Horticulture 4.0

Vocational Education for Digital Transformation in Horticulture

Digital competence map for future workers in smart greenhouses according to the DigComp 2.1 framework

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INTRODUCTION

The aim of the Horticulture 4.0 project is to develop innovative, high-quality teaching materials for horticulture vocational training teachers on the technologies used in smart greenhouses, and to prepare horticulture teachers to train precision greenhouse operators in the future. In the partner countries of the project, the curriculum on the automation and remote control of greenhouses does not yet exist in vocational training.

In order to ensure that the results of the project are closely linked to the needs of the labour market, the partnership was the first to compile a digital competence map of smart greenhouse operators in line with the DigComp 2.2 framework.

Based on the digital competence map, the second step of the project will be the Operation of Smart Greenhouses, which will be prepared for teachers in horticultural vocational training. Compilation of a theme, in accordance with the EQF and DigCompEdu frameworks.

OPERATOR OF PRECISION GREENHOUSES

Description of the most typical work area, activity or job to be performed in connection with the professional training of the operator of precision greenhouses

The operator of Precision Greenhouses is familiar with the structure of the growing equipment, is familiar with horticultural and ornamental plant horticultural crops, and is aware of the cultivation, propagation and plant protection procedures used in the growing equipment, which do not require a permit. He/she is familiar with the propagation procedures in micropropagation laboratories, assists in the work in the laboratory under the guidance of his/her superior.

After obtaining the professional qualification, the operator of the Precision Greenhouses manages the IT, precision and other special systems of the growing equipment related to horticultural and ornamental horticultural procedures, identifies minor errors and makes proposals for their correction. It collects the data collected by IT systems, transmits and organizes them with the help of the appropriate data transfer systems. Under the supervision of highly qualified professionals, it helps to install and configure the equipment of the growing equipment, and performs queries and data collection from the databases used in accordance with the instructions.

CLASSIFICATION OF THE LEVEL OF TRAINING

According to the European Qualifications Framework (EQF): LEVEL 4

According to the Hungarian National Qualification Framework: LEVEL 4

MODULE 1: DIGITAL SKILLS NEEDED TO OPERATE SMART GREENHOUSES

Knowledge	Skills	Responsibility and autonomy
Know basic digital technologies.	Applying digital technologies.	You will independently select the digital technologies you need for your work.
He/she is aware of ICT tools and their structure and operation.	Applying ICT tools.	Together with his professional colleagues, they determine the ICT tools necessary for the work.
You are familiar with basic office software and how to use them.	Applying software applications.	They use the necessary software independently and participate in further training.
He/she has a basic knowledge of IT networks and their structure and operation.	Working in IT networks.	It independently transfers data using the most well-known network solutions.
Know the basic concepts related to database management.	Using ű databases.	Based on the guidance of his professional manager, he enters data into the database used.

Digital competencies for Module 1 according to the DigComp 2.2 framework

Level	Basic level		Intermediate level		Advanced level		Expert Level	
	1	2	3	4	5	6	7	8
Competence area 1: Information and data management								
1.1 Browsing and searching for data, information and digital content						X		
1.2 Evaluation of data, information and digital content					X			
1.3 Handling of data, information and digital content						X		

Level	Basic level		Intermediate level		Advanced level		Expert Level	
	1	2	3	4	5	6	7	8
Competence area 2: Communication and collaboration								
2.1 Interaction supported by digital technology						X		
2.2 Sharing using digital technologies						X		
2.3 Exercise of citizenship through digital technologies					X			
2.4 Collaboration using digital technologies						X		
2.5 Netiquette					X			
2.6 Digital identity management						X		
Competence area 3: Creation of digital content								
3.1 Digital content development				X				
3.2 Integrating and transforming digital content				X				
3.3 Copyright and Terms of Use				X				
3.4 Programming			X					
Competence Area 4: Security								
4.1 Protecting Devices						X		
4.2 Protection of personal data and privacy								
4.3 Protecting health and well-being						X		
4.4 Protecting the environment						X		
Competence Area 5: Problem Solving								
5.1 Solving Technical Problems				X				
5.2 Identifying Needs and Technology Response Solutions						X		
5.3 Creative application of digital technology				X				

Level	Basic level		Intermediate level		Advanced level		Expert Level	
	1	2	3	4	5	6	7	8
5.4 Recognising digital competence gaps						X		

MODULE 2 – SMART TECHNOLOGIES IN GREENHOUSES

Topic 1: Mobile communication in greenhouses, data transmission

Knowledge	Skills	Responsibility and autonomy
He knows the mobile communication devices and their accessories.	Using of mobile communication devices.	Works independently with mobile communication devices.
Be aware of the operation of software used in mobile communication.	Using of software related to mobile communication.	It navigates independently and with great security when using the software.
Be familiar with mobile communication devices, especially technologies used in agriculture.	Efficient and responsible use of digital technologies in agriculture-related mobile communications.	Independently and competently apply existing technologies. It monitors the development of technology.
You know the wired and wireless data transfer options. He knows the structure and operation of these at a basic level.	Working in IT networks.	Based on the guidance of his workplace manager, he chooses network solutions and makes suggestions for their application.
Know the basic concepts related to database management. He/she knows the basic forms and methods of querying data from databases.	Using of databases.	Based on the guidance of his professional manager, he enters data into the database used, performs queries and data collection.
It is an expert in navigating various technological innovations, especially agricultural innovations.	Using special solutions in agriculture-related mobile communications.	He is committed to using mobile communication tools related to agricultural digitization technologies.

Topic 2: Other greenhouse automation, sensors, robotics

Knowledge	Skills	Responsibility and autonomy
He/she is familiar with the concepts related to precision harvesting, sorting and packaging machines, the data generated during measurements, their nature and usability. He/she is familiar with the range of data necessary for the proper functioning of systems and the related concepts.	Precision harvesting, sorting and packaging machines, robots.	It makes a proposal for the digitization of systems related to harvesting, sorting and packaging machines of the given growing equipment. It makes recommendations on the range of data necessary for the proper operation of the equipment and how to feed them.
He/she has a basic knowledge of the mechanical and operational principles of the harvesting, sorting and packaging machines and equipment used in cultivation equipment.	Equipment related to the operation of precision harvesting, sorting and packaging machines.	It assists its professional manager in the selection and installation of the harvesting, sorting and packaging machines used in the given growing equipment. It operates the installed equipment independently, performs minor repairs and interventions.
He/she is familiar with the software that controls the work of harvesting, sorting and packaging machines and equipment, the method of data transfer and applications running on mobile applications.	Software and digital applications used to optimize precision harvesting, grading and packaging.	It makes recommendations to the workplace manager on the purchase and update of the software, and the most optimal design of its settings. The user uses the installed software independently, makes and checks the necessary settings.
He/she is aware of the structure of the data to be collected, the methods of transmission, both in terms of input and output data.	Collection and transmission of data generated during precision harvesting, grading and packaging optimization.	In cooperation with its professional colleagues, it determines the scope of data to be collected and evaluated. The defined data is collected independently and transmitted to the data structures used.
Know the data structures of different devices.	Optimize the data network of your grow equipment.	It helps professionals to ensure that the data transfer between different systems is the most optimal.

Knowledge	Skills	Responsibility and autonomy
He/she is familiar with the central control and data collection devices, the processes and software running on them.	Knowledge of central control units.	At the request of his professional manager, he makes a proposal for the optimization of central control.
He has a basic knowledge of robotics systems and automatic solutions used in cultivation equipment.	Robots in growing equipment.	It assists its professional manager in judging the applicability of innovations and makes optimization proposals.

Topic 3: Micropropagation techniques in the laboratory

Knowledge	Skills	Responsibility and autonomy
He/she knows the equipment and tools necessary for micropropagation processes.	Knowledge of the equipment and tools of the micropropagation laboratory.	Operates laboratory equipment under the guidance and supervision of a professional.
At a basic level, he/she has a basic knowledge of the procedures used during the process and their utilization directions.	Knowledge of micropropagation procedures.	Under the guidance of a laboratory assistant, he selects the necessary procedures.
He/she is aware of the IT solutions of the equipment and devices used for micropropagation.	Knowledge of the digitization procedures and technologies used during micropropagation.	It is able to independently select the most optimal solutions and make suggestions for their application.
He knows the process and sub-activities of micropropagation at a basic level.	Knowledge of the process of micropropagation.	With the support of professionals, it monitors the micropropagation processes.
At a basic level, he knows the nutrient, light and other needs of plants during micropropagation processes.	To provide the needs of micro-propagated plants.	Possessing the applied technological knowledge, he or she makes a recommendation to the laboratory staff for the application of the most optimal procedures.
You are familiar with the process of transferring micropropagated plants to growing equipment and the procedures used.	Transplanting micropropagated plants into growing equipment.	To carry out the process, you will choose the most suitable procedure with the support of specialists.

Topic 4: Greenhouse vegetable and ornamental crop production technologies

Knowledge	Skills	Responsibility and autonomy
He knows the propagation, planting and harvesting workflows of vegetable and ornamental plants at a basic level.	Greenhouse vegetable growing processes from seed to harvest.	He performs the work processes of planting under supervision or on the basis of instructions.
At a basic level, you will have a basic understanding of the care and plant protection workflows of vegetable and ornamental plants.	Knowledge of plant protection and plant care works applied in growing equipment.	He or she carries out plant protection and plant care work processes under supervision or on the basis of instructions.
It recognizes different growing equipment. According to the functions, he knows the types and properties of the growing equipment. He/she is familiar with the technologies used in cultivation equipment and the related concepts.	Comparison and grouping of different growing equipment. Knowledge of the cultivation technologies used in cultivation equipment.	Based on the guidance of their workplace manager, in cooperation with their colleagues, they participate in the selection of the appropriate cultivation equipment and the technologies used in it.
He is familiar with the concepts related to growing equipment, with special regard to the concepts of climate, irrigation, lighting, plant care and plant protection.	Operation of cultivation equipment.	Together with his professional colleagues, he selects the crop production methods and the best solutions for the technologies to be applied.
He has a basic knowledge of the parts and materials of the growing equipment. and the process of establishment.	Simple ways to assemble and assemble grow equipment.	During the establishment of the cultivation equipment, the worker performs his work under the guidance of his workplace manager, in cooperation with his colleagues.
He knows the parts and machines of the growing equipment and their operating principles at a basic level.	Operating and maintenance procedures for growing equipment.	Under professional supervision, he performs simpler, practiced machine maintenance tasks.

Knowledge	Skills	Responsibility and autonomy
He/she is familiar with the legal, work, fire and environmental regulations of the profession.	It complies with the working, fire and environmental protection rules of the greenhouse. He is familiar with the relevant legal and official procedures.	Use protective equipment as instructed by your supervisor.
He knows the concepts related to the topic, knows the operation of sensors, the type of data.	Data collection options related to growing equipment.	With the help of his professional manager, he determines the type, quantity and frequency of data to be collected. With the help of his professional manager, he selects the suitable sensors and then installs them independently.
He/she is familiar with the concepts related to the topic and the method of transmitting the collected data.	Transmission of data collected during the operation of the cultivation equipment.	With the help of his professional manager, he builds a network. It provides assistance to professionals in the construction of wired and wireless network systems.
He knows where the different data is located in the databases used. He knows the structure of different data.	Organize the collected data into a database. Passing data to requests from other systems.	It determines the scope of data requested by professionals and prepares data collections.
He/she is familiar with the machines operating with different precision technologies, and is aware of their mechanics and operating principles at a basic level.	Precision machines and equipment used in cultivation equipment.	Together with your workplace manager, you select the equipment to be used. With the help of its professional manager, it strives for the most optimal solutions. It operates the installed equipment independently, performs minor maintenance.
They know the software running on machines and devices, the method of data transfer and the applications running on mobile applications.	Software used in cultivation equipment, digital applications.	It makes recommendations to the workplace manager on the purchase and update of the software, and the most optimal design of its settings.

Topic 5: Digitalisation of the microclimate of greenhouses

Knowledge	Skills	Responsibility and autonomy
He/she is familiar with the concepts related to micro- and macroclimate, the data generated during measurements, their nature and utilization. He/she is familiar with the range of data required for the proper operation of air conditioning systems and the related concepts.	Digitization of the microclimate of cultivation equipment.	It makes a proposal for the digitization of the air conditioning systems of the given growing equipment. It makes recommendations on the range of data necessary for the proper operation of the equipment and how to feed them.
He has a basic knowledge of the mechanical and operational principles of air conditioners used in cultivation equipment.	Tools for shaping the microclimate.	It helps its professional manager in the selection and installation of air conditioners for the given growing equipment. It operates the installed air conditioners independently, and performs minor repairs and interventions.
They are familiar with the software that controls the work of air conditioners, how data is transferred and applications running on mobile applications.	Software used by air conditioners.	It makes recommendations to the workplace manager on the purchase and update of the software, and the most optimal design of its settings. The user uses the installed software independently, makes and checks the necessary settings.
He/she is aware of the structure of the data to be collected, the methods of transmission, both in terms of input and output data.	Collection and transmission of air conditioning data.	In cooperation with its professional colleagues, it determines the scope of data to be collected and evaluated. The defined data is collected independently and transmitted to the data structures used.

Topic 6: Precision Greenhouse Irrigation and Fertilization Systems

Knowledge	Skills	Responsibility and autonomy
He/she is familiar with the concepts related to irrigation and nutrient solution application systems, the data generated during operation, their nature and their usability. He/she is familiar with the range of data required for the proper operation of equipment and the related concepts.	Digitization of irrigation and nutrient solution application systems.	It makes a proposal for the digitization of the irrigation and nutrient solution application equipment of the given growing equipment. It makes recommendations on the range of data necessary for the proper operation of the equipment and how to feed them.
He/she has a basic knowledge of the mechanical and operational principles of the irrigation and nutrient solution application equipment used in cultivation equipment.	Machines and equipment used in the construction of irrigation and nutrient solution application systems.	It assists its professional manager in the selection and installation of irrigation and nutrient solution application equipment for the given growing equipment. It operates the installed equipment independently, performs minor repairs and interventions.
He/she is familiar with the software that controls the work of irrigation and nutrient solution application equipment, the method of data transfer and applications running on mobile applications.	Software and digital applications used by the equipment of irrigation and nutrient solution application systems.	It makes recommendations to the workplace manager on the purchase and update of the software, and the most optimal design of its settings. The user uses the installed software independently, makes and checks the necessary settings.
He/she is aware of the structure of the data to be collected, the methods of transmission, both in terms of input and output data.	Collection and transmission of data from irrigation and nutrient solution application systems.	In cooperation with its professional colleagues, it determines the scope of data to be collected and evaluated. The defined data is collected independently and transmitted to the data structures used.

Topic 7: Digitalisation of artificial lighting in greenhouses

Knowledge	Skills	Responsibility and autonomy
He/she is familiar with the concepts related to natural and artificial lighting, the data generated during measurements, their nature and utilization. He/she is familiar with the range of data necessary for the proper functioning of illumination systems and the related concepts.	Digitization of natural and artificial lighting.	It makes a proposal for the digitization of systems related to the lighting of the given growing equipment. It makes recommendations on the range of data necessary for the proper operation of the equipment and how to feed them.
He/she has a basic knowledge of the mechanical and operational principles of lighting systems and equipment used in cultivation equipment.	Equipment related to the operation of natural and artificial lighting.	It assists its professional manager in the selection and installation of lighting equipment for the given growing equipment. It operates the installed equipment independently, performs minor repairs and interventions.
They are familiar with the software that controls the work of natural and artificial lighting systems and equipment, the method of data transmission and applications running on mobile applications.	Software and digital applications used in lighting optimization.	It makes recommendations to the workplace manager on the purchase and update of the software, and the most optimal design of its settings. The user uses the installed software independently, makes and checks the necessary settings.
He/she is aware of the structure of the data to be collected, the methods of transmission, both in terms of input and output data.	Collecting and transmitting data generated during the optimization of natural and artificial lighting.	In cooperation with its professional colleagues, it determines the scope of data to be collected and evaluated. The defined data is collected independently and transmitted to the data structures used.

Topic 8: Pest protection in precision greenhouse cultivation

Knowledge	Skills	Responsibility and autonomy
At a basic level, the student is aware of the factors damaging the plants, knows their basic types and groupings.	Ensure the living conditions of living organisms (viruses, bacteria, fungi, animal pests) that damage plants, and the forms of their damage. The most important weeds of horticultural crops.	With the help of its professional colleagues, it participates in the determination of damaging factors.
He knows the basic concepts of plant protection. Know the environmental risk of pesticide application.	The significance and subject of plant protection. Knowledge of the environmental effects of pesticides.	Under the supervision of a specialist with a higher education degree in plant protection, he participates in timely plant protection works.
He knows plant protection products at a basic level, how to use them, and their storage regulations. Be familiar with the legal requirements for pesticides.	Use and storage of pesticides.	Under the supervision of a specialist with a higher education degree in plant protection, he carries out the plant protection treatment in compliance with the law.
He/she has a basic knowledge of the chemical and biological mechanism of action of plant protection procedures.	Plant protection procedures in growing equipment.	Together with its professional colleagues, it determines the plant protection procedures to be applied.
He is familiar with plant protection systems and their digitization opportunities. He knows the connections with other precision equipment.	Precision crop protection equipment.	Under the supervision of a plant protection expert, he or she performs the adjustment of the machines, the calibration of the doses required for plant protection, and the timing of application.

Knowledge	Skills	Responsibility and autonomy
He/she is familiar with the software used in precision crop protection and their network communication.	Using software for precision crop protection equipment.	Under the instructions of its professional manager, it establishes the connection with the programs and applications used in the cultivation equipment, and ensures communication and data transfer between the different systems.
He is aware of the concepts of pesticide residues, residue limits, food health withdrawal period and occupational health withdrawal period, and the importance of pesticide dosage. He knows what to do in case of poisoning until medical help arrives.	Human toxicological effects of pesticides, first aid knowledge.	He feels responsible for his work, and under the supervision of a specialist with a higher education in plant protection, he performs plant protection management in compliance with the law and the permit document. In case of possible poisoning, he is able to make independent decisions.

Digital competencies for Module 2 according to the DigComp 2.2 framework

Level	Basic level		Intermediate level		Advanced level		Expert Level	
	1	2	3	4	5	6	7	8
Competence area 1: Information and data management								
1.1 Browsing and searching for data, information and digital content						X		
1.2 Evaluation of data, information and digital content						X		
1.3 Handling of data, information and digital content						X		
Competence area 2: Communication and collaboration								
2.1 Interaction supported by digital technology						X		
2.2 Sharing using digital technologies						X		
2.3 Exercise of citizenship through digital technologies					X			
2.4 Collaboration using digital technologies						X		
2.5 Netiquette					X			
2.6 Digital identity management						X		
Competence area 3: Creation of digital content								
3.1 Digital content development				X				
3.2 Integrating and transforming digital content				X				
3.3 Copyright and Terms of Use				X				
3.4 Programming			X					
Competence Area 4: Security								
4.1 Protecting Devices						X		

Level	Basic level		Intermediate level		Advanced level		Expert Level	
	1	2	3	4	5	6	7	8
4.2 Protection of personal data and privacy								
4.3 Protecting health and well-being						X		
4.4 Protecting the environment						X		
Competence Area 5: Problem Solving								
5.1 Solving Technical Problems						X		
5.2 Identifying Needs and Technology Response Solutions						X		
5.3 Creative application of digital technology				X				
5.4 Recognising digital competence gaps						X		

ATTACHMENTS

Annex 1: DigComp 2.2 Conceptual Reference Model

Competence area 1: Information and data management

1.1 Browsing and searching for data, information and digital content
1.2 Evaluation of data, information and digital content
1.3 Handling of data, information and digital content

Competence area 2: Communication and collaboration

2.1 Interaction supported by digital technology
2.2 Sharing using digital technologies
2.3 Exercise of citizenship through digital technologies
2.4 Collaboration using digital technologies
2.5 Netiquette
2.6 Digital Identity Management.

Competence area 3: Creation of digital content

3.1 Digital content development
3.2 Integrating and transforming digital content
3.3 Copyright and Terms of Use
3.4 Programming

Competence Area 4: Security

4.1 Protecting Devices
4.2 Protection of personal data and privacy
4.3 Protecting health and well-being
4.4 Protecting the environment

Competence Area 5: Problem Solving

5.1 Solving Technical Problems
5.2 Identifying Needs and Technology Response Solutions
5.3 Creative application of digital technology.
5.4 Recognising digital competence gaps

Annex 2: EQF definitions

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For the purposes of this Recommendation, the following definitions shall apply:

(a)'qualification' means the formal outcome of an assessment and validation process; is subject to a competent authority establishing that the individual has achieved a learning outcome in accordance with the given standards;

(b)'national qualifications system' means all aspects of a Member State's activity in relation to the recognition of learning and other mechanisms linked to the labour market and civil society. It involves the development and implementation of institutional policies and processes related to quality assurance, assessment and the awarding of qualifications. The national qualifications system may consist of a number of sub-systems and may include a national qualifications framework;

(c)'national qualifications framework' means a tool for classifying qualifications according to criteria used to determine the level of learning achieved. It aims to integrate and harmonise national qualifications subsystems and to increase the transparency, accessibility, interdependency and quality of qualifications towards the labour market and civil society;

(d)'international qualification' means a qualification issued by a legally established international body (association, organisation, sector or company) or by a national body acting on behalf of an international body and used in more than one country, which includes learning outcomes assessed against the standards of an international body;

(e)'learning outcomes' means the findings of knowledge, skills, responsibilities and autonomy as to what a learner knows, understands and is able to accomplish at the end of a learning process;

(f)'knowledge' means the result of the acquisition of information through learning. Knowledge is the set of facts, principles, theories, and practices related to a field of work or study. The EQF describes knowledge from a theoretical and/or objective (factual) point of view;

(g)'skills' means the ability to apply knowledge and use know-how to perform tasks and solve problems. The EQF describes skills from a cognitive (use of logical, intuitive and creative thinking) and practical (manual dexterity and the use of methods, materials, tools and instruments);

(h)'responsibility and autonomy' means the ability of a learner to apply knowledge and skills autonomously and responsibly;