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CHAPTER 10
TECHNOLOGY-ENHANCED LEARNING & INNOVATIVE EDUCATION AND TRAINING FOR DRINKING WATER TREATMENT PLANTS

10.1. Introduction to the Approach

A large variety of professional groups are involved in the drinking water supply system (e.g. Civil Engineers, Ms. Environmental Engineers, Chemical Engineer, Town and traffic Planner etc.). These professionals will all have to learn about the structure and maintenance of drinking water supply systems and learn to deal with important aspects of centralised, urban, decentralised and rural supply systems (e.g. aspects related to distribution and treatment). The types of treatment are dependent on the source, size and changing supply of such an extended system, and thus a system approach is required. Innovative Educational arrangements, like multidisciplinary case studies, supported by technology enhanced learning (TEL) environments, can contribute to teaching this subject matter in a more integrated fashion. TEL environments, in addition, afford learning across distances and over time.

Since each water system comprises several interconnected components, which are co-dependent for water quality and quantity, and thus cannot be seen in isolation from each other, collaborative study around cases which demonstrate this interconnection is a necessity. The understanding of this interconnectedness is the basis for any management of the water system. All parties in this locally and often transnationally interconnected system ideally are to be aware of the complexities and dependencies in the drinking water supply system, so that all water-related interests can be optimally served.

Technology enhanced learning (TEL) can enable new ways of learning and collaboration for professionals involved in the Drinking Water Supply system. Innovative solutions like Open Educational Resources and Massive Open Online Courses (MOOCs) offer opportunities to meet the needs and challenges in increasing globalised and interconnected systems like the international water management.

In this chapter an integrated approach, based on learning within interdisciplinary teams is developed. Interdisciplinary teams can learn how to develop their own innovative solutions for drinking water supply challenges, which could be applied to local situations. They can co-develop scenarios to simulate and predict the performance and operation of water supply system components.

In addition, this chapter will describe an example of how to apply synchronous and asynchronous social media, and Open Educational Resources (OER), in solution engineering around case studies. Furthermore it will provide some references to online available MOOCs, among others the PURE-H2O MOOC that was developed based on the chapters of this book.

10.2. Online Course Design for Drinking Water Solution Engineering

In this section general design guidelines for an online course are introduced to involve multidisciplinary teams (representing a variety of water-related interests) in a learning process that entails the collaborative engineering of a unique solution for the supply of drinking water. Learning goals for online courses on drinking water solution engineering do not only include students gaining, applying and sharing domain knowledge, but represent a clear focus on multidisciplinary cooperation and system thinking, for reasons as argued above.

Since we are assuming that (upcoming) professionals from different global locations will be involved in this approach, the students will have to subscribe to the course online. When they apply they should provide some background information (e.g., indicating the discipline they are affiliated with or want to learn about, and provide an indication of their current level of pre-knowledge in this field).

The facilitator of the course develops a course schedule that represents the course trajectory, including e.g., course milestones and (synchronous, online) contact-moments. The teacher describes in broad terms the ways of working in the course, and his/her own role. Also, the students will be informed about the learning goals and possible assessment procedures.

The teacher sets up a platform for online collaboration around case studies. How a teacher does this depends on their level of sophistication in the use of online tools, media and platforms. It is generally recommended to start working with a platform that you know and are feeling comfortable with (e.g., Skype/ Google Drive/ Dropbox/ Facebook/ Elgg, or a combination of these).

For inspiration and support materials which can assist the trainer in preparing and teaching ICT-enhanced courses, teachers can consult the leading European portal called the 'Open Discovery Space' (ODS, www.opendiscoveryspace.eu). It offers resources (OER) to enhance training and learning (http://portal.opendiscoveryspace.eu/tr-activity/section-2-teaching-and-learning-669741) as well as many online communities established for and by teachers. The 'Inspiring Science Education' (ISE) portal (www.inspiringscience.eu) is providing similar communities, services and tools in particular for the science, technology, engineering and mathematics (STEM) subjects plus an authoring environment for re-using, designing, adapting and sharing learning scenarios and lesson plans. Both portals (ODS and ISE) are offering many selected e-learning tools, too. In addition the teacher can get inspiration, discuss ideas and find help at Cloudworks, an online social network focussed strictly on learning design. On this platform, resources, ideas and scenarios for integrating new technologies in education are discussed and shared: http://cloudworks.ac.uk/.

Sometimes teachers feel like like experimenting, and there are many online communities which can help them set up platforms completely adapted to their own requirements; for instance the open educational tools of openEdX: https://open.edx.org/features-roadmap/teaching-and-learning-tools/all (it is recommended to also use the community discussion board, under 'Getting Started'). If the teacher is comfortable with computer code, or has someone to help with this, the open EdX site offers, e.g., a tool for creating discussion experiences; https://open.edx.org/features/cohort-specific-discussion-experiences[x].

Preparing interdisciplinary group work requires considerable thoughts and planning, because all professionals are shaped by their own traditions and have to work within well

defined professional boundaries (with associated norms and working methods). They also have most often implicit assumptions about what people in the other professions do. When learning in an interdisciplinary, collaborative group these professionals should not resort defending the interests of their profession only, nor implicitly dismiss the interests of another. Exercises can be devised to encourage each professional (group) to externalise their views on the other's priorities, and state their own key roles. Common problems and comparable challenges will surely arise in these exercises. The team can then be encouraged to share their own practical techniques and methods for working with such problems. The team may arrive at naming some long-standing common difficulties and decide on their approach to devise new, practical initiatives to tackle them. The trainer will provide the multidisciplinary team with guidelines to this effect.

10.3. Skills of Trainers

Online course design is a profession of its own. And supporting case-based learning of multidisciplinary groups similarly requires its own set of skills and competencies.

The vocational trainer required for this is on minimal EQF level 5, and could be a Training and Staff Development Professional (ISCO 2424), or a Teaching professional (ISCO 2359). Trainers can work with internal VET trainers (in water treatment plants) to determine the curriculum that needs to be covered, but the vocational trainer who will implement this innovative approach does not necessarily need much domain knowledge in the different water treatment domains (like Microbiology, Civil Engineering, Chemical Engineering and Environmental Engineering). The necessary content and background knowledge to be used in the course can be collected from internal VET trainers or by the participants themselves in the course as part of their coursework, or it can be found as Open Educational Resources online (see also section below).

The different tasks that the vocational trainer (course coordinator) would perform are listed below. These tasks overlap with the tasks specified for ISCO 2359, but are geared more specifically towards *online* facilitation of multidisciplinary learning around case-studies. Some of them are based on an inventory of social media skills (Bailie, 2011; González-Sanmamed, Muñoz-Carril, & Sangrà, 2014; Kirwan, & Roumell, 2015).

Tasks performed and knowledge applied would include:

1. Planning an online course (for multidisciplinary groups), applying organisational and planning skills (e.g. plan and manage course schedule, develop a welcome protocol with rules and regulations);
2. Applying knowledge of distance learning, online teaching strategies and models/ adult learning theory;
3. Applying skills to use internet tools (e.g. staying up to date and use proper software, establishing online communication structures based on learners ease of use of the technology, organising external tech support, selecting and creating multimedia educational resources, meeting standards in e-learning);
4. Prepare and set up a course structure, using an online platform or portal;
5. Collect, organise and archive (re)sources and materials to share on the online platform;

6. (Co-)Create content/materials for, or in the online platform;
7. Assessing learners' level of ability, and taking into consideration their learning needs (using e.g. an initial online questionnaire/form, filled out when they register online for the course);
8. Making available materials on Technology Enhanced Teaching and Learning (for the Internal VET trainers). Collecting and making available online, for reference, material (or OER's) on the theory of the subject areas being studied;
9. Instructing and demonstrating practical aspects for facilitation of Technology Enhanced Learning (current tools used in TEL, e.g. from Open Discovery Space; http://portal.opendiscoveryspace.eu/tr-activity/section-4-tool-library-669744/ or Inspiring Science Education; http://portal.opendiscoveryspace.eu/repository-tool).
10. Assigning tasks, exercises and work (cases) relevant to learners (in terms of their level of ability, interests and aptitude);
11. Applying skills in collaborative (online) learning;
12. Assessing students and offering advice, criticism and encouragement (this may include using learning analytics or online dashboards);
13. Revising curricula, course content, course materials and methods of instruction
14. Preparing students for examinations and assessments;
15. Counselling students regarding educational issues such as scheduling, adjustment, truancy, study habits etc. and help them understand and overcome personal, social, or behavioral problems affecting their education;
16. Encouraging students to explore learning opportunities and to persevere with challenging tasks;
17. Applying student engagement and facilitation techniques (e.g. design of online collaborative learning activities, questioning skills, moderation, encouraging and stimulating positive online participation, suggesting activities to facilitate collaborative knowledge development amongst participants, provide feedback on interactions, public and private recommendations, summarization of input, leading and integrating discussions);
18. Helping students in multidisciplinary teams to uncover their implicit assumptions about each other's' interests and ways of working; the diversity of their domain-specific norms and values;
19. Empowering learners in networked environments and fostering critical thinking and collaboration;
20. Moderating the online interactions of the learners (multidisciplinary teams) and promoting positive learning relationships between learners (applying interpersonal, online, communication skills and intercultural knowledge);
21. Monitoring the participation of the learners;
22. Developing competence based outcomes for the learning teams;
23. Encouraging peer assistance and assessment through social appraisal;
24. Providing strategies and tools for self-regulation and group regulation;
25. Using a variety of media and ICTs to create and publish learning resources and outputs;

26. Evaluating the learners/team products (applying knowledge of online assessment and feedback skills).

Online facilitation of drinking water solution engineering can thus be supported by Training and Staff Development Professionals or a Teaching professionals, but requires some specific skills outlined in the tasks above.

10.4. (Open Educational) Resources for the Courses

10.4.1. Nine examples of engineered solutions

Many resources are available online that can be used for training and learning opportunities. That can be considered as Open Educational Resources even though most of them are lacking a clear and explicit license statement (like a Creative Commons license): Their re-usage will not cause legal problems as long as they are cited and used only for (internal) training purposes.

As one major source the European Commission is providing many data and key information on their websites, e.g., collections of good practices and highlights like an online brochure[xi] that is presenting, in which are described 49 cases and projects providing inspirational examples of new ways to use water, both in industrial contexts and in private households, and of solutions that (local) authorities have devised to give water an appropriate place in our living environment.

We highlight nine examples that deal with water systems (not individual components). These should be sufficiently complex to demonstrate a system approach.

CASE 1: Maastricht cluster project: Integral water management for eight industrial companies with central supply and semi-collective wastewater processing.
(keywords: Integral management, industrial wastewater, water management)

CASE 2: Decision-support system for the prediction of groundwater quality.
(keywords: Modelling, prediction, drinking water, environmental impact assessment, groundwater, decision-support)

CASE 3: Sustainable and integrated water and energy system in the Hessenpoort industrial area.
(keywords: Integral management, industrial area, water supply, energy supply)

CASE 4: Development of a general method for quality determination and management of contaminated river basins.
(keywords: Decision-support, monitoring system, evaluation method, river, hydrographic basin, environmental assessment, toxicological assessment)

CASE 5: Integral management plans for catchment areas of trans-border rivers: the River Dommel.
(keywords: Hydrographic basin, integral management, modelling, border area, river management)

CASE 6: Development of the Oude Diep through integral land development.
(keywords: Policy integration, land-use planning)

CASE 7: Smart Flow in Reiderland.
(keywords: Wastewater treatment, urban area, prevention of pollution, sewers)

CASE 8: Sustainable urban technology in Schoonebeek.
(keywords: Urban development, sustainable development, human settlement)

CASE 9: The Blue Transformation: towards a water-friendly city.
(keywords: Rain water, water management, urban wastewater)

10.5. MOOCs about Water Treatment

There are already several MOOCs (Massive Open Online Courses) available online dealing with the subject of (drinking) water treatment. The PURE-H2O project will create it's own MOOC which will be available from the project website.

MOOCs can be engaged with in several ways (individual modus or group modus, synchronous or asynchronous). Most of them can be done at one's own pace and in one's own time.

Introduction to the Treatment of Urban Sewage (TUDelft, edX), Apr 12th 2016 , English.
Link: https://www.edx.org/course/introduction-treatment-urban-sewage-delftx-ctb3365stx-0
Learn about urban water services, focusing on basic sewage treatment technologies. (Keywords: Biology & Life Sciences, Engineering, Urban Sewage, Sewage Treatment, Water Treatment, Sludge Treatment, Primary Treatment, Biological Treatment, Engineering.

Introduction to Drinking Water Treatment (TUDelft, edX), Jan 12th 2016, English.
Link: https://www.edx.org/course/introduction-drinking-water-treatment-delftx-ctb3365dwx-0
Learn about urban water services, focusing on conventional technologies for drinking water treatment.(keywords: Biology & Life Sciences, Energy & Earth Sciences, Engineering, Water Treatment, Wastewater, Treatment Technologies, Water, Water Quality).

Water and Wastewater Treatment Engineering (Tsinghua University, edX), Oct 5th 2015, English, Chinese, English.
Link: https://www.edx.org/course/water-wastewater-treatment-engineering-tsinghuax-40050455x-0
Water and Wastewater Treatment Engineering is a major course of environmental engineering and municipal engineering. The basic principles, calculation methods and characteristics of physicochemical and biochemical technologies in water and wastewater treatment engineering are introduced in this course. (Keywords: Energy & Earth Sciences, Engineering, Wastewater, Water Treatment, Wastewater Treatment, Environmental Science, Environmental Engineering, Flocculation, Sedimentation, Flotation, Filtration, Disinfection)

Introduction to Household Water Treatment and Safe Storage (École Polytechnique Fédérale de Lausanne , Coursera), Jun 1st 2015, English, English, French, Spanish.
Link: https://www.coursera.org/course/hwts
Learn about the most important water treatment methods at household level, successful implementation strategies and about assessing the impact of Household Water Treatment and Safe Storage (HWTS). (Keywords: Health & Society, Water Treatment, Safe Storage).

Use statistics from:
Water Information System for Europe (WISE), which comprises a wide range of data and information collected by the EU institutions; http://water.europa.eu/data-and-themes

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