DIGIWATER

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R2.1.3 DIGITAL WATER CURRICULUM

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Table of Content

1 Introduction

The most significant share in the digitalization of the water sector depends on the sector employees and professionals. A curriculum that includes both the theoretical background and the practical application of currently used technologies will facilitate the transition to digitalization. Many approaches and methodologies are presented for curriculum design. In addition, online education provides both advantages and disadvantages. An online and dynamic curriculum is required to overcome deficiencies such as being disconnected from the course and the program, being deprived of the social environment provided by the course. At this point, besides the presentation of the lectures, group research and case studies will contribute.

Curriculum development and content were discussed at the Curriculum Design Workshop in Oslo, Norway on 23-25/11/2021 (Annex 1). A curriculum has emerged by considering the best practices review presented in R.2.1.2. This section presents the aims, learning outcomes, learning and teaching methods of the Digiwater curriculum.

2 Curriculum Development Strategies

2.1. Elements/Components of the Curriculum

For most curricula, the major components or elements are (i) aim, goals and objectives; (ii) content or subject matter; (iii) learning experiences; (iv) evaluation approaches. When translated into questions, each component can be addressed by the following (Figure 1):

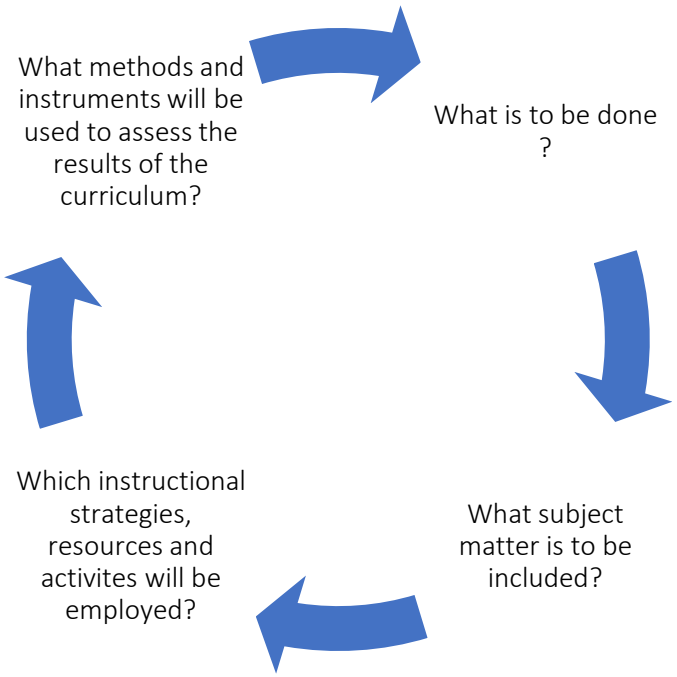

Figure 1: The major components or elements of the curriculum

Crafting the Curriculum

Component 1- Curriculum Aims, Goals and Objectives

Component 2- Curriculum Content or Subject Matter

Component 3- Curriculum Experiences

Component 4- Curriculum Evaluation

The components of a curriculum are distinct but are interrelated to each other in a curriculum design as shown in Figure 2.

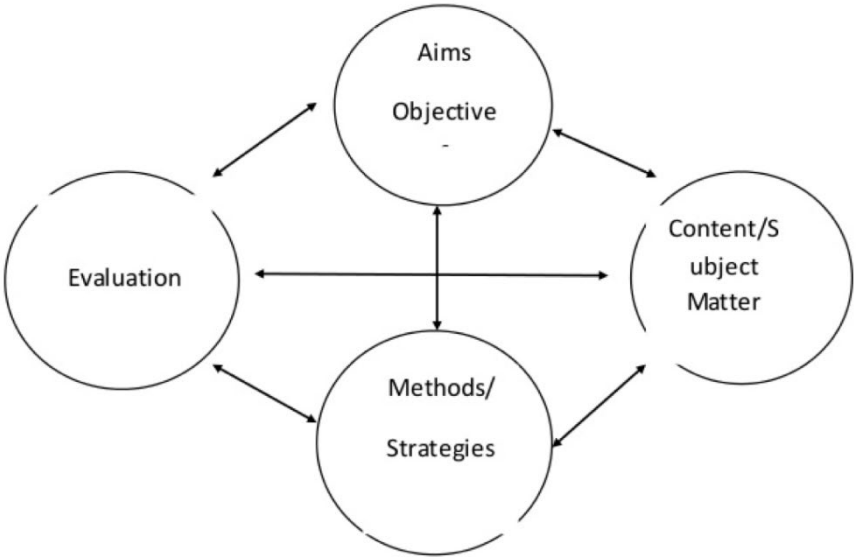

Figure 2: Interrelationshipof the components of a curriculum

2.2 Curriculum Approaches

There are five curriculum approaches. Curriculum practitioners and implementers may use one or more approaches in planning, implementing and evaluating the curriculum.

2.2.1 Behavioral Approach

Anchored on the behaviorist principles.Behavioral Approach to curriculum is usually based on a blueprint. In the blueprint, goals and objectives are specified, contents and activities are also arranged to match with the learning objectives. The learning outcomes are evaluated in terms of goals and objectives set at the beginning. In education, behavioral approach begins with educational plans that start with the setting of goals or objectives. These are considered as important ingredients in curriculum implementation as evaluating the learning outcomes as a change of behaviour.

2.2.2 Managerial Approach

The principal is the curriculum leader and at the same time instructional leader who is supposed to be the general manager. The general manager sets the policies and priorities,establishes the direction of change and innovation, planning and organizing curriculum and instruction.

2.2.3 System Approach

The systems approach to curriculum was influenced by systems theory.In the systems approach to curriculum,

- The parts of the total university/school are examined in terms of how they relate to each other.The organizational chart of the university/school represent a systems approach.It shows the line-staff relationships of personnel and how decision are made.

In this approach the following to be equal importance;

Administration → Counselling → Curriculum → Instruction →Evaluation

2.2.4 Humanistic Approach

This approach is rooted in the progressive philosophy and student-centered movement. In the systems approach to curriculum, considers the formal or planned curriculum and the informal or hidden curriculum. It considers the whole students and believes that in the curriculum development of the individual is the prime consideration.The learner is at the center of the curriculum.

2.3 Curriculum Design Models

Crafting a curriculum is like writing a lesson plan.It's like making something with different componets, and putting them together in a very creative way.

In general, a curriculum can be organized either horizontally or vertically.

Horizontal organization → The direction of the curriculum element is sideways

Vertical organization → Circular elements follow a vertical design

For example, the subject social studies move horizontally along history, geography, civisc and culture. In social studies content, putting the family ahead of the topic community is vertical articulation or in science the bigger topic on living thing comes ahead of topics on plants and animal.

2.3.1 Subject-Centered Design Model

This model focuses on the content of the curriculum. The subject centered design corresponds mostly of the textbook, written for the specific subject. Examples of subject-centered curriculum:

a) Subject design: What subjects are you teaching? What subjects are you taking?

b) Discipline design: Focuses on academic disciplines.

c) Correlation design: Links separate subjects designs in order to reduce fragmentation.

d) Broad field design/interdisciplinary: Variation of the subject-centered design, was made to prevent the compartmentalization of subjects and integrate contents that are related to each other

2.3.2 Learner-Centered Design Model

Learner is the center of the educative process.

a) Student-centered design: Curriculum design is anchored on the needs interest of the student. Learners actively create; construct meanings and understandings as viewed by the constructivists. Learning is a product of the student's interaction with the environment.

b) Experience-centered design: Similar to student-centered design. Difference is the interest and needs of learners cannot be pre-planned. The learners are empowered to shape their own learning from different opportunitiesgiven by lecturer.

c) Humanistic design: The development of self is the ultimate objective oflearning. It stresses the whole person and the integration of thinking, feeling and doing.

2.3.3Problem-Centered Design Model

Generally, it draws on social problems, needs, interest and abilities of the learners. Contents cuts across subject boundaries and must be based on the need, concerns and abilities of the student.

a) Life-situations design:Uses the past and the present experiences of learners as a means to analyze the basic areas of living.

b) Core design: Centers on general education and the problems are based on common acitivites.

2.3.4 Competence-Based Design Model

A competence model was elaborated and follows five quality criteria derived from competence research. Stakeholders are informed about the elaborated competence model. The methodology is summarized in Figure 3 and Figure 4.

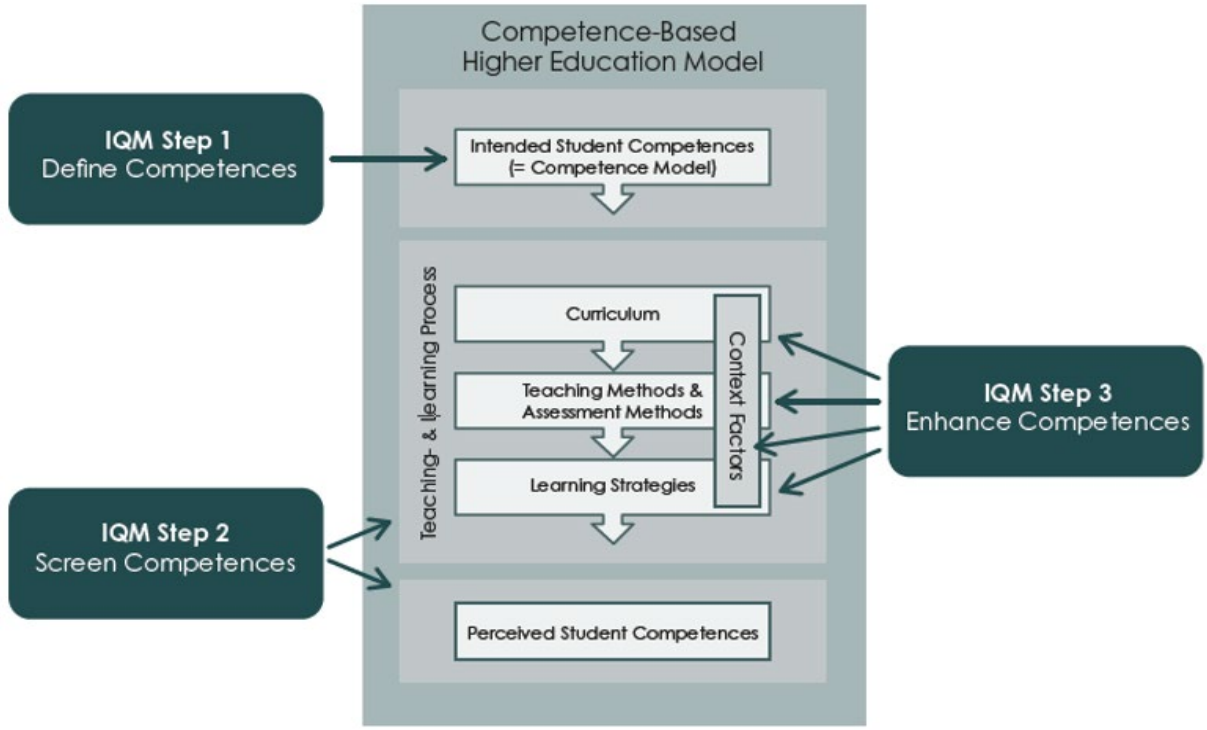

Figure 3: The IQM-Procedure

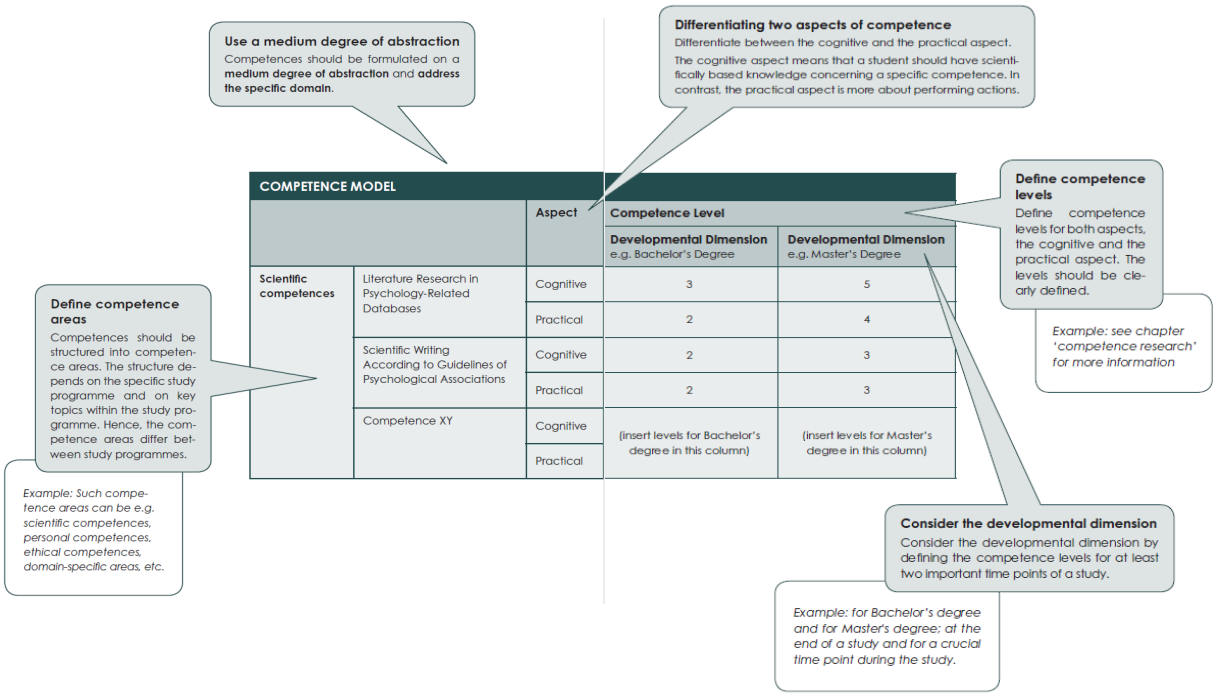

Figure 4: The Five Quality Criteria of the Competence Model in Internal Quality Management (through the example of scientific competences in psychology).

The competence-based higher education focuses on students' competences as an outcome of the teaching and learning process. Concentrating on the competences in higher education was caused by the paradigm shift from a teacher-centred to a student-centred learning environment.

Competence-based higher eductaion includes the process from defining intended student competences due to a study programme, to assessing the final perceived student competences achieved mediated by the teaching and learning process. The process is illustrated in more detail in the model of competence-based higher education depicted in t he middle part of Figure 1. The model starts with the definition of intended student competences. There are different type of competences such as research- and policy- based.

3 Process of Curriculum Development

3.1 Phases Of Curriculum Development Process

The Curriculum Development process encompassesthe design and development of integrated plans for learning, thedesign of implementation of the plans, and of the evaluation ofthe plans, their implementation and the outcomes of the learningexperience (Figure 5).

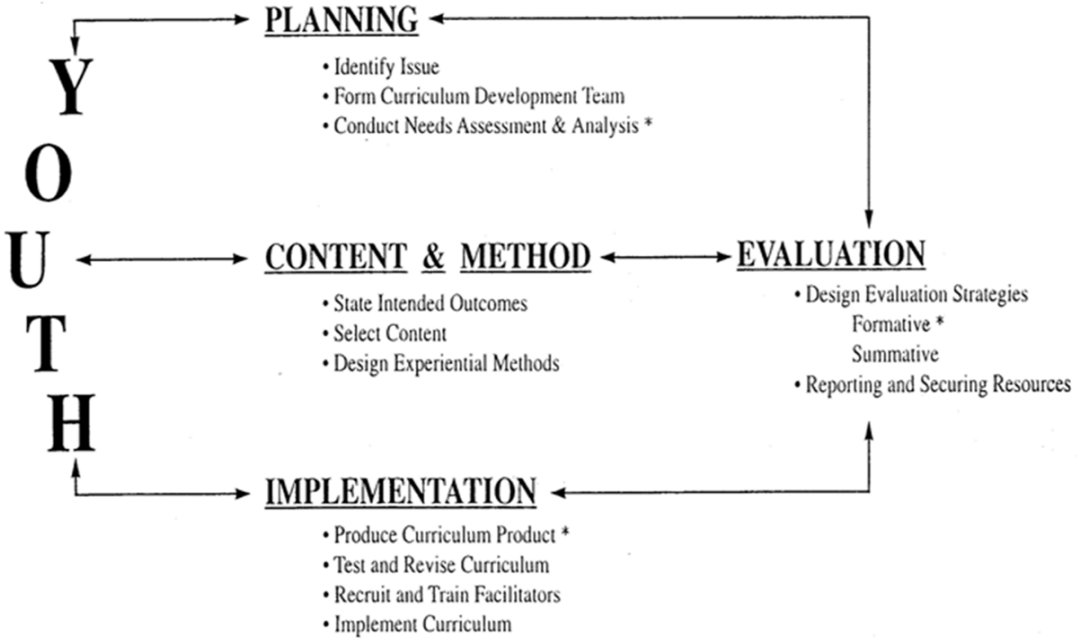

Figure 5: Process of curriculum development

Produce Curriculum Product

Once the content have been agreedupon, the actual production of curriculum materials begins. Thissection includes:

1) suggestions for finding and evaluatingexisting materials;
2) evaluation criteria;
3) suggestions forproducing curriculum materials.

Test and Revise Curriculum

This step includes suggestions to select test sites and conducta formative evaluation of curriculum materials during theproduction phase.

Recruit and Train Facilitators

It is a waste of resources to develop curriculum materials if adequate training is not provided for facilitators to implement it. Suggestions for recruiting appropriate facilitators are providedwith a sample three-day training program.

Implement Curriculum

Effective implementation of newly developed curriculumproducts is unlikely to occur without planning. We need to think about the strategies topromote and use the curriculum.

4 Course Purpose and Objectives

The main goal of the Digiwater Curriculum is to develop improved learning and teaching tools, methodologies and pedagogical approaches using best practices. As a result, there will be developed skills in multiple use of resources and long-term planning for multiple benefits in such a way that project partners will have harmonized teaching and pedagogical approaches in water related gradual education. Objectives are:

- Develop learning and teaching tools, methodologies and learning approaches on two courses related to digitalization of water industry
- Develop e-learning modules using the resources from newly developed courses
- Train staff to think more from a user perspective, creating better opportunities for graduates and opportunities for contract research
- Train staff to think multi-purpose utilization of resources and opportunities to enhance enterprise collaborations
- Strengthen entrepreneurship skills both for students and staff as a tool for securing financial sustainability
- Understand what digital transformation means for a water and wastewater utility (understanding the opportunities, understanding the barriers)
- Learn about digital solutions enabling better management and distribution of water resources
- Grasping essential guidelines for the real-world implementation of IoT and Big Data
- The ability to assess the technology integration, business wise, and to identify opportunities of enhancing it and provide strategic advantages
- An understanding of the ways you can use IoT and Big Data in transforming and implementing new digital infrastructures

In the workshop held in Oslo on 23-25/11/2021, it was decided to cover two majorpartsof course:
I. IoT&Big Data in The Water Industry (Table 1)
III. Cybersecurity of Critical Water Infrastructure (Table 2)

Table 1: IoT course contents and topic editors

Topic name	*Topicresponsible partner*
Introduction to IoT	P7-UCY
Sensors in IoT	P6-DOSCON
Instrumentation and SCADA	P9-SMARTECH
Cyber Security in IoT	P2-THOWL
Standarts & good practices (incl. Legal framework)	P1-NMBU
Case studies based on simulations	P4-SUMAQUA
Future trends	P1-NMBU

Table 2: Big Data applications in the water sector course contents and topic editors

Topic name	*Topic responsible partner*
Introduction to Big Data (Inc. Data Aquisation)	P5-KUL
Big data analytics (incl. Artificial Intelligence and machine learning tools)	P7-UCY
Visualization of data	P6-DOSCON
Cybersecurity in Critical Water Infrastructure	P1-NMBU
Data safety and standardization (incl. Crash course on Open data)	P6-DOSCON
Case studies	P4-SUMAQUA
Data assessment exercises	P2-P6-DOSCON-THOWL
Future trends	P1-NMBU

5 Learning outcomes

Leaning outcomes are measurable statements that articulate at the beginning what students should know (cognitive), be able to do (skills), or value (affective) as a result of taking a course or completing a program. As a result of participating in DIGIWATER Curriculum, students will be able to learn a general information about importance, application of digitalization of water industry. Using our learning outcomes as a tool, student will inform wtih teaching activities and course assessments.

After learning the course, the students should be able to:

- Develop a fundamental understanding of basic concepts of nano-biotechnology and its uses in the field of life sciences.
- Evaluate applications of various concepts & techniques of digitalization to facilitate treatment advancement and innovations.
- Understand what digital transformation means for a water and wastewater utility (understanding the opportunities and the barriers).
- Learn about digital solutions enabling better management and distribution of water resources.
- Be informed about the state-of-the-art in IoT devices and techniques.
- Understand the key technological building blocks of IoT devices, such as sensors, wireless networking, embedded and distributed processing and energy considerations.
- Understand IoT data aggregation and analytics using edge, fog and cloud computing.
- Appreciate the features found in modern IoT and Big data processing platforms.
- Learn about data analytics algorithms for analysing real-time IoT data and data sets.
- Gain experience in applying data analytics algorithms on IoT data to develop actionable insights based on an industry case study.

6 Teaching and Learning Methods

In introductory lessons, questionnaires can be used during the lesson to make interactive lessons with the students. Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work. The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the Digiwater.

Create short but effective, downloadable lecture videos to reduce the time and bandwidth needed to complete transfers as well as enable students to watch videos even in the absence of internet connectivity. As a backup, store all recorded videos in the cloud and ensure students can access them for instances where they lose their downloads.

Provide text transcripts for all recorded lectures and videos to enable students to easily read what transpired if streaming the video becomes impossible due to bandwidth difficulties.

Prioritize mobile-first design strategies, “especially for Android devices” to promote easy accessibility as many students in low-bandwidth areas lack laptops or high digital literacy and solely depend on the most affordable phones (Sperber, 2022). First steps can be taken in this endeavor through testing courses on phones to identify potential challenges in order to correct and make incremental improvements along the way.

7 Assessments

The assessment is continuously done by assigning tasks alternating between low and high-stake assignments. The final grade is made up following the formula 50% high stake assignments + 50% final project.

8 Minutes of Digital Water Curriculum Design Workshop

MEM-TEK

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Erasmus+ DIGIWATER Project
Curriculum Design Workshop

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November 24, 2021

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