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Best design for the competencies framework report

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Executive summary

This report presents the Best Design for the Competencies Framework (Deliverable D3.3) developed under WP3 of the INNAQUE project. The deliverable defines the key knowledge, skills, and transversal competences for students enrolled in the AquaSMART educational pathway, providing a strategic reference for curriculum design, learning outcomes, and quality assurance, while ensuring alignment with labor market needs.

EMUNI University coordinated the preparation of this deliverable in close collaboration with all project partners: Alexandria University (Coordinator), University of Palermo, University of the Aegean, King Salman International University, University of South Africa, and University of Fort Hare. The framework reflects diverse academic traditions, regional priorities, and socio-environmental contexts across Europe, North Africa, and Sub-Saharan Africa, while maintaining a common European reference for skills and qualifications.

The framework was developed through a structured, qualitative approach, including desk review of EU and international policies and skills frameworks (EQF, ESCO, European Skills Agenda), analysis of project objectives, and internal partner consultations. Emphasis was placed on aligning competences with real-world challenges in aquatic ecosystem management, nature-based solutions, ecosystem resilience, and environmental innovation.

The resulting framework defines technical, digital, sustainability, and transversal competences to prepare graduates to respond to environmental pressures such as pollution, climate change, and biological invasions, while addressing socio-economic and public health aspects. It supports inclusive and innovative study programs that integrate nature-based solutions, biotechnological approaches, and entrepreneurial thinking.

The framework aligns with EU priorities in skills, employability, digitalization, green transition, and sustainable development, providing a foundation for improved higher education quality, institutional capacity building, and the development of professionals capable of addressing complex environmental and societal challenges.

1. Introduction

1.1- Context of the AquaSMART program

AquaSMART, developed within the INNAQUE project, is a competence-oriented educational pathway strengthening higher education in aquatic ecosystem management, resilience, and nature-based solutions. The program addresses environmental, climatic, and socio-economic pressures,

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particularly in Egypt and South Africa, where aquatic resources are critical for sustainability, public health, and economic development.

The program shifts from theory-driven to practice-oriented, interdisciplinary education, integrating nature-based solutions, biotechnological approaches, and ecosystem resilience concepts. It also fosters innovation, entrepreneurial thinking, and employability, enabling graduates to respond to local and global environmental challenges.

WP3 defines the competences underpinning AquaSMART, providing a shared framework for curriculum development, learning outcomes, and quality assurance across partner institutions. Competence-based education is key for the Blue Economy, equipping graduates with scientific, digital, sustainability, governance, and socio-economic skills to manage resources responsibly and engage with policy and innovation.

1.2- Objectives of Deliverable D3.3

Deliverable D3.3, Best Design for the Competencies Framework, aims to provide a structured reference defining core competences for AquaSMART graduates. It:

- Identifies, describes, and organizes technical, digital, sustainability, and transversal competences;
- Supports curriculum design and learning outcomes across partner institutions;
- Ensures labor market and policy relevance, linking competences to professional profiles, sectoral needs, and sustainability policies.

This deliverable ensures consistency, quality, and contextual adaptation across curricula in Egypt and South Africa, contributing to the long-term impact and sustainability of the AquaSMART program.

2. Methodological Approach

The competence framework was developed through a structured and collaborative process involving all the partner universities participating in the AquaSMART project. The objective was to define the key skills and knowledge required for AquaSMART students and to present them in a coherent competence framework. The report provides a concise overview of this framework, which aims to support the development of relevant academic content and strengthen the alignment of educational outcomes with emerging needs in the Blue Economy sector.

The methodological approach combined desk research, consultations among project partners, and alignment with relevant European frameworks to ensure that the identified competences are clearly defined, academically sound, and consistent with international standards.

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2.1. Framework Design Process

- **Desk research and policy review:** Relevant European and international frameworks were reviewed, including the EQF, ESCO, the European Skills Agenda, and policy documents related to the Blue Economy and digital innovation. This review helped identify key competence areas and ensure consistency with broader European education and skills policies.
- **Consultation among partner universities:** EMUNI worked in cooperation with the participating universities to identify priority competence areas for the AquaSMART programme. These consultations ensured that the framework reflects both academic perspectives and regional priorities across the partner institutions.
- **Identification and structuring of competences:** Based on the collected inputs, a list of competences was developed and organized into thematic areas. The framework defines the essential knowledge and skills expected from AquaSMART students and includes at least 20 competences covering technical, digital, and sustainability-related domains.
- **Alignment with European frameworks:** The competences were reviewed in relation to the European Qualifications Framework (EQF) and informed by ESCO terminology and relevant policy initiatives. This alignment supports transparency, comparability, and recognition within the European education and skills landscape.

2.2. Stakeholder Involvement

The development of the competence framework primarily involved academic experts from the participating universities. Their contributions ensured that the identified competences are relevant, coherent, and appropriate for higher education programmes addressing emerging challenges in the Blue Economy. The framework provides a foundation for further engagement with external stakeholders, including industry representatives, policymakers, and other relevant actors in the sector.

3. Structure of the AquaSMART Competence Framework

The AquaSMART competence framework, developed within the INNAQUE project, provides a structured and interdisciplinary approach for curriculum development and capacity building in aquatic ecosystem management and the Blue Economy. The framework aims to define the knowledge, skills, and responsibilities that students should acquire through the program in order to address complex environmental challenges affecting marine and freshwater systems.

The competence framework supports the development of learning outcomes, course design, and student skill profiles, ensuring that the educational program developed within the project respond to

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emerging environmental, technological, and societal needs. It is designed to be modular, transferable, and adaptable, allowing partner institutions to integrate it into their curricula while maintaining alignment with international academic standards and European competence frameworks.

The AquaSMART program is structured around five core thematic pillars, which reflect the interdisciplinary nature of aquatic ecosystem management and innovation within the Blue Economy.

Core Pillars of the AquaSMART Program

a) Nature-Based Solutions (NBS)

This pillar focuses on ecosystem-based approaches for environmental restoration, climate adaptation, and sustainable resource management. It emphasizes the application of ecological principles to design solutions that enhance biodiversity, ecosystem services, and ecosystem resilience in both marine and freshwater environments.

b) Marine and Freshwater Sciences

This pillar provides the scientific foundation for understanding aquatic ecosystems, including biodiversity, ecological processes, water quality dynamics, and environmental monitoring. It equips students with the scientific knowledge required to assess ecosystem health and support conservation and restoration initiatives.

c) Biotechnology

Biotechnology plays an increasingly important role in addressing environmental challenges in aquatic systems. This pillar covers bio-based innovations, environmental biotechnology, and technological applications aimed at supporting ecosystem restoration, pollution mitigation, and sustainable resource utilization.

d) Climate Change

Climate change significantly affects aquatic ecosystems through changes in temperature, hydrological cycles, and biodiversity patterns. This pillar addresses climate impacts on marine and freshwater environments, climate adaptation strategies, and resilience-building approaches for sustainable environmental management.

e) Artificial Intelligence and Digital Technologies

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Digital transformation is increasingly shaping environmental monitoring and decision-making processes. This pillar focuses on the use of artificial intelligence, data analytics, modelling tools, and digital monitoring systems to support ecosystem assessment, environmental management, and innovation within the Blue Economy.

Together, these pillars establish a holistic framework integrating scientific knowledge, technological innovation, environmental governance, and practical skills, enabling students to address complex environmental challenges in an interdisciplinary context.

3.1. Competence Structure

To support the objectives of the AquaSMART program, the competence framework defines a set of key competences and skills that students progressively develop throughout their studies. These competences are grouped into seven competence groups, each addressing a specific dimension of professional expertise required for aquatic ecosystem management, environmental innovation, and Blue Economy development.

The competence groups reflect the integration of scientific knowledge, research capacity, practical application, environmental governance, communication, and digital innovation.

The seven competence groups are:

1. Scientific, technical and intellectual skills
2. Laboratory and research skills
3. Practical skills
4. Environmental management knowledge
5. Regulatory and ethical knowledge
6. Communication and advisory skills
7. Digital and technological skills

Each competence group contributes to building a comprehensive professional profile capable of addressing environmental challenges through scientific analysis, technological innovation, responsible governance, and stakeholder engagement.

3.2. AquaSMART Competence Framework

The AquaSMART competence framework follows the European Qualifications Framework (EQF) learning outcome structure, which describes competences in terms of knowledge, skills, and responsibility and autonomy. This structure supports transparency, comparability, and consistency across educational programs implemented by partner institutions.

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The framework ensures that students not only acquire theoretical knowledge but also develop the practical and professional abilities necessary to apply this knowledge independently in real-world environmental contexts.

Table 2 presents the competence groups and their corresponding learning outcomes.

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Competence group	Knowledge	Skills	Responsibility and autonomy
Scientific, technical and intellectual skills	Understanding of key concepts in marine and freshwater sciences, ecosystem functioning, environmental processes, climate change impacts, and biotechnology applications relevant to aquatic systems.	Ability to analyze scientific data, interpret environmental indicators, apply critical thinking to ecological challenges, and integrate interdisciplinary scientific knowledge.	Ability to independently evaluate scientific information and apply theoretical knowledge to support sustainable aquatic ecosystem management and innovation.
Laboratory and research skills	Knowledge of laboratory techniques, experimental design, scientific methodology, sampling protocols, and analytical procedures used in aquatic sciences and biotechnology.	Ability to conduct laboratory experiments, apply analytical methods, process and interpret experimental data, and document research results according to scientific standards.	Ability to design and conduct research activities with scientific integrity, ensure data reliability, and contribute to research and innovation in aquatic environmental sciences.
Practical skills	Knowledge of field-based methods for ecosystem monitoring, environmental assessment, sampling strategies, and restoration practices in marine and freshwater environments.	Ability to perform field measurements, collect and analyze environmental samples, apply monitoring tools, and implement practical environmental management techniques.	Ability to carry out environmental monitoring and assessment activities responsibly and contribute to applied environmental management and restoration initiatives.

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Environmental management knowledge	Understanding of ecosystem-based management principles, sustainability strategies, environmental planning approaches, and Blue Economy concepts.	Ability to develop environmental management strategies, evaluate environmental risks, and apply sustainability principles to aquatic resource use and ecosystem protection.	Ability to contribute to decision-making processes and support the implementation of sustainable environmental management strategies.
Regulatory and ethical knowledge	Knowledge of environmental legislation, international conventions (such as UNCLOS and MARPOL), regulatory frameworks, and ethical considerations related to aquatic ecosystems, biotechnology, and climate governance.	Ability to interpret environmental policies, assess regulatory compliance, and integrate ethical principles into environmental decision-making.	Ability to apply regulatory and ethical standards in professional practice and support responsible governance of aquatic resources.
Communication and advisory skills	Understanding of scientific communication principles, stakeholder engagement processes, and interdisciplinary collaboration in environmental management contexts.	Ability to communicate scientific findings to diverse audiences, prepare technical reports and policy briefs, and engage with stakeholders and decision-makers.	Ability to contribute to advisory processes, facilitate dialogue between scientific and policy communities, and support evidence-based environmental decision-making.
Digital and technological skills	Knowledge of digital tools used in environmental monitoring, including GIS, remote sensing, data analytics, modelling	Ability to apply digital technologies for environmental data analysis, ecosystem monitoring, modelling, and decision-support systems.	Ability to independently use digital tools and emerging technologies to support environmental assessment, innovation,

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techniques, and artificial intelligence
applications.

and sustainable management of aquatic
ecosystems.

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3.3. Role of the Competence Framework

The AquaSMART competence framework serves as a strategic reference for curriculum design, teaching, and assessment within the INNAQUE project. By clearly defining expected learning outcomes, it helps partner institutions develop coherent and competence-based educational programs that prepare graduates for professional roles in aquatic environmental management, research, policy development, and technological innovation.

The framework also supports the harmonization of educational approaches among partner universities, ensuring that program developed within the project remain aligned with international academic standards while addressing the specific environmental and socio-economic contexts of the participating regions.

Through the integration of scientific expertise, practical application, digital technologies, and governance knowledge, the AquaSMART competence framework contributes to strengthening the capacity of higher education institutions to train professionals capable of supporting sustainable management of aquatic ecosystems and the development of the Blue Economy.

3.4. Operationalization of the Competence Framework

To enhance the practical implementation and impact of the AquaSMART competence framework, additional operational elements are defined to support teaching, assessment, and alignment with labor market needs.

3.4.1. Measurable Learning Outcomes

Each competence group is further translated into measurable learning outcomes that can be assessed within the curriculum. These outcomes specify what students are expected to achieve upon completion of the program.

Examples include:

- **Scientific and technical skills:**
Students are able to analyze and interpret environmental data and apply interdisciplinary scientific knowledge to assess aquatic ecosystem health.
- **Laboratory and research skills:**
Students are able to design and conduct experiments, apply appropriate analytical techniques, and interpret results following scientific standards.
- **Practical skills:**
Students are able to perform field-based environmental assessments and apply monitoring and restoration techniques.
- **Digital and technological skills:**
Students are able to use GIS, remote sensing, and data analysis tools to support environmental decision-making.

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– **Communication and advisory skills:**

Students are able to communicate scientific results to both technical and non-technical audiences and contribute to stakeholder engagement processes.

3.4.2. Assessment Criteria

To ensure consistency and quality across partner institutions, the following assessment criteria are proposed:

- Ability to apply theoretical knowledge to real-world environmental challenges
- Accuracy and reliability in data collection, analysis, and interpretation
- Quality of laboratory and field work execution
- Effective use of digital tools and technologies
- Clarity and effectiveness in communication (written and oral)
- Critical thinking and problem-solving capacity
- Level of autonomy and responsibility in project work

Assessment methods may include:

- Written exams and reports
- Laboratory and fieldwork evaluation
- Project-based assignments
- Case studies and problem-solving exercises
- Presentations and group work

3.4.3. Performance Indicators

To monitor the effectiveness of the competence framework and its implementation, the following performance indicators are proposed:

- Student achievement of defined learning outcomes
- Success rates and academic performance across modules
- Student participation in practical and field activities
- Level of digital tool usage in coursework
- Feedback from students and academic staff
- Graduate employability and alignment with labor market needs
- Engagement with external stakeholders (industry, policy, NGOs)

These indicators support continuous improvement and quality assurance of the program.

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3.4.4. Enhanced Stakeholder Involvement

To strengthen the relevance and applicability of the framework, greater involvement of external stakeholders is recommended, particularly:

- **Industry representatives**, to ensure alignment with current and emerging labor market needs
- **Policy-makers**, to reflect regulatory and governance priorities
- **Environmental agencies and NGOs**, to integrate practical and societal perspectives

Stakeholder engagement can take the form of:

- consultations and feedback sessions
- guest lectures and workshops
- internships and field placements
- participation in curriculum design and evaluation

This broader involvement enhances the practical orientation of the program and supports stronger connections between academia, industry, and policy.

4. Conclusion

The AquaSMART competence framework is aligned with the principles of the European Qualifications Framework, which structures learning outcomes in terms of knowledge, skills, and responsibility and autonomy. This alignment ensures transparency, comparability, and recognition of the competences developed within the program across different higher education systems. By following the EQF learning outcomes approach, the framework supports competence-based curriculum design, facilitates student mobility, and strengthens the relevance of the program for the labor market and the evolving needs of the Blue Economy sector.

Change control data sheet

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