The role of eLearning in supporting analytical laboratories

Elizabeth Carazo, Director
Centro de Investigación en Contaminación Ambiental (CICA)
Universidad de Costa Rica (UCR)
Ciudad Universitaria Rodrigo Facio
2060 San José
Costa Rica
E-mail: ecarazo@cariari.ucr.ac.cr

Ian G. Ferris, Technical Officer
Food & Environmental Protection Section,
Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture,
PO Box 100, Wagramer Strasse 5, A-1400, Vienna, Austria
E-mail: I.G.Ferris@iaea.org

Kerstin Gross-Helmert, Nutrition Analyst
Nutritional and Health Related Environmental Studies Section, Division of Human Health, IAEA,
Wagramer Strasse 5, A-1400 Vienna, Austria
E-mail: K.Gross@iaea.org

Britt M. Maestroni, Training Officer
FAO/IAEA Agriculture & Biotechnology Laboratory, Agrochemicals Unit
IAEA Seibersdorf Laboratories, A-2444 Seibersdorf, Austria
E-mail: B.M.Maestroni@iaea.org

The Centro de Investigación en Contaminación Ambiental, Universidad de Costa Rica (CICA-UCR), is among other tasks responsible for the analysis of pesticide residues and a range of environmental contaminants and is accredited under ISO 17025-2005. ISO 17025 stipulates that new staff must be trained before undertaking laboratory work. The IAEA Collaborating Centre for eLearning and Accelerated Capacity Building for Food and Environmental Protection provides basic training courses over the Internet (http://elearning.iaea.org). Students can take the courses at any time but they should complete the online examinations successfully before undertaking laboratory work or research projects. The focus is on training-the-trainer, whereby alumni should train at least two other scientists, thus accelerating capacity building. In addition, trainees are encouraged to add training materials either by developing new course content or translating existing course content. An open source-learning management system (ATutor) that supports the Shareable Content Object Reference Model (SCORM) and the sharing of course content is employed. CICA, in cooperation with the Advanced Radiation Technology Institute Radiation Application Research Division of the Korea Atomic Energy Research Institute and the Food Science and Technology Programme, Department of Chemistry of the National University of Singapore, share a long-term vision of an external M.Sc. that would be offered through the collaborating institutions and respective universities. The aim is to build regional laboratory capacity to tackle pressing food and environmental problems.

Introduction

The Centro de Investigación en Contaminación Ambiental Universidad de Costa Rica (CICA) is a unit of the Universidad de Costa Rica (UCR) and was created in 1982. In 1995 CICA, supported by IAEA, began to implement a Quality Assurance System according to Good Laboratory Practice (GLP) principles. In 2000 CICA was accredited under the Guide ISO/IEC 25 for 49 analyses for water quality and pesticide residue analysis. In 2003 the transition commenced from ISO/IEC 25 to ISO/IEC 2000 17025 and accreditation was obtained for 96 assays in water quality and pesticides residue analysis. Now CICA completed the transition to the 2005 version and is in the process of renewing accreditation for the next four years.

Accreditation gives formal recognition of the competence of the laboratory to perform specific tests. In Costa Rica, Ente Costarricense de Acreditacion (ECA) is the accreditation body created by law in 2002 according to the National System for the Quality Law (Law No 8279). This law requires laboratories performing analyses for the Government, i.e., pesticide residue analyses, to have its tests accredited.

This article is about how the FAO/IAEA eLearning system[1] is helping to maintain accreditation and address training needs in an environment of rapid change.

2. Pre-requisites

Figure 1 Laboratory Pre-requisites 1--navigation links

Since 2000, CICA has trained more than 20 IAEA fellows and more than 30 Costa Rican staff from a wide range of backgrounds and experience. A training-the-trainer approach is used so each staff is assigned at least one mentor. Typically, he or she introduces the eLearning system. While most learners find the browser-based interface intuitive, a tutorial is available for reference[2]. The starting point for analysts is Laboratory Pre-requisites 1[3]. The course familiarizes new staff with: safety precautions and emergency measures; know how to handle labelled compounds and radiotracers safely; ability to prepare chemical solutions, calculate concentrations of solutions, and know how to make correct dilutions; safe use of laboratory equipment; the principles of safe waste management; good cleaning procedures. New staff can take each module in a linear fashion. For registered users the system opens up where the trainee last left off. Alternatively, more experienced analysts may only need to scan a topic. The course map or right hand navigation links help learners quickly access information (Figure 1). Thus, trainees are able to tailor the learning process to their specific needs and background knowledge.
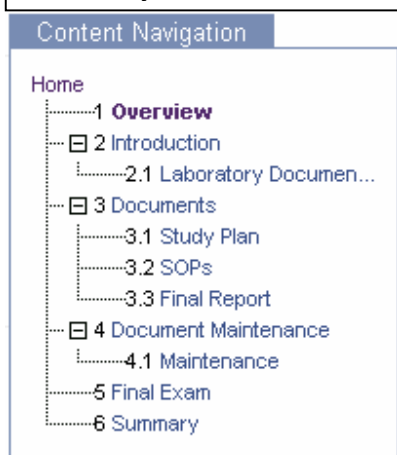
For example, a course on "Handling Pipettes and Syringes"[4] may sound trivial and unnecessary. Yet experience has shown that many problems do occur with regard to the reliability of results and safety issues. Handling pipettes and syringes correctly is essential for good analytical performance and reliable results. To ensure repeatability and accuracy of measurements, new staff must have good handling techniques. Proper maintenance and correct calibration of pipettes and syringes are also essential especially given new requirements under ISO 17025-2005.

2. Document control

Documentation of work is a key activity in a laboratory and is required by internationally accepted quality assurance standards such as Good Laboratory Practice (GLP) and ISO 17025. The importance of documentation of work is demonstrated by the simple and strict statement:

"If you did not write it down, you did not do it."

Figure 2 Documentation of Laboratory Work

The Documentation of Laboratory Work course[5] gives an insight into the importance and scope of adequately documenting laboratory work. This course is not exhaustive (Figure 2). Rather the course references the quality assurance standard of the laboratory. In this regard, it is essential that the documentation is tailored according to laboratory needs and actual practices. CICA conducts in-depth training as and when required. This approach combines the eLearning material and on-the-job training to ensure that staff have the appropriate skills for the task at hand. This helps address the information overload suffered by new staff while meeting the requirements of the laboratory's quality system. Documentation of Laboratory Work has another feature that CICA uses, namely examinations. The results help new staff and mentors identify weak areas and target what additional training is needed. They also document staff training for auditing purposes.

3. Instrumentation

CICA has a high performance liquid chromatograph, gas chromatographs/mass spectrometers and minor laboratory equipment. ISO 17025 requires that the instrumentation is under statistical control. Pesticide residue analyses at parts per million, and increasingly at parts per billion, is a challenging task. New analysts are encouraged to complete the Pesticide Residue Analysis course[6]. It takes analysts through the steps in pesticide residue analysis including: sample preparation; extraction and clean-up, quantitative determination of the analyte; estimation of uncertainty of results; confirmation of the analyte's identity; and quality control procedures for pesticide residue analysis. Again this is a starting point for more detailed CICA training materials in Spanish that eventually leads to the certification of new staff for those instruments under statistical control. At the moment, the main value of the eLearning is to ensure that analysts have the pre-requisite skills and competencies to improve their career prospects and value to CICA.

4. Maintaining accreditation

Staff commitment is the key to maintaining laboratory accreditation. This requires a very deep knowledge of those parts of the quality system they are responsible for as well as an overall knowledge of CICA activities. CICA activities include monitoring the implementation of good agricultural practices (GAP)[7]. Staff are also encouraged to take the Pesticide Management course[8]. This course addresses the challenge of pest management through the control of pests in a way that ensures biological diversity, preserves the environment and fosters human and animal health. More targeted training may be required such as the course on Ecological Risk Assessments of Pesticides[9] that provides those dealing with pesticide registration instructions about the risk assessment process and how it is used to evaluate the potential impacts of pesticides in agricultural environments. The approach is to build on existing local knowledge/experience about a familiar "reference" pesticide and compare a new candidate pesticide with the "reference" using

relative risk, i.e., high quotients indicate higher risk. Quality managers/auditors may take the Conformity Assessment course[10], which aids laboratories in preparing themselves to comply with the relevant quality standards.

Outcome-based performance programming is now the rule for donor organizations. IAEA's Department of Technical Cooperation has contributed with a course on Project management[11]. The course gives an overview of what constitutes project management. It introduces a commonly used project management technique: the logical framework. Finally, it provides case studies to be used as examples when planning IAEA Technical Cooperation Projects. Soft skills such as Time Management are increasingly recognized as the key to addressing the exponential increase in knowledge and the human "bottle neck" in applying that knowledge. The Time Management course[12] guides staff in selecting the best techniques for them and their working conditions.

5. Converging technologies

Figure 3 Hand-held web browser. Source: Wikipedia

One of the strengths of the FAO/IAEA eLearning system is the web-browser interface. This is the same interface used by the Bika LIMS[13] under consideration by CICA as a replacement for the paper-based quality management system and as a tool for managing clients and consumables. The problem was how to merge these two disparate developments seamlessly in the context of the laboratory quality management system.

Radio Frequency Identification (RFID) provides an automatic identification method by storing and remotely retrieving data using RFID tags or transponders. This is a useful solution for linking physical records, such as chromatograms, with the electronic analytical worksheet[14]. Hand-held devices have long been touted to make eLearning more easily accessible for a wider range of individuals and provides opportunities for lifelong learning[15]. What is realizing the full potential of both technologies is the release of a 135 g commercial device[16] in the USA in June 2007. The half-size video graphics array screen has 480x320 pixels (63 pixels/cm) and is covered with optical-quality glass for use with a finger, or multiple fingers for multi-touch sensing and virtual keyboard. Access to the World Wide Web is possible via a built in wireless network (Wi-Fi) and modified version of the Safari web browser. Wireless connection to peripherals such as earpieces is also possible through a built-in Bluetooth technology. Third party "applications", created in Ajax or JavaScript, are supported via the Safari web browser. With this device eLearning and LIMS is accessible within the analytical laboratory making more efficient use of the analysts' and quality managers' time. UCR has a wireless network and excellent computing laboratories to test this concept. There is no doubt that this hand held device, and other developments to follow, will revolutionize laboratory work, where and how learning is undertaken and blur the line between the university, laboratory, office and home.

6. IAEA Collaborating Centre Learning and Accelerated Capacity Building for Food and Environmental Protection (EACB)

The EACB was inaugurated on 16 July 2007. The initiative combined three world-class research/teaching institutions in Costa Rica, the Republic of Korea, and Singapore. CICA is the lead institution, or Collaborating Centre, acting on behalf of the designated laboratories in relations with the Agency. The laboratories have facilities for food manufacturing, environmental monitoring and radiation technology for related industrial, agricultural and biotechnological applications, including research and training capabilities.

The impetus for the EACB was the strong synergies between eLearning and hands-on-training. Training is resource intensive, particularly when travel is involved. Thus, training activities need to be cost-effective to be justifiable. This applies particularly to people already in the work force, who may have to pay for the training, but also have to account for work time spent on training. Accelerated capacity building is envisaged as step-by-step approach that meets the demand for efficient information dissemination through eLearning when, where and as it is required. Fundamental to the eLearning strategy is the re-use of information as it avoids unnecessary duplication of work and wasting of resources by ensuring participants can take full advantage of hands-on-training. Information is disaggregated into smaller parts such as a glossary of terms, references, multimedia items, and frequently asked questions. These information subcomponents can then be aggregated into knowledge objects, such as eArticles and slide shows and over-arching eLearning courses on a thematic issue. SCORM compliant learning management systems allow the sharing of each other's content. The low distribution cost of sharing course over the Internet allows anyone with Internet access to take courses for free. The long-term vision is to have sufficient courses for a post-graduate M.Sc. offered through participating universities. The model for this is yet to be developed but is expected to see credits being earned in the workplace and a possible reduction in the initial cost of higher education, which has become a barrier to developing knowledge based economies.

7. Summary

Costa Rica and the UCR have invested heavily in education, analytical quality management and providing broadband Internet access. This investment has enabled knowledge and experience gained at CICA in implementing and maintaining laboratory accreditation to be shared regionally and globally.

---

[1] FAO IAEA eLearning
   http://elearning.iaea.org/

[2] ATutor HowTo: Part I
   http://elearning.iaea.org/ATutor/bounce.php?course=27

[3] Laboratory Pre-requisites 1

http://elearning.iaea.org/ATutor/bounce.php?course=64

[4] Handling Pipettes and Syringes

http://elearning.iaea.org/ATutor/bounce.php?course=22

[5] Documentation of Laboratory Work
http://elearning.iaea.org/ATutor/bounce.php?course=90

[6] Pesticide Residue Analysis
http://elearning.iaea.org/ATutor/bounce.php?course=37

[7] In the use of pesticides, GAP includes the officially recommended or nationally authorized uses of pesticides under actual conditions necessary for effective and reliable pest control. It encompasses a range of levels of pesticide applications up to the highest authorized use applied in a manner which leaves a residue that is the smallest amount practicable. (http://www-infocris.iaea.org/en/w3.exe$GloSearch?ID=27355)

[8] Pesticide Management
http://elearning.iaea.org/ATutor/bounce.php?course=38

[9] Ecological Risk Assessments of Pesticides
http://elearning.iaea.org/ATutor/bounce.php?course=84

[10] Conformity Assessment
http://elearning.iaea.org/ATutor/bounce.php?course=89
[11] Project management
http://elearning.iaea.org/ATutor/bounce.php?course=53

[12] Time Management
http://elearning.iaea.org/ATutor/bounce.php?course=42

[13] Bika open source web-based laboratory information management system
http://bika.sourceforge.net/

[14] Chart Trakker in Management Innovations XVII
http://www.ache.org/PUBS/Research/poster_05.pdf

[15] Accessibility challenges with mobile lifelong learning tools and related collaboration
http://www.idi.ntnu.no/~divitini/umocec2003/Final/Ahonen.pdf

[16] iPhone from Wikipedia
http://en.wikipedia.org/wiki/IPhone