Horticulture 4.0

Vocational Education for Digital Transformation in Horticulture

SMART TECHNOLOGIES IN GREENHOUSES

Curriculum for Vocational Teachers

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

2021-2-HU01-KA220-VET-000050665

Co-funded by the European Union

BASIC DATA OF THE COURSE

Title of the course	Technologies for smart greenhouses
EQF/MKKR level	Level 6
Digital competence	DigCompEdu - B1-C1 level
Target group	Teachers in horticultural education
Form of training	Blended training

PRESENTATION OF THE TRAINING

E-Agriculture is not the future, it is the present. In an era of digital transformation, horticulture plays a key role in providing fresh and nutritious food for a growing world population, while the use of smart technologies in greenhouses reduces uncertainty and increases productivity. The global role of automated greenhouses is growing in popularity, demand is increasing, but skilled labour is in short supply.

The training will prepare vocational teachers to integrate the knowledge needed to automate and remotely control greenhouses into the training of students specialising in horticulture and to equip their students with the necessary digital skills.

The training programme

In the teacher training programme, the descriptors of the European Qualifications Framework (EQF) (see Annex 1) are used to describe the learning outcomes at EQF level 6 for consistency. The general themes will be adapted and localised by the Member States according to their national systems.

The digital competences to be expected at the end of the training were defined in line with the recommendations of the Digital Competences Framework for Educators (DigCompEdu) developed by the EU.

Method of training

The course is blended and uses the methodology proposed in the EU Digital Agenda for Education 2021-2027:

1. learning by doing;
2. active learning;
3. the use of digital education methods.

Entry requirement

Conditions for successful completion (qualifications, prior knowledge, skills)

1.At least an EQF level 4 qualification in horticulture or IT

2. Basic IT skills, at least basic digital skills

Training modules, their weighting within the training

	Title of the module	Weight
1.	IT basics for the operation of smart greenhouses	15%
2.	Smart technologies in greenhouses	70%
3.	Innovative teaching methods	15%

Performance evaluation

	Posted on	Type	Score
1.	Solve a 30-question test in Moodle based on the content of the first two modules.	individual task	30 points
2.	Teaching students the topic selected from Module 2 using a project method in the following steps: (1) Topic selection, pedagogical planning on https://dmc.prompt.hu/hu (2) Setting up the project teams, planning and scheduling the project. (3) Professional and pedagogical evaluation of the project results. (4) Preparation of a project report based on the criteria specified.	group task	70 points
	Performance threshold		**80%**

Duration of training, expected workload

Duration: 3 months

Expected workload: 24-36 hours, 2-3 hours per week

Learning environment, IT infrastructure, facilitation

E-learning platform: https://course.h40.itstudy.hu/

Virtual consultation: at least 1 time per month on Zoom.

Presentation of the student projects at the final conference of the project with the participation of the student teams

Facilitation: the online learning process is facilitated by facilitators. The Moodle system administrator provides technical support and responds to problems within 8 hours of the problem being reported.

Quality assurance

Participants will complete an evaluation questionnaire at the end of the training, the results of which will be made public by the training provider.

LEARNING OUTCOMES

VOCATIONAL LEARNING OUTCOMES ACCORDING TO EQF LEVEL 6

Module 1

IT basics for the operation of smart greenhouses

The aim of the module is to provide the general IT basics (such as the basics of mobile communication, basic concepts of data collection and digitisation) and digital skills needed to learn how to operate automation and control systems in smart greenhouses.

By the end of the module, participants will be able to…

Knowledge	Skill	Responsibility and autonomy
Explain the basic concepts of communication, mobile communication in a clear and understandable way.	List the main areas of mobile communications, illustrate their application with examples from agriculture.	Lead a student project to explore the latest advances in mobile communication technology.
Explain the process from data collection, to data storage and interpretation, to explain the basic types and steps of digitising analogue signals.	It can distinguish between digitally stored media items based on the file format of the stored data, and infer the type and quality parameters of the media content based on the file extension.	Work independently with software to display, edit, convert and process digitised data.
To present the types and basic functions of control systems in intelligent greenhouses, the system components and sensors required for data collection and automation.	Explain and illustrate the structure and components of control systems and their functions and operation.	Operate a selected control system autonomously, interpret the data collected by the system, supervise the maintenance necessary for safe operation.

Module 2:

Smart technologies in greenhouses

The second module is the professional focus of the course. While the first module aims to provide the IT basics necessary to understand automation systems in greenhouses, the second module prepares participants for the competent application, safe operation and maintenance of specific technical solutions. The complex objectives of the module focus on four areas:

I. The introductory chapter (topic 1) covers the theoretical foundations and IT knowledge required for the deployment and safe operation of mobile communication network technologies in greenhouses.
II. Topic 2 aims to provide a practical introduction to the types of automation suitable for the targeted monitoring and care of plants, with concrete examples of greenhouse drones, sensors, robots and already implemented artificial intelligence solutions.
III. The third, larger content unit of the module (topics 3-8), starting with micropropagation in the greenhouse and moving through the growing process, introduces smart systems for optimising plant physiology, optimal climate control, optimisation of lighting and irrigation, and smart technologies for precision crop protection.

I. Content unit (topic 1)

By the end of the learning phase, participants will be able to…

Knowledge	Skill	Responsibility and autonomy
• explain the basic concepts of network communications and mobile communications. • define mobile systems connectivity and communication protocols. • define the concept of iot.	• to teach students the theoretical foundations and IT skills needed to build and safely operate network technologies, and to illustrate them with examples of systems built in a greenhouse.	• to use mobile communication applications independently and teach students how to use them.

II. Content unit (Theme 2)		
By the end of the learning phase, participants will be able to…		
Knowledge	**Skill**	**Responsibility and autonomy**
• explain the theoretical basis of automation for targeted monitoring and care of plants, the advantages and limitations of greenhouse sensors, robots, artificial intelligence solutions. • demonstrate analogue and digital sensors that collect data on the plant's environment (temperature, soil moisture, light, wind direction, wind speed, air pressure).	• to present the types of greenhouse automation in a practical approach, explaining their advantages and limitations through the example of concrete greenhouse drones, sensors, robots and already implemented artificial intelligence solutions. • to demonstrate the use of sensory data collection tools, to teach how to interpret the results on a concrete device.	• independently operate at least one automatic greenhouse for monitoring and plant care, transfer the knowledge necessary for safe operation to others and develop the necessary skills.

III. Content unit (topics 3-8)		
By the end of the learning phase, participants will be able to…		
Knowledge	**Skill**	**Responsibility and autonomy**
• to highlight the advantages of greenhouse micropropagation techniques over manual propagation. • explain the technical conditions of automated micropropagation systems (e.g. light rooms) and justify their role in species conservation. • classify greenhouse production systems according to the level of technology used. • list the automation options that can be applied at each step of the growing process, explain the concept of vertical farm. • present climate models that provide an optimal environment adapted to the physiological characteristics of greenhouse plants.	• to demonstrate the basics of micropropagation techniques under laboratory conditions, explaining the working phases. • to make students understand the basic concepts of automated micropropagation systems and discuss their relevance for sustainable development. • compare technological solutions of different quality according to different criteria (uptake, impact, expected outcome). • present to students a virtual simulation program for predicting and optimising the microclimate of greenhouses. • to present technical solutions for the optimisation of lighting,	• to set up a micropropagation laboratory for learning purposes in collaboration with colleagues. • to raise students' awareness of global issues through guided discussion, and to discuss their potential as future agricultural professionals and their role in solving them. • to initiate a discussion with students and guide the debate: to analyse the possibility of introducing modern technologies from the point of view of the future agricultural entrepreneur. • plan and organise, either independently or with a

• describe the technologies suitable for the optimum light, nutrition and irrigation required by the plant at each stage of cultivation justify their importance. • explain the essence of precision plant protection practices in greenhouse cultivation and analyse their environmental impact.	irrigation and irrigation, to use software for the installation and adjustment of control systems. • justify the environmental importance of precision crop protection technologies, explain the concept of sustainable resistance management.	teacher, a visit for students to a model farm where high quality greenhouse production techniques are used. • design and implement a project with students to identify research and solutions in a specific area of greenhouse technology, using a multidisciplinary approach, involving teachers where possible.

Module 3

Innovative teaching methods

The aim of the module is to present innovative teaching methods of the 21st century, including the project method, which is particularly recommended in vocational training and higher education, in a practical approach. The project method is an excellent tool for vocational education and training, as it allows students to translate theoretical knowledge into practical projects and apply it to real-life situations and real-life problems. The course will use practical examples to show how the project method can be used to develop professional competences (expertise, professional skills, professional confidence) and 21st century transversal skills.

By the end of the module, participants will be able to…

Knowledge	Skill	Responsibility and autonomy
• define the concept of active learning methods and justify their relevance in the 21st century. • describe the concept, life cycle and stakeholders of a business project, • identify the common and different characteristics of a business project and an educational project, • justify, with examples, how the project method contributes to the development of transversal skills in pupils, • define the method of pedagogical planning based on learning outcomes, • plan, manage and implement a pedagogical project together with fellow teachers. • present innovative evaluation methods to assess the results of the project.	• To consciously exploit the pedagogical potential of business projects in the project method, • help students choose topics and formulate research questions, • plan the pedagogical design and learning objectives of the learning project, • tools for project scheduling, documentation and continuous monitoring (e.g. Gantt chart) • use relevant digital tools at each stage of the project • decide whether it is useful or unnecessary to use a digital tool in a particular project step	• to work independently with stakeholders (teachers, students and companies) to plan and implement the project, • to evaluate pedagogical results independently and together with students in a complex way (student progress, product, problem solving…etc.) • draw useful conclusions from the evaluation results for continuous professional development.

Digital competences to be acquired according to DigCompEdu

COMPETENCY	SCINT	DESCRIPTION
1. Professional commitment		
1.1. Organisational communication The use of digital technologies strengthens organisational communication with students, parents and other partners. Contribute to the collective development of organisational communication strategies.	**Expert (B2)**	Using digital technologies in a structured and sensitive way to communicate.
1.2. Professional cooperation The use of digital technologies helps to collaborate with other teachers, share knowledge and experience, and innovate pedagogical practices.	**Expert (B2)**	Using digital technologies for collaborative knowledge building.
1.3. Reflective practice Individually and collectively reflect, critically evaluate and actively improve our own and our educational community's digital pedagogical practices.	**Expert (B2)**	It uses a range of resources to develop its own individual digital and pedagogical practices.
1.4. Continuous professional development Use digital resources for continuous professional development.	**Leader (C1)**	Critical and strategic use of the internet for continuous digital professional development.
2. Digital resources		
2.1 Selecting digital resources Identify, evaluate and select digital educational resources to support and enhance teaching and learning. When selecting digital resources and planning their use, the specific learning objective, context, pedagogical approach and learner group should be taken into account.	**Leader (C1)**	A comprehensive identification and assessment of appropriate resources, taking into account all relevant aspects.
2.2 Creating and modifying digital resources Creating and making digital content available to students, parents and other educators. Effectively protecting sensitive digital content. Respecting and correctly applying privacy and copyright rules. Understand how to use and create open licences and open educational resources.	**Expert (B2)**	Adapting advanced digital resources to specific learning environments.
2.3 Managing, protecting and sharing digital resources Modify and enhance existing open licensed resources and other resources where permitted. Create or co-create new digital educational resources. When creating new digital resources and planning their use, taking into account the specific learning objectives, context, pedagogical approach and learner group.	**Integrator (B1)**	Effectively sharing and protecting resources through core strategies.

Funded by the European Union

COMPETENCY	SCINT	DESCRIPTION
3. Teaching and learning		
3.1. Teaching Planning and using digital tools and resources in the teaching process to improve teaching effectiveness. Appropriate management and organisation of teaching with digital tools. Testing and developing new formats and teaching methods.	**Leader (C1)**	Targeted, planned use of digital technologies to develop pedagogical strategies.
3.2. Advice,guidance Use digital technologies and services to enhance interaction with learners individually and collectively within and outside the learning process. Use of digital technologies to provide up-to-date and targeted guidance and support. Develop and test new forms and formats to provide guidance and support.	**Leader (C1)**	C1 Strategic and targeted use of digital technologies to provide guidance and support.
3.3. Collaborative learning Use digital technologies to promote and develop student collaboration. To enable learners to use digital technologies as part of collaborative tasks and as a means of communication, collaboration and co-creation of knowledge.	**Leader (C1)**	C1 Use of digital environments for the co-creation, self-assessment and peer assessment of knowledge by learners.
3.4 Self-regulated learning Using digital technologies to support self-regulated learning processes, i.e. empowering learners to plan, reflect and assess their own learning, demonstrate their progress, share their insights and find creative solutions.	**Expert (B2)**	B2 Using digital environments to support self-regulated learning in a comprehensive way.
4. Evaluation		
4.1 Evaluation strategy Using digital technologies for formative and summative assessment. Improve the diversity and use of assessment formats and approaches.	**Leader (C1)**	C2 Develop innovative forms of assessment using digital technologies.
4.2 Analysis of evidence (documents) Selecting, critically analysing and interpreting student activities. Communicating performance and progress in the teaching-learning process.	**Leader (C1)**	C1 Using digital data to reflect on learning habits and teaching strategies.
4.3. Feedback and planning Using digital technologies to provide targeted and immediate feedback to learners. Adapt teaching strategies and provide targeted support based on the evidence (documents) generated by the digital technologies used.	**Leader (C1)**	C1 Using digital technologies to personalise feedback and support.
5. Support for learners		
5.1 Accessibility and inclusion Ensuring that learning resources and activities are accessible to all learners, including those with special needs. Assess and support learners' (digital) expectations, abilities, uses and misconceptions, and contextual, physical or cognitive limitations in the use of digital technologies.	**Integrator (B1)**	Managing accessibility and inclusion.

COMPETENCY	SCINT	DESCRIPTION
5.2 Differentiation and personalisation Using digital technologies to meet learners' learning needs, allowing learners to progress at different levels and speeds, and to follow individual learning paths and goals.	**Expert (B2)**	Designed using a range of different digital technologies to differentiate and personalise.
5.3 Active involvement of learners Using digital technologies to promote active and creative participation of learners. The use of digital technologies within pedagogical strategies to support the development of learners' cross-cutting skills, deep thinking and creative expression. Ensuring active student participation in complex subjects, practical activities, scientific research or complex problem solving.	C1 DIRECTOR	Comprehensive and critical implementation of active learning strategies
6. Helping students to develop their digital competences		
6.1 Information and media literacy Incorporating learning activities, tasks and assessments that require learners to formulate information needs: searching for information and resources in the digital environment; searching for, processing, analysing and interpreting information; comparing and critically evaluating the credibility and reliability of information and its sources.	**Expert (B2)**	It uses pedagogical methods that promote the development of students' information and media literacy.
6.2 Digital communication and collaboration Using learning activities, tasks and assessments that require learners to use digital technologies effectively and responsibly.	**Expert (B2)**	B2 Use pedagogical methods that promote digital communication and digital collaboration among learners.
6.3. Creating digital content Incorporate learning activities, tasks and assessments that require learners to solve tasks using digital tools, and to modify and create digital content in different formats. For these, you will need to be familiar with and comply with copyright and licensing rules relating to digital content, source links and attribution.	**Pioneer (C2)**	C2 Uses innovative methods to get learners to create digital content.
6.4 Responsible use When using digital technologies, measures should be taken to ensure the physical, psychological and social well-being of learners so that they are able to manage risks and use digital.	**Expert (B2)**	It uses pedagogical methods that promote the digital well-being of learners.
6.5 Problem solution Learning activities, tasks and assessments that require learners to identify and solve technical problems or creatively apply technological knowledge in unfamiliar situations.	**Expert (B2)**	It uses pedagogical methods that promote the development of students' digital problem-solving skills.

Produced in the framework of the Erasmus+ project 2021-2-HU01-KA220-VET-000050665

The training programme was put together by

Mária Hartyányi, iTStudy Hungary Computer Technology Training and Research Centre

Zoltán Horváth, ASZC Pigeon József Agricultural Technical and Vocational School of Alföld.

Date: August 2023.

Funded by the European Union

ANNEXES

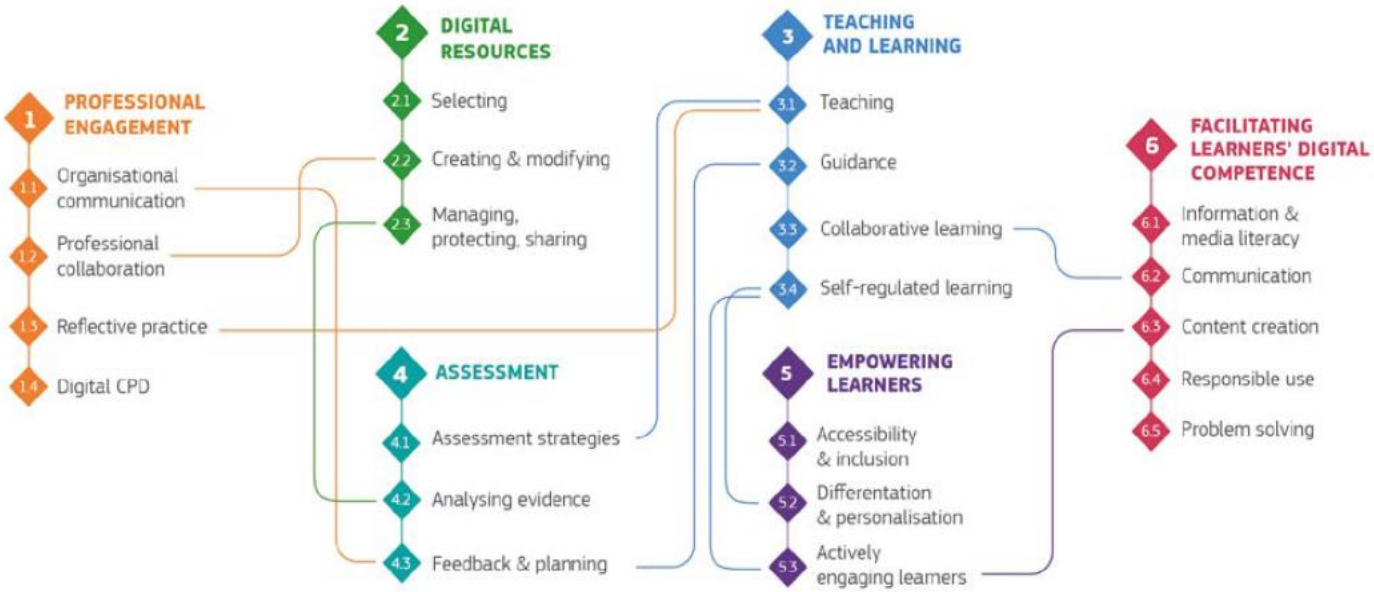
Annex 1: European Qualification Framework – EQF

Knowledge	Skills	Autonomy and responsibility
The outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. In the context of the EQF, knowledge is described as theoretical and/or factual.	The skills means the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments);	Responsibility and autonomy means the ability of the learner to apply knowledge and skills autonomously and with responsibility;
EQF level 6		
High level of knowledge of a field of work or study, with a critical understanding of theories and principles	Advanced skills demonstrating professional confidence and innovation to solve complex and unforeseen problems in a specialised field of work or study	Leading complex technical or professional activities or projects, taking responsibility for decision-making in unforeseen work or study situations, taking responsibility for guiding the professional development of individuals or groups.

Funded by the European Union

Annex 3: DigCompEdu Competence Framework

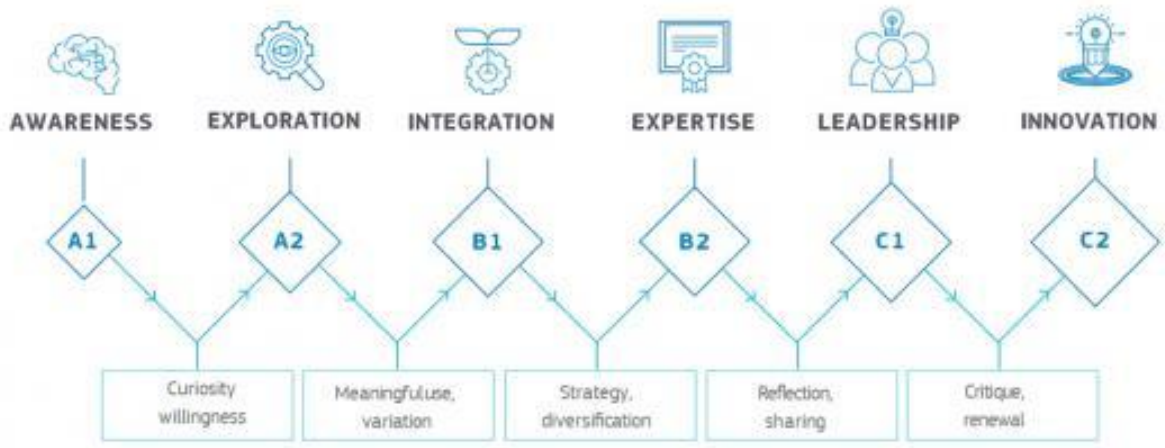
Source: DigCompEdu framework



Source: DigCompEdu framework

Funded by the European Union

DIGCOMPEDU COMPETENCE LEVELS



Newcomer (A1)

Newcomers are aware of the potential of digital technologies for enhancing pedagogical and professional practice. However, they have had very little contact with digital technologies and use them mainly for lesson preparation, administration or organisational communication. Newcomers need guidance and encouragement to expand their repertoire and to apply their existing digital competence in the pedagogical realm.[/collapsed]

Explorer (A2)

Explorers are aware of the potential of digital technologies and are interested in exploring them to enhance pedagogical and professional practice. They have started using digital technologies in some areas of digital competence, without, however, following a comprehensive or consistent approach. Explorers need encouragement, insight and inspiration, e.g. through the example and guidance of colleagues, embedded in a collaborative exchange of practices.

Integrator (B1)

Integrators experiment with digital technologies in a variety of contexts and for a range of purposes, integrating them into many of their practices. They creatively use them to enhance diverse aspects of their professional engagement. They are eager to expand their repertoire of practices. They are, however, still working on understanding which tools work best in which situations and on fitting digital technologies to pedagogic strategies and methods. Integrators just need some more time for experimentation and reflection, complemented by collaborative encouragement and knowledge exchange to become *Experts*.

Expert (B2)

Experts use a range of digital technologies confidently, creatively and critically to enhance their professional activities. They purposefully select digital technologies for particular situations, and try to understand the benefits and drawbacks of different digital strategies. They are curious and open to new ideas, knowing that there are many things they have not tried out yet. They use

Funded by the European Union

experimentation as a means of expanding, structuring and consolidating their repertoire of strategies. Experts are the backbone of any educational organisation when it comes to innovating practice.

Leader (C1)

Leaders have a consistent and comprehensive approach to using digital technologies to enhance pedagogic and professional practices. They rely on a broad repertoire of digital strategies from which they know how to choose the most appropriate for any given situation. They continuously reflect on and further develop their practices. Exchanging with peers, they keep updated on new developments and ideas. They are a source of inspiration for others, to whom they pass on their expertise.

Pioneer (C2)

Pioneers question the adequacy of contemporary digital and pedagogical practices, of which they themselves are *Leaders*. They are concerned about the constraints or drawbacks of these practices and driven by the impulse to innovate education even further. Pioneers experiment with highly innovative and complex digital technologies and/or develop novel pedagogical approaches. Pioneers are a unique and rare species. They lead innovation and are a role model for younger teachers.