Teaching & Training

Hendrik Emons

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Despite the introduction of highly automated measurement instrumentation, sophisticated computer software for the steering of experiments and data evaluation, standard operating procedures and various guidance documents—the most crucial ‘component’ in an analytical laboratory is its staff. To be effective, they must have an adequate education in relevant areas and undergo lifelong training. Besides getting to know specific measurement methods, generic principles of the ‘science of measurement’ including the basics of statistical data evaluation, method validation, estimation and use of measurement uncertainties as well as laboratory internal and external quality control measures should be in the curricula.

Teaching the ‘art of measurements’ is demanding. It requires the in-depth understanding of a broad range of measuring principles, of complex measurement instrumentation and procedures, of measurement tasks in different application areas and consequently a considerable level of multidisciplinary knowledge. During the preparation and execution of teaching or training courses, one will detect both personal knowledge gaps and deficits in the available scientific understanding of a specific measurement task and/or solution. Indeed ‘teaching is learning twice’. Nowadays, it is more important than ever that

scientific approaches and systematic classifications are taught, which provide orientation in the multi-faceted world of available facts and findings. The abundance of information provided by, for example, the Internet demands the ability to efficiently extracting the reliable part of information and to evaluate its usefulness for a specific purpose. Scientific journals publishing peer-reviewed papers are an important instrument in this filtering process. The editors of *Accreditation and Quality Assurance (ACQUAL)* are aware of the needs of teachers and trainers who are disseminating knowledge how to assess the quality and reliability of measurement results in chemical and biological sciences. Actually, a significant number of papers in this journal contain tutorial aspects even if this may not be explicitly stated in the abstract.

Many of us, who are teaching at universities or designing and performing training courses and workshops, are regularly confronted with questions such as: what generic knowledge on metrology and quality assurance should be transferred? How do we demonstrate to a specific group of students/trainees/participants, by use of convincing examples, that the demonstrated accuracy of measurement results is a crucial issue for their activities? How do we help them navigate through the highly dispersed information of varying quality and trustworthiness?

This journal is not the prime platform for discussing what should be taught at various university levels and for different scientific disciplines. But articles in *ACQUAL*:

- provide examples for real-life measurement challenges,
- explain metrological concepts and approaches,
- outline the rationale and development of international quality systems,
- make available (as a ‘side effect’) contact information about the active players in the field.

H. Emons (✉)
Geel, Belgium
e-mail: JRC-IRMM-ACQUAL@ec.europa.eu

There are many interesting conceptual, education and communication issues arising in the cycle:

- identifying the measurement question-of-interest
- gathering and exchange information
- knowledge building (by measurements, etc.)
- knowledge transfer (teaching and training)
- knowledge application in solving the original question
- identifying the new (follow-up) measurement questions-of-interest.

A scientific journal devoted to the quality of measurement results (see *ACQUAL*'s aims and scope) can and should be a source of information and inspiration for related concepts and best practice guidance. It serves also as a platform for consensus building. The latter takes place during the preparation of educational materials, during the teaching, in the reflection process of participants and via the feedback between trainers and trainees.

In practice, *ACQUAL* itself is to a large extent also a kind of teaching or training material. Such materials are very much requested, as I learned just recently again at the international conference on reference materials, BERM-13, in Vienna (Austria). Many conference contributions pointed to the relevance of reliable measurement results for decision-making under the influence of the further globalisation of trade and human mobility. The BERM-13 organiser, the International Atomic Energy Agency (IAEA), was successful in bringing new participants to the conference series coming from countries or regions with less experience but with significant needs in accreditation, quality assurance and related topics for a broad variety of application sectors. Corresponding training requests were explicitly expressed by participants.

Regularly updated training materials are especially needed for post-graduate training and lifelong learning. For instance, the increasing number of documentary standards on specific measurement methods (and the ones including measurement aspects) requires harmonised guidance documents on quality assurance. They are available on a generic level, for example, ISO/IEC 17025, guides from Eurachem/CITAC. However, further explanatory documents are often necessary for illustrating the application of quality assurance measures to specific user communities in a tailored technical language. Dedicated journals like *ACQUAL* are an instrument to disseminate information about the availability of such guidance and explanatory documents, to publish papers outlining best practice as well as identifying gaps and shortcomings in existing international documents on the quality of measurement results. The teaching role of *ACQUAL* is also reflected in the joint efforts of authors, reviewers and editors to gradually diminish barriers between various scientific communities arising from the use of different technical language. It is always interesting to note how common some measurement challenges are across different application sectors and how much one could learn from innovative solutions developed in another area. But this learning process requires a common understanding of the meaning of the various terms used.

Therefore, colleagues involved in teaching and training are invited to submit manuscripts on new approaches for education related to metrology and the quality of measurement results in chemical and biological sciences.

Hendrik Emons
Editor-in-Chief