Chemical education research (CER) (Note †)

Every field of knowledge has practice and research into the advancement of the discipline. Chemical education is the same. Chemical education research (CER) aims to evaluate improvements and innovation in practice and also investigate how students learn chemistry. The following examples illustrate the scope of CER, with analogies to better well-known examples of research in chemistry.

Chemistry students spend a significant amount of their time in laboratory. It is an accepted principle that one good way of learning is through learning by doing. Hence one recurring theme in chemical education is the improvement of existing laboratory exercises, and the development of new laboratory exercises. These are innovations in teaching-and-learning practice. What makes these innovations into research, is the testing of the activities to ensure their scientific validity and robustness, and finally evaluation and feedback to assess the effectiveness of the experiment by students and teaching staff. This is similar to method development research in analytical chemistry, where proposed methods must be evaluated for robustness and reliability. Some recent examples include the national ASELL (Advancing science by enhancing learning in the laboratory) Project.[2] Many papers from ASELL and its predecessor projects have been published in the RACI's *Australian Journal of Education in Chemistry* (AusJEC).[3-6]

Discussions about the school curriculum is topical: for example, Australia is in the middle of implementing a National Curriculum, while New Zealand is continually updating its senior school curriculum by introducing new topics, removing some topics and amending others. One active area of research is the analysis of curriculum in terms of logical versus psychological progressions of topics order,[7] and trials on better sequences of topics for better outcomes. It is interesting to note that the importance of getting better sequences have direct chemical analogies: for example, the reaction of ethanamine with phosgene, followed by reaction with 1-naphthol produces pesticide via a dangerous methyl isocyanate intermediate, as shown by the Bhopal disaster, while the same reactants, reacted in a different sequence, has better outcomes as it leads to the same product, but without the methyl isocyanate intermediate.

Advances in technology have lead to advances in chemistry, with microwave-assisted synthesis, microfluidic devices, and better spectrometers to name just a few. So too, advances in technology have changed the practice of chemical education. Some CER has examined new uses for mobile phones,[8] using podcasts to enhance lectures,[9] as flashcards,[10] or to access chemistry resources[11] and student-created videos and photo blogs.[12] Another new technology is the development of small hand-held wireless devices that enable participants (students) to give anonymous or pseudo-anonymous responses or feedback. A wireless receiver feeds the responses to a computer that collates the responses in real time and displays them for the presenter (lecturer) and participants. Other CER has looked at the use of these classroom response systems or "clickers".[13,14]

A recurring theme in any new development, whether in industry or education, is how can we validate it? How do we truly know that this new process/method/approach is effective? Evaluations of teaching-and-learning effectiveness can be doe through observations (c.f. wildlife research), interviews (c.f. social and health science research), measures of learning outcomes like marks and grade distributions, and through survey instruments. Other area of CER is in the development and validation of these survey instruments.[15]

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Research is about collecting data to support or refute a hypothesis. Chemical education research is no different. Chemical education seeks to improve the learning of chemical science. Chemical education research collects data to evaluate whether a particular course of action is good or bad for learning.

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