

# Research and Development in Chemistry Education at HBCSE: An Overview

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# Introduction

The talk has two aims:

1. To give an overview of R & D activities in Chemistry Education at HBCSE
2. To give concluding remarks about the ICEC – 2014 conference

Emphasis will be on overall vision of Chemistry Education activities at HBCSE

# R &D activities in Chemistry Education at HBCSE

- Designing innovative problems in Chemistry theory and experiment: **promoting problem solving** skills (particularly at senior secondary level)
- Promoting **meaningful learning** in Chemistry through research-like activities<sup>1</sup>
- Investigating students' conceptions in Chemistry and developing suitable instructional material

<sup>1</sup> Goedhart, M.J., Finlayson, O.E., & Lindblom-Ylänne, S. (2009). Research-based teaching in higher level chemistry education. In: I. Eilks & B. Byers (Eds.), *Innovative methods of teaching and learning chemistry in higher education* (pp. 61-84). Cambridge : RSC.

## CERD/HBCSE/Continued

- Developing innovative experiments for undergraduate laboratory
- Cognitive research on representational competency in Chemistry (multiple representations in Chemistry)
- Work in Chemistry at school level
- Teacher training programmes in Chemistry
- Short project on learning resources for Chemistry

# Designing innovative problems in Chemistry

Both in theoretical and experimental areas (Chemistry Olympiad programme of HBCSE)

Focus here: designing of theoretical tasks

## Distinctive features of the theoretical tasks

Thematic and contextual

Often straddle across conventional areas and frontier areas of Chemistry

Interlink different areas of Chemistry. Within each area too the problem task spans different concepts

Involve use of higher level cognitive processing

Challenging in nature & stimulates interest in Chemistry among serious learners

Assessment is learner friendly

Thus, the problems are pedagogically significant

## Promoting creative learning in Chemistry

At undergraduate level

- Primary aim is learning (education) and thus processes are important. Thus, the meaning and scope of **research projects** is different
- Empowering students (particularly from regular set-ups) with respect to Experimental work (procedural understanding/handling of some advanced instruments)
- Improving motivation and self image of students
- Enhancing positive image of Chemistry
- 313 students participated in NIUS chemistry, Projects: 54 completed, 33 ongoing

# Students conceptions in Chemistry

Growing area in Chemistry Education Research (CER) worldwide

At HBCSE

Student conceptions related to Chemical equations and Periodic table (past work- school level, 1990s)

A. We have now initiated work in this area



1. Student workshops and study circle: interactions with undergraduate chemistry students, to teach and understand their conceptions through questionnaires etc.
2. Developing innovative instructional material based on insights from 1. A comprehensive instructional book on chemical thermodynamics has been developed
3. Development of concept inventories for large scale diagnosis of student conceptions Eg. on chemical potential.
4. All material will be constantly revised (in the light of 1 and 3
5. Large scale dissemination (through web)

## B) Development of activities to elicit student alternative conceptions

This has been done in the area of thermodynamics by a colleague in Physics department. Based on Predict-observe-Explain approach

The activities aim to diagnose alternative conceptions on pressure, thermal equilibrium, and first law of thermodynamics

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## Developing innovative experiments

The Chemistry Olympiad efforts:

Experience with respect to standardization, safety and

Designing

Channelizing the learning to the experimental component of the NIUS Chemistry programme

Experimental sessions and projects

Development of innovative experiments for undergraduate

Chemistry laboratory

Done by undergraduate students from regular colleges but at HBCSE laboratory

# Cognitive research on multiple representations in chemistry

Cognitive research is being conducted about representational competency in chemistry

Integrating different modes of representations of chemistry (graph, symbolic equations, molecular models, reaction mechanisms etc.) Eye trackers are being used

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## Work in Chemistry at school level

Developing experiments for chemistry concepts covered in school chemistry

Demonstrations type

Developed both for teachers and students

Use of easily available material. Therefore, low cost and can be replicated in schools

Sessions of chemistry experiments is an integral part of various teacher training programmes at school level

Involvement with textbook writing (chemistry) at state level

## Teacher Training programmes

Chemistry Olympiad

Exposure camps: teachers teaching at class XI and XII

Resource generation camps : teachers teaching at

Undergraduate and post-graduate level

Emphasis on designing and solving problems in theoretical and experimental areas, doing laboratory experiments, and assessment (200+ teachers)

Under NIUS chemistry,

We are planning programmes for teachers emphasizing content and pedagogy and workshops for Chemistry Education Research

HBCSE has been conducting teacher training programmes for different school systems on continual basis, chemistry teaching is an integral part of the same

This year, Royal Society of Chemistry (RSC)

Yusuf Hamied Inspirational Chemistry Programme in India

HBCSE is an collaborative partner

Focus

Active learning practices, content enrichment and experiments, sensitizing teachers about misconceptions

In all R&D activities at HBCSE summarized above, we have endeavored to partner with teachers from local colleges as well as from teachers across the country.

This partnering has been facilitated by the Association of Chemistry Teachers (ACT).

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# Summary Remarks on ICEC -2014

# Summary Remarks on ICEC 2014

## ICEC-2014

4 international speakers

3 speakers from India

6 workshops (pedagogic aspects of Chemistry)

10 oral presentations and 11 poster presentations

A fairly representative teacher population from different parts of the country

## Interlinked in various talks and workshops

- the paradigm of Inquiry based learning and how to implement it in chemistry education was included in (POGIL) and Peer-Led Team Learning model (PLTL)
- discussion on course re-design, problem based learning and assessment in undergraduate chemistry teaching
- Journal of Chemical Education and its role in disseminating innovation in Chemistry Education
- the enormous potential of ICT and how to harness it for pedagogical use in Chemistry teaching-learning practices

## CERD/Summary Remarks/Cont.

- an introduction to Massive Open Online courses and their role in higher education
- problems and challenges in undergraduate Chemistry education in India, Integration of research in Chemistry education (Chemistry as undone domain vs done domain)
- history of science and its implications on Science education, talk with broader canvas beyond Chemistry education

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## Chemistry Education and India

Considerable R&D activity in Chemistry education is under way at many places in India

Low cost Equipment project (IUPAC/ UNESCO)  
(K.V.Sane, University of Delhi, 1980s)

Green Chemistry drive by Department of Science and Technology (DST)

Green chemistry Network centre (<http://greenchem.du.ac.in/>)  
Prepare and disseminate the educational materials on Green Chemistry for school, college and university levels

## Chemistry Education and India

Teaching Learning Centre (2011, IIT Madras)

(<http://tlc.iitm.ac.in/welcome.html>)

Assisting faculty to become conversant with research-based, practically proven, widely adopted/adapted teaching Learning methodologies which they can adopt in their class rooms

National Council for Education Research and Training

(<http://www.ncert.nic.in/index.html>)

National Mission on Education through ICT

(<http://www.sakshat.ac.in/asp/frmrelatedlink.aspx>)

Virtual Laboratory in chemical sciences (<http://vlab.co.in/>)

National Portal on Technologically Enhanced learning (NPTEL)

(<http://nptel.ac.in/>)

# ACT and Chemistry Education

Finally, we should like to bring out the catalyzing role of ACT in improving Chemistry Education in India.

- The Annual conventions of ACT aim to bring teachers from different colleges across the country for joint efforts in improving Chemistry education.
- ACT is supporting numerous Chemistry education activities in different zones of the country.
- In near future, keen on sensitizing teachers towards the domain of CER.

Most of the work in Chemistry education in India is developmental in nature. The discipline of Chemistry Education Research (CER) aims to put these efforts on a rigorous basis backed by research based evidence.

There is a need to strengthen CER in India. ICEC-2014 is a step in that direction.



Thank You