

RESEARCH IN CHEMISTRY EDUCATION AND ITS IMPLICATIONS FOR TEACHING AND LEARNING OF CHEMISTRY AT TERTIARY LEVEL

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Chemistry Education Research (CER) from its inception has addressed issues related to teaching and learning of chemistry at various levels. There are two distinct but related aspects of CER; one is to empirically analyze students' difficulties and misconceptions in chemistry, the other is to develop methods for effective learning of chemistry.

Though a relatively young field, the goals, norms and methodologies of CER are now fairly standardized; the field draws on the more established disciplines of chemistry, psychology, sociology, philosophy and education. CER studies, conducted over the last five decades, have provided valuable insights to teachers, curriculum planners and policy makers engaged with chemistry education.

A comprehensive review, published by Teo et al. (2014), analyzed 650 empirical papers (2004 - 2013) in CER. The review found the following three major trends in CER - a) students' and teachers' conceptions and conceptual change, b) examination of different pedagogies used for teaching of chemistry, and c) classroom contexts and learner characteristics (e.g. attitudes and beliefs of participants, factors affecting students' performance in chemistry, classroom interactions, etc.). The reviewers further observed that majority of these studies were conducted in the context of chemistry education at tertiary level. Geographically, these studies span across several countries in different regions (North/Central America, Europe, Asia, Oceania, Africa and South America). The review highlighted the lacunae in studies exploring historical/philosophical aspects of chemistry and nature of chemistry.

An earlier review by Towns and Kraft (2011), analyzed 379 empirical CER papers (2000-2010) particularly related to undergraduate chemistry education. This review included two additional areas, namely, CER studies in the context of chemistry laboratories and development of reliable and valid instruments for measurements in chemistry education (used for-conceptual understanding, beliefs about chemistry and learning chemistry, attitudes towards chemistry, etc.). These authors have separately focused on studies related to understanding particulate nature of matter (PNOM) and included work that use static visuals, handheld ball and stick models and 2D perspective drawings for understanding PNOM.

On the whole, there are fewer studies on the strategies to be used to address misconceptions and effective pedagogies to assist conceptual change. Thus, this aspect of CER needs urgent attention. Also, in general, transfer of knowledge across contexts has not been addressed adequately in CER studies.

Eilks and Byers (2010) have suggested that chemistry teachers at tertiary level should know about CER studies and research based practices. They have argued that people opting for teaching profession in chemistry up to secondary level, are required to have qualifications both in chemistry and pedagogy. This requirement recognizes the fact that chemistry teachers

need to know about pedagogy (in its general form) along with content expertise. Ironically, the same is not considered essential for chemistry teachers at tertiary level, and hence at this level, teachers are often content experts with no exposure to general and/or domain specific pedagogy. This is also very much valid in the Indian context.

The most dominant mode of teaching chemistry in India, and perhaps elsewhere, till date, is lecturing. Chemistry teachers who themselves have been exposed only to this mode (perceived to be successful) will continue to practice the same when they opt for the teaching profession. Often, classroom experiences and assessment provide sufficient evidence indicating that students understand and learn chemical concepts differently from what is being taught. All these facts, undoubtedly, indicate the pressing need to pay attention to CER studies and the insights that can be drawn from them.

A working group formed by European Chemistry Thematic Network (ECTN) has identified different areas for innovation in teaching and learning of chemistry in higher education (Eilks & Byers, 2010). Some of these areas are: a) addressing uniqueness of chemistry (nature of chemistry), b) context and problem-based learning, c) research-based teaching and learning, d) innovating practical work, e) use of cooperative learning, f) role of ICT in chemistry learning and assessment, g) using innovative assessment to promote meaningful learning and h) training programmes for newly appointed university chemistry teachers.

In the Indian context too, the above areas are relevant. Today, the chemistry education scenario, in India, is dynamic as several new institutions devoted to science education and research at tertiary level have become functional in the recent past. These institutions have experimented with the chemistry curricula and the process is still being continued. A sizable number of young personnel are entering into teaching chemistry at higher education. In addition, under National Mission on Education through ICT (MHRD initiative in India), development of virtual laboratory and e-content in chemistry has been undertaken. Homi Bhabha Centre for Science Education (TIFR) and Association of Chemistry Teachers (ACT) have started an International Conference on Education in Chemistry (ICEC- 2010 and 2014). This initiative will help to catalyse, support and consolidate sporadic CER work in India. Thus, the time is apt to reflect on CER studies and their implications in Indian academics.

References

- Eilks, I. & Byers, B. (2010). The need for innovative methods of teaching and learning chemistry in higher education - reflections from a project of the European Chemistry Thematic Network. *Chemical Education Research and Practice*, 11, 233-240.
- MHRD, <http://www.sakshat.ac.in/asp/frmrelatedlink.aspx> (accessed in October 2015).
- Teo, T. W., Goh, M. T., & Yeo, L. W. (2014). Chemistry education research trends: 2004-2013. *Chemical Education Research and Practice*, 15, 470-487.
- Towns, M. H., & Kraft, A. (2011). Review and synthesis of research in Chemical Education from 2000-2010. A white paper for the National Academies National Research Council Board of Science Education, Committee on Status, Contributions, and Future Directions of Discipline Based Education Research.