

Open Educational Resources for Learning Environmental Analysis †

Camelia Draghici

Department of Product Design, Mechatronics and Environment, Transilvania University of Brasov, 500036 Brasov, Romania; c.draghici@unitbv.ro

† Presented at the Virtual Eurachem Workshop 2020—“Quality Assurance for Analytical Laboratories in the University Curriculum”, 14–15 July 2020; Available online: <https://eurachem2020.ro/>.

Published: 29 October 2020

Abstract: It is accepted that the COVID-19 pandemic opened the interest for open learning/education, for which there are three accepted meanings: (i) open universities, (ii) massive open online courses (MOOCs), and (iii) open educational resources (OERs). In this context, this work presents the development of OERs for learning about the environmental quality monitoring system and its related activities, where environmental analysis is a critical stage part of the process. The contents of the created OERs include video presentation/commented slides, text-based learning resources, and intermediate/final tests, available for free in the public domain.

Keywords: environmental analysis; massive open online courses; open educational resources

1. Introduction

Massive Open Online Courses (MOOCs) are online courses designed for a large number of participants that can be accessed by anyone having internet access, from anywhere; opened to everyone without entry qualifications, and are offered for free, while Open Educational Resources (OERs) are teaching, learning, and research resources available in the public domain, that include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge [1].

Identifying a lack of MOOCs in toxicology, a European partnership was created to share toxicology-related knowledge and skills by developing OERs, to be available in the public domain on a MOOC platform. Thus, the “Learning Toxicology through Open Educational Resources (TOX-OER)” project aimed to share scientific and educational knowledge among specialists from seven academic institutions. The University of Salamanca (Spain—USAL) was acting as coordinator, and the six partners were Space Research and Technology Institute (Bulgaria—SRTI-BAS), Charles University, Prague (Czech Republic—CUNI), South-Eastern Finland University of Applied Sciences (Finland—XAMK), University of Bologna (Italy—UniBo), University of Porto (Portugal—Uporto) and Transylvania University of Brasov (Romania—UNITBV).

Following the descriptions of MOOCs and OERs, a toxicology course syllabus was proposed during the TOX-OER project. Consequently, a MOOC platform was developed, and related OERs were created, containing course modules, videos, text-based documents, and evaluation tests. All the OERs were available in eight languages, English, and the languages of the partner countries.

This work presents part of the OERs developed for the sixth module (M6), Environmental Toxicology. The third topic (T6.3) is Introduction to the Environmental Quality Monitoring System, which also gives learning contents related to the environmental analysis stage of environmental quality monitoring.

2. Results and discussion

The partners proposed a Toxicology syllabus (Table 1), and course modules are available on the project MOOC platform, installed and customized by the Unibo group [2].

Table 1. Toxicology syllabus and partners contributing to the development of the modules.

Modules Names (Number of Topics)	ECTS	Partners Contribution
M1: General Concepts (1)	1	UPorto
M2: Pharmacokinetics (4)	6	UPorto
M3: Principal Groups of Xenobiotics (2)	4	UniBo
M4: Environmental Pollutants (5)	7	UNITBV, CUNI, SRTI-BAS
M5: Target Organ Toxicity and Biomarkers (5)	8	CUNI, USAL, UPorto
M6: Environmental Toxicology (4)	7	UNITBV, XAMK
M7: Patents and Patent Application (1)	2	UniBo
Total number of ECTS	35	

Contributing to the Toxicology syllabus, Transylvania University of Brasov was responsible for the OERs development for modules/topics related to the pollutants as xenobiotics and to the environmental quality monitoring [3]:

- topics of M4—Gaseous pollutants (T4.1) and Persistent organic pollutants (T4.3)
- topics of M6—European Union and National Regulations Related to Environmental Quality (T6.1), Introduction to the Environmental Quality Monitoring System (T6.3) and Monitoring the Environmental Quality—Air, Water, Soil (T6.4).

The OERs created for environmental quality monitoring contained video presentations/commented slides, text-based resources (detailing the information given in the videos), and self- or final evaluation tests (Table 2), available for free to students and/or other interested learners [4].

Table 2. Developed OERs for environmental quality monitoring.

Topics and Units	Types of OERs		
	Video	Text	Test
T6.3. Introduction to the Environmental Quality Monitoring System	1 + 4 ^(a)	3	3 + 1 ^(b)
U1. Environmental monitoring scheme and related activities	1	1	1
U2. Environmental sampling and analytical measurements			
(U2.1) Sampling and sample preparation	1	1	1
(U2.2) Measuring – analytical methods	1		
U3. Environmental data processing and reporting	1	1	1

Legend: ^(a) 1 introduction video for the topic + 4 video presentations/learning units (U); ^(b) 3 self-evaluation tests + 1 final evaluation tests.

Environmental monitoring (EM) activities were presented as a cycle-based scheme, following well-defined stages: planning, execution, and evaluation (Figure 1a). For the execution stage of EM, the OERs introduce basic information about the analytical process, consisting of all the activities performed to determine the values of the environmental parameter/indicator of interest, about sampling and measuring. Data acquisition and data processing are presented as activities of interest for the analytical process, included in the EM's evaluation stage. It was underlined the difference between the data obtained from the measurement equipment (measured values) and the monitoring results, which are mainly expressed as pollutant concentrations in units according to the regulations.

Environmental analyses are subject to quality assurance and quality control (Figure 1b), with basic information being introduced about laboratory accreditation requirements, to demonstrate the laboratory compliance to perform specific tests or calibrations. Additionally, traceability, method validation, uncertainty estimation, reference materials, proficiency testing, and inter-laboratory

comparison are mentioned. Related to the laboratory accreditation, method validation, and uncertainty estimation are also briefly presented.

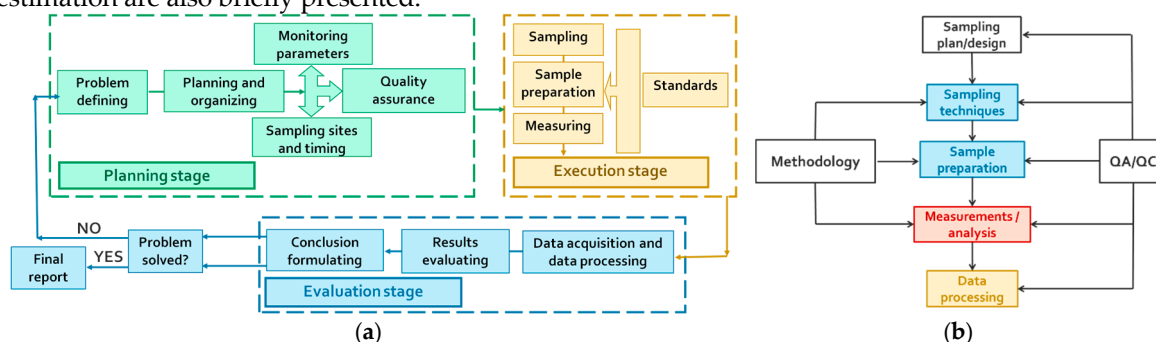


Figure 1. Environmental analysis integrated with the EM process: stages of the environmental monitoring activities (a): planning, execution, and evaluation; environmental analysis steps (sampling, measuring and data processing) requiring quality assurance and quality control (b).

Although the TOX-OER project was designed to develop OERs for toxicology learning, the developed OERs opened some insights for environmental education, especially environmental quality monitoring and environmental analysis, which turns out to be a novelty in this domain. Looking for MOOCs and OERs created for environmental education, only six MOOCs were identified to be available worldwide, in European and American open educational systems [5]. This lack of MOOCs developed for specific subjects of interest raze the interest for project-based OERs development.

3. Conclusions

The TOX-OER project created the conditions for the recognition and certification (ECTS) of learning achievements. A MOOC platform was installed, with available OERs that are subject to improvements in content and presentation. One disadvantage was identified: the eight languages of OERs presentation, since future improvements will require the contribution of all seven partners, for the OERs translation in the seven languages.

Project-based OERs development seems to be a challenge as well as a convenient approach for contributions to open education. For this, several key ingredients are needed: (i) subjects of interest for learners; (ii) identified interested target groups; (iii) specialists with high-level experience and expertise; (iv) strong/adequate partnership; (v) creative approach of the OERs. In this respect, EURACHEM offers a cooperation/partnerships network; why not also for MOOCs and OERs development for courses dedicated to chemical analysis and their related quality requirements?

Acknowledgments: The author addresses thanks to the Project Learning Toxicology through Open Educational Resources (TOX-OER), with financial support from the European Erasmus+ Programme, key action KA2, Strategic Partnership, project code 2015-1-ES01-KA203-015957.

Conflicts of Interest: The authors declare no conflict of interest.

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