

Readings in Chemistry Education Research

Credits: 4 credits

Duration: 16 weeks, one contact session of 3 hours every week + 1 laboratory discussion session (3hours) every alternate week

Schedule: Starting from August 12,2016, every Friday Time: 2.30 pm to 5.30 pm

Course Instructors: Savita Ladage and Arvind Kumar (Theory)

Chemistry Education Research (CER) from its inception has addressed issues related to teaching and learning of chemistry at various levels. The goals, norms and methodologies of CER are now fairly standardized and the field draws on from 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 and curriculum planners. The main objective of this course is to acquaint participants with major areas of CER with special emphasis on work done in the context of undergraduate chemistry laboratory. The readings will include review papers related to a) History and philosophy of chemistry and chemistry education, b) Misconceptions/conceptual pitfalls in chemistry, and c) Inquiry based learning and assessment in chemistry laboratory.

Assessment

Written summaries (40%), presentations(30%), designing of experiments (30%)

List of Readings

History and philosophy of chemistry and chemistry education

Reference Book: International Handbook of Research in History, Philosophy and Science Teaching, Michael R. Matthews (Editor), ISBN 978-94-007-7654-8 (eBook), Springer Dordrecht Heidelberg, 2014.

1. Philosophy of Chemistry in Chemical Education: Recent Trends and Future Directions, Sibel Erduran and Ebru Z. Mugaloglu
2. The Place of the History of Chemistry in the Teaching and Learning of Chemistry, Kevin C.de Berg
3. Historical Teaching of Atomic and Molecular Structure, José Antonio Chamizo and Andoni Garritz

Misconceptions/conceptual pitfalls in chemistry

Reference Book: Chemistry Education: Best Practices, Opportunities and Trends, Javier Garcia-Martinez and Elena Serrano-Torregrosa (Editors), ISBN 978-3-527-33605-0 (Print), Wiley VCH Germany, 2015.

- 1.The Role of Conceptual Integration in Understanding and Learning Chemistry, Keith S. Taber
- 2.Learners Ideas, Misconceptions, and Challenge, Hans-Dieter Barke

Inquiry based learning and assessment in chemistry laboratory

1. A.H. Johnstone and A. Al-Shuailib.(2001). “Learning in the laboratory; some thoughts from the literature”. *University Chemistry Education.*, 5, 42-51.
2. Abraham, M.R.(2011). “What Can Be Learned from Laboratory Activities? Revisiting 32 Years of Research”. *Journal of Chemical Education.*, 88(8), 1020-1025.
3. Reid, Norman, and Iqbal Shah.(2007). “The Role of Laboratory Work in University Chemistry.” *Chemistry Education Research and Practice*, 8(2), 172–85.

Reference Book: Innovative Methods of Teaching and Learning Chemistry in Higher Education, Ingo Eilks and Bill Byers (Editor), ISBN 978-1-84755-958-6 (Print), Royal Society of Chemistry, Cambridge, UK, 2009.

4. Context and Problem-based Learning in Higher Level Chemistry Education, Tina L. Overton, Bill Byers and Michael K. Seery
5. Practical Work in Higher Level Chemistry Education, Stuart W. Bennett, Michael K. Seery and Doris Sovegjar-to-Wigbers
6. Assessment in Higher Level Chemistry Education, Stuart W. Bennett and Iain Wilson

Reference Book: Chemistry Education: Best Practices, Opportunities and Trends, Javier Garcia-Martinez and Elena Serrano-Torregrosa (Editors), ISBN 978-3-527-33605-0 (Print), Wiley VCH Germany, 2015.

7. Experimental Experiences through Project-based Learning, Jens Josephsen and Soren Hvidt

Reference Book: Chemical Education: Towards Research-based Practice, John K. Gilbert, Onno De Jong, Rosaria Justi, David F. Treagust and Jan H. Van Driel (Editor), ISBN 1-4020-1028-1 (Print), Kluwer Academic Publishers, The Netherlands, 2002.

8. Learning Chemistry in a Laboratory Environment, Mary B. Nakhleh, John Polles and Eric Malina

Reference Book: Chemists' Guide to Effective Teaching, Norbert J. Pienta, Melanie M. Cooper and Thomas J. Greenbowe (Editor), ISBN 0-13-149392-2 (Print), Pearson Education, USA, 2005.

9. Inquiry and the Learning Cycle Approach, Michael R. Abraham

Miscellaneous

Reference book: Nuts and bolts of CER, Diane M. Bunce and Renee Cole(Eds.), ACS symposium series 976 ACS,2008

1. Importance of a Theoretical framework for Research, Michael R. Abraham
2. Constructing Good and Researchable questions, Diane M. Bunce

Laboratory Discussion Sessions

Papers related to research in the context of undergraduate chemistry laboratory will be discussed and/or presented by participating students. These papers are primarily from Journal of Chemical Education (JCE, ACS journal) and Chemistry Education Research and Practice (CERP- RSC journal). Tentative list of these papers is as follows-

1. Burke, K. A., Thomas J. Greenbowe, and Brian M. Hand (2006). "Implementing the Science Writing Heuristic in the Chemistry Laboratory." *Journal of Chemical Education*, 83 (7): 1032-1038.
2. Claire Mc Donnell, Christine O'Connor and Michael K Seery. "Developing practical chemistry skills by means of student-driven problem based learning mini-projects". In *Chemistry Education Research and Practice*, 8 (2), 130-139, 2007.
3. Domin, Daniel S. (1999). "A Review of Laboratory Instruction Styles." *Journal of Chemical Education* 76 (4), 543-547.
4. Domin, D. S. (1999). "A content analysis of general chemistry laboratory manuals for evidence of higher-order cognitive tasks". *Journal of Chemical Education*, 82, 1178-1180.
5. Donnell, C. Mc., O'Connor, C., & Seery, M. K. (2007). "Developing practical chemistry skills by means of student – driven problem based learning mini-projects". *Chemistry Education Research and Practice*, 8 (2), 130 – 139, RSC.
6. Fay, Michael E., Nathaniel P. Grove, Marcy Hamby Towns, and Stacey Lowery Bretz (2007). "A Rubric to Characterize Inquiry in the Undergraduate Chemistry Laboratory." *Chemistry Education Research and Practice* 8(2), 212–19.
7. Hofstein, A. (2004). "The Laboratory in Chemistry Education: Thirty Years of Experience with Developments, Implementation, and Research". *Chemistry Education Research and Practice*, 5(3), 247-264.
8. Hofstein, Avi, and Rachel Mamlok-Naaman (2007). "The Laboratory in Science Education: The State of the Art." *Chemistry Education Research and Practice*, 8(2), 105–7.
9. McGarvey D. J., (2004). "Experimenting with undergraduate practicals". *U.Chem.Ed.*, 8, 58-65.
10. Orla C. Kelly and Odilla E. Finlayson (2007). "Providing solutions through problem-based learning for the undergraduate 1st year chemistry laboratory". *Chemistry Education Research and Practice*, 8 (3), 347-361.