh, Sri Lanka, Nepal and Thailand.

After the Olympiads

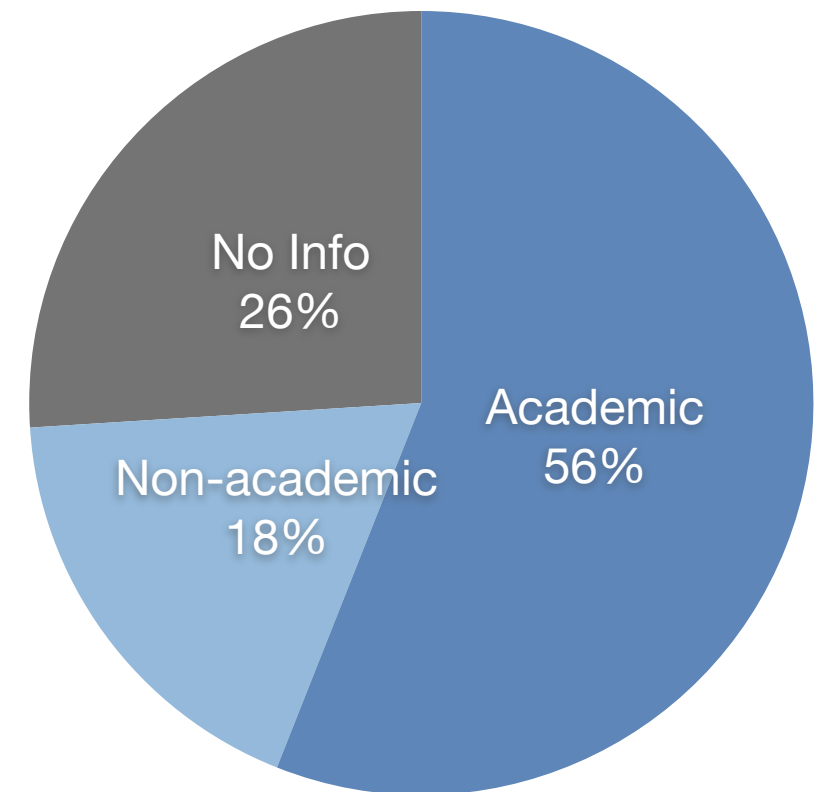
Career paths of Olympiad medallists



S: Science
E/M: Engineering/Medical
N: Non-academic
X: No information

Tracking of science Olympiad medallists from about 1999 to 2009

A higher percentage in mathematics enter academics (data being collected).



	Science	Engineering / Medical	Non-academic	No Info	Total
Physics	8	21	8	23	60
Chemistry	5	18	17	4	44
Biology	6	13	2	19	40
Astronomy	19	10	7	1	37

Project 3

Research and Development in Science, Technology and Mathematics Education (R&D in STME)

Principal Investigators

- Jayashree Ramadas
- Sugra Chunawala
- G. Nagarjuna
- K. K. Mishra
- Karen Haydock
- Aniket Sule
- Centre Director, HBCSE
- Chitra Natarajan
- K. Subramaniam
- Vijay Singh
- Jyotsna Vijapurkar
- Sanjay Chandrasekharan
- S. C. Agarkar
(superannuated in June, 2013)

XII Plan areas

- Learning and reasoning with representations (was Visuo-spatial Reasoning)
- Science, technology and design; socio-scientific issues
- Mathematics education: teacher professional development, resources for teaching
- Open educational resources, Citizen Science
- Middle school science curriculum; teacher support for inquiry science
- Print and electronic resources in Hindi

Budget (before cut of November 2014) Rs.675 lakh

STME - Research and Development

- Two new labs being set up - CUBE Studio and Learning Sciences
- Learning Sciences
 - Multiple representations in understanding DNA structure
 - How chemistry learners integrate different representations
 - How manipulation of physical models helps in learning mathematical concepts
- Collaboration with the interdisciplinary program in educational technology, IITB
- Rs.40 lakh grant under DST's cognitive science research initiative
- First paper from HBCSE (and India) accepted in Cognitive Science, the flagship journal of the Cognitive Science Society



Equation gaze sequence



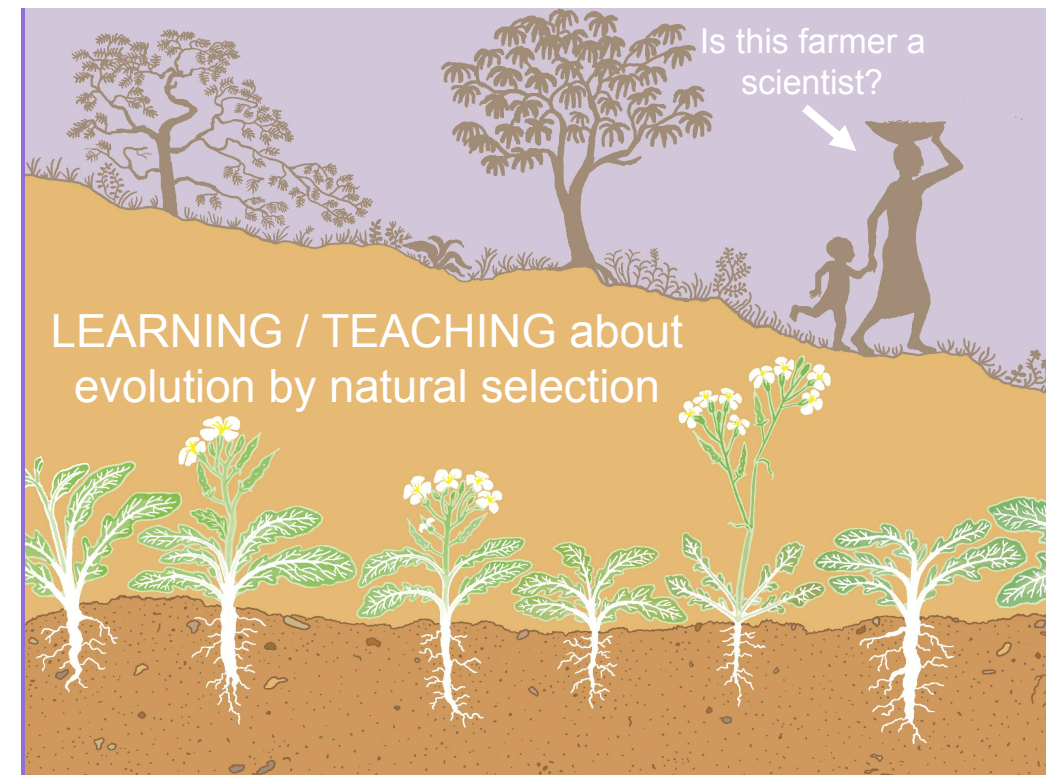
Study on the cognitive aspects of maths learning

Chandrasekharan, S., Nersessian, N.J. (In Press). Building Cognition: the Construction of Computational Representations for Scientific Discovery. Cognitive Science.

STME - Research and Development

Science and society

- Science education for diversity - dynamics between gender, culture, ethnicity and language
- Attitudes towards inclusive education
- Socioscientific issues - reproductive health in biology textbooks; reading of fallacious media claims
- Beliefs and understandings of farmers related to science, education and cultivation
- Problem-solving strategies of grassroots innovators from the perspective of engineering education
- Use of drawing and visual art in learning natural and social science.



STME - Research and Development

Mathematics Education

- Specialised content knowledge (SCK) for teaching 'integers'
- Interaction between SCK and teaching practice on 'decimals'
- Integrating out of school mathematics knowledge with classroom learning

Physics Education

- Concept inventory on rotational motion
- Misconceptions in thermodynamics

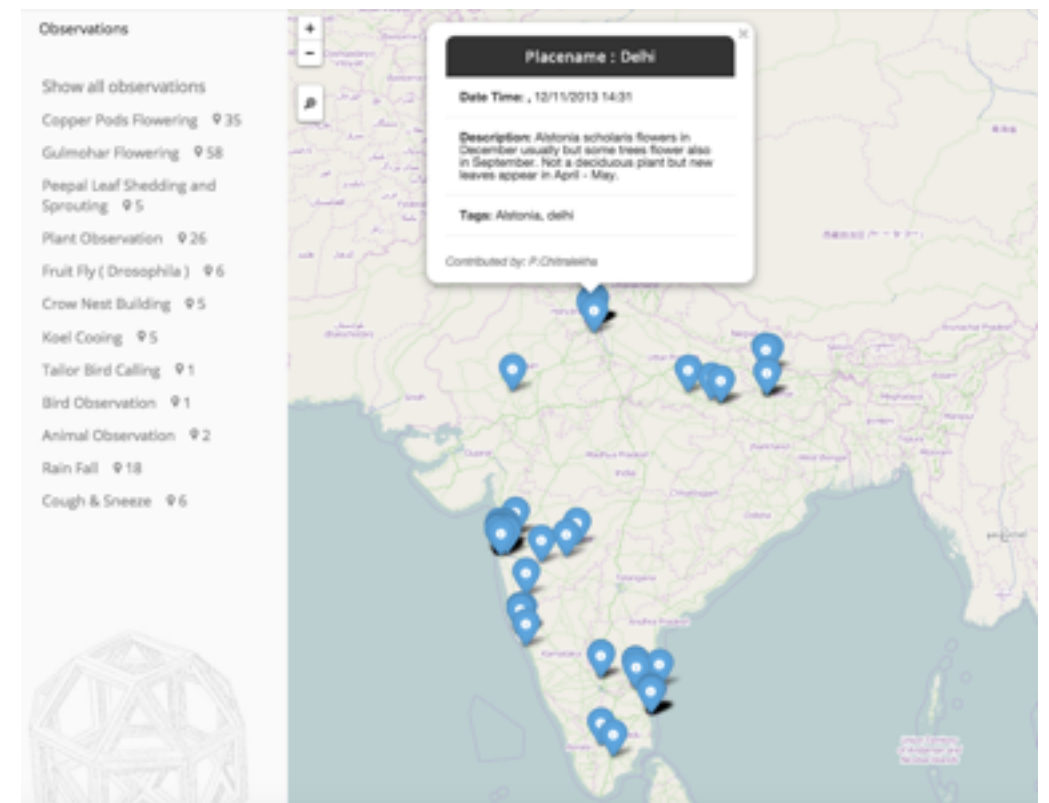
STME - Research and Development

- Collaborative Undergraduate Biology Education (CUBE, Summer 2012)
 - Undergraduate biology students work with simple model systems - Drosophila, Daphnia, Zebra fish, C. elegans, earthworm and snails
 - >10 presentation events organized at HBCSE and in participating colleges
 - Network of 17 colleges, 500 students, 25 college teachers; Hubs at AND college in Delhi, CHM and VES colleges in Mumbai

STME - Research and Development

Gnowsys-Studio - Open Knowledge, National Repository

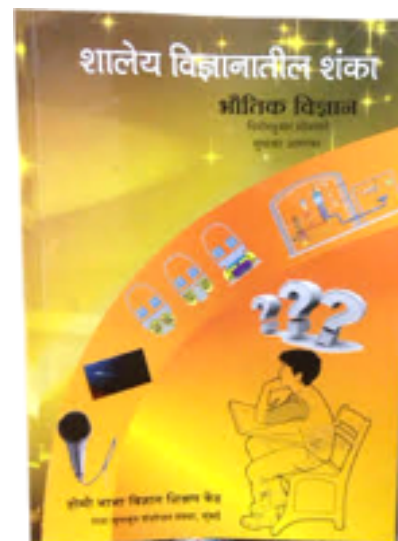
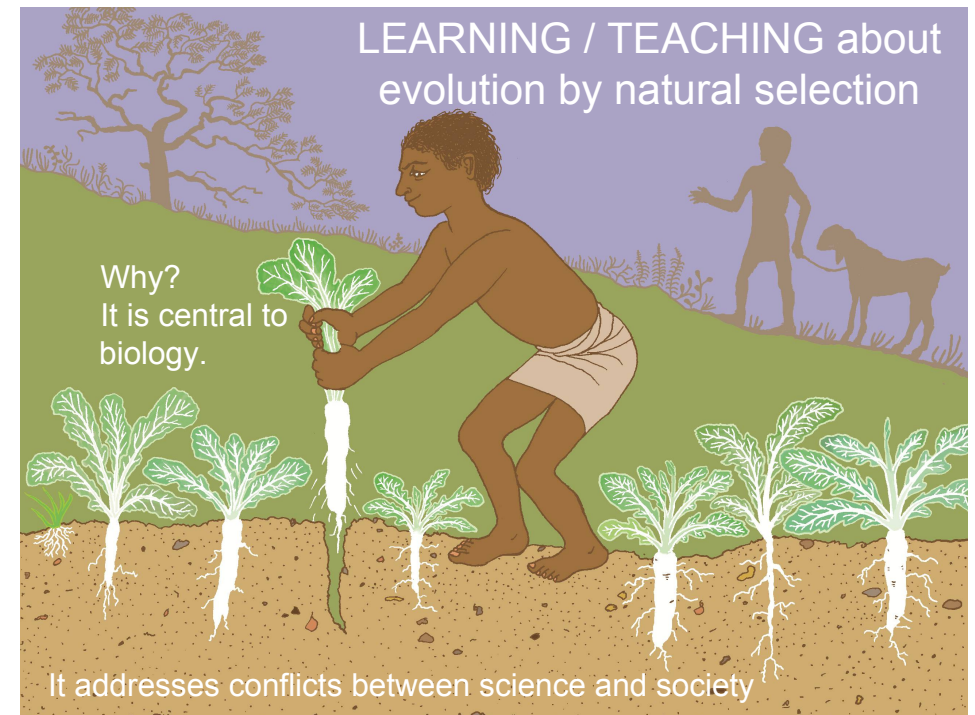
- Two collaborative platforms:
beta.metastudio.org and
cube.metastudio.org
- National Repository of Open Educational Resources (NROER) - <http://nroer.gov.in>
- Digital literacy course on MOOC platform for 7000 students from backward districts of Central India - <http://studio.tiss.edu/>
- Behaviour watch; Weather watch



<http://www.metastudio.org/cube/observation>

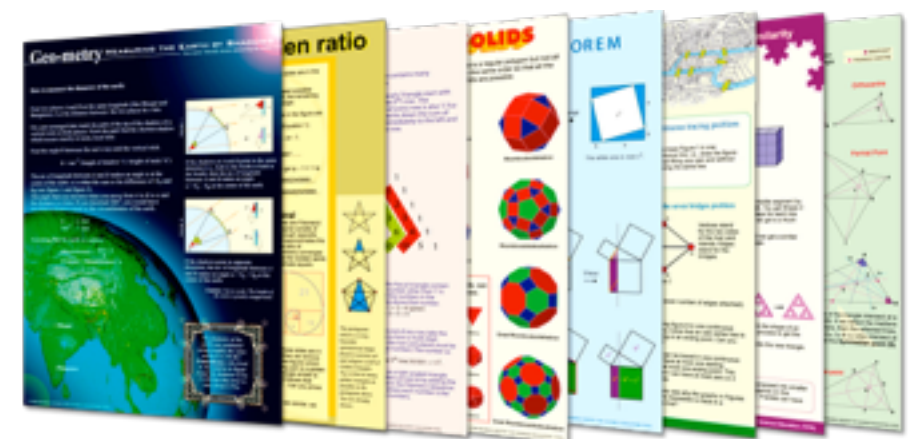
Creation of resources - Science Education

- Module on teaching/learning about evolution: teaching sequence, activities, and an illustrated book, "How Do They Evolve?"
- Activity-based periodic table
- Several books in Marathi on school science and mathematics
- Three books in Hindi
 - विज्ञान कैलेंडर,
 - ज्ञान विज्ञान शैक्षिक निबंध
 - खान पान और रसायन



Creation of resources - Mathematics Education

- NIME website with information and resources (status book on mathed in India, video films, research articles presented at ICME, conference proceedings)
- NIME exhibition materials for National Presentation on Mathematics Education in India at ICME-12
- New mathematics education @ hbcse website with resources for teachers (Mathlab activities, games, worksheets, classroom teaching videos)
- Mathematics posters



Publications XII Plan mid-term

- 68 articles in Journals
- 53 articles in Proceedings
- 19 Books - authored or edited
- 15 chapters in Books
- 17 Technical Reports
- 2 Ph.D Theses
- 18 Web publications / blog posts
- 31 Popular articles

Growth of HBCSE Library

	1993-94	2013-14
Collection	~ 6200	27045
Budget (Non-plan)	Rs.4,27,730	Rs.23,93,000
Users	~ 75	~ 700
Journals	60	131
Online Journals	-	900
Automation	No automation	Fully Automated Open Source Library

Library: Recent Achievements

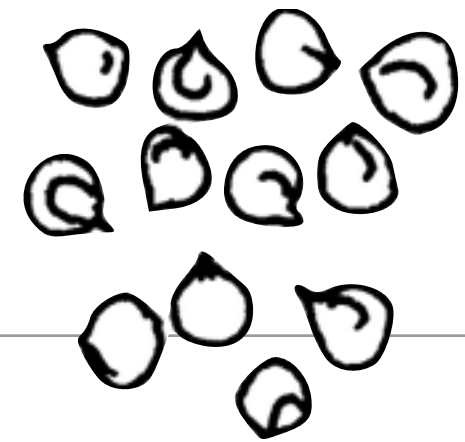
Software

- Successful migration to KOHA: Open Source Library Management Software
 - Fully web-based multi-featured Integrated Library Management System
 - OS independent: Can be used on Windows, Linux, Unix, Mac
- DSpace Open Source software for creating digital library
 - Support long-term preservation of digital material
 - Allows creation, indexing and searching of meta-data
 - Will host all HBCSE publications, theses, research papers etc.

Infrastructure (proposed additions)

- Create new reading area
- Storage for bound volumes

Some scattered seeds



- Numerous consultations: NCERT, SCERTs, MHRD, DST
Pratham, UNICEF, Navnirmiti, Gyanshala, Mukhtangan, Gram-mangal, Quest
- Tarang Scientific Instruments
"... the toys were not only conceptually sound, but also well engineered. We didn't check on costs, but it looks like a very positive development."
— *Communication from a friend, August 16, 2014*
- A 100 crore project on science popularisation - Agastya Foundation
"P K Iyengar, former chairman of the Atomic Energy Commission and one of the founders, got a bunch of experiments from the Homi Bhabha Centre for Science Education which he assured Raghavan would spark curiosity, if not creativity, and put them in a vehicle donated by a friend ..."
— *Business Standard, November 8, 2014*

Expenditure - Actual and Estimated

Revised after budget cut of November 2014

Budget Head	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	Total Rs. in lakh
NIUS	40.25	125.08	123.00	110.00	98.67	497.00
NSO	38.39	73.89	65.49	64.00	59.98	301.75
ST&ME	51.36	75.28	76.51	149.00	127.10	479.25
Total	130.00	274.25	265.00	323.00	285.75	1,278.00

Thanks

All HBCSE Members