Farming 4.0

# Guidelines for Integration of Curriculum

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# Introduction

The Guidelines for integration of curriculum is one of the main results of Farming 4.0 project. The guidelines examine all factors that are crucial for the successful training in the field of implementing information and communication technologies (ICT) in agriculture. Moreover, this guide describes the training program, its contents, educational materials and tools, as well as the training methodology. The Guidelines aim to be a model for educational processes on the subject of ICT use in agriculture that refers not only to the content, amount of information and its distribution according to the time schedule, but it also contains instructions that will try to cover the rest of educational and methodological aspects.

The Farming 4.0 Guidelines have the following general objectives:

- Provide teachers and trainers in VET with support for methodological work in the field of ICT use in agriculture;
- Update and improve instructors' knowledge and support related professional groups, environmental institutions and training centres with training related to ICT and their use in the agricultural sector;
- Define the whole structure of the training, its length in time, and the range of information that will be presented to the trainees;
- Contribute with suggestions of content, themes and activities as common basis, allowing the adaptation of the curricular proposal to specific conditions of a training centre.

## Farming 4.0 Project

The main project foundation is to develop and implement a specifically designed curriculum for ICTs for agricultural purposes and the knowledge and skills for delivering this curriculum through VET. The goal is to achieve more successful adoption of specifically developed ICTs for agriculture, that will contribute to the development of the agriculture sector and the rural areas. Considering the important role of the young farming population and the advisors in the agricultural extension for the development of the agriculture, we have put special attention on creating a curriculum for the following target groups: high school students, farmers, advisers and teachers.

**Expected outputs of the project are:**

1. **Focused Needs Analysis for ICTs knowledge and skills in agriculture** The purpose of the Focused Needs Analyses is to identify the specific needs of the target audience in the project (high-school students, farmers, advisors and teachers). This activity will enable creating a crucial input information for development of the curriculum for ICT knowledge and skills in VET for agriculture.
2. **E-collaboration platform for ICT for VET in agriculture** The e-collaboration platform is consisted of two major parts: front-end (FE) and back-end (BE). FE will be available for the entire public meaning all direct and indirect beneficiary in this project. Through this component of the e-platform, all created documents that are results of this project (curriculum, written reports, forum discussions, e-book, videos etc.) will be shared for public use. The BE will be created for efficient sharing of all relevant documents for management, monitoring and evaluation of the execution of the project activities. Through this component, all partners will have a convenient access to all relevant resources of the project, during the project implementation and after its completion. Through the e-collaboration platform the project team will create a tool that can be used for this area of activities, after the completion of the project.
3. **Curriculum for ICT knowledge and skills for VET in agriculture** This curriculum has the purpose to transfer the specific knowledge, skills and competences in the area of ICTs, needed for students in the VET for agriculture, advisors and all other participating subjects going through the process of VET for agriculture. The curriculum will be adapted to the

specific experience to all participating countries. The curriculum will be adapted to the specific needs to all participating countries, focusing on:

- knowledge and skills that the target group is expected to acquire;
- the learning standards and objectives they are expected to meet;
- the units and lessons that teachers must teach;
- the assignments and projects assigned to students;
- the books, materials, videos, presentations and readings used in the courses;
- the tests, assessments and other methods used to evaluate student learning and outcomes.

4. **Guidelines for integration of curriculum**
5. **Handbook for improving ICTs knowledge and skills for VET in agriculture** This Handbook will be the final product of the project and it will include a digital text file and some short video tutorials. All the models, tools, methodologies produced within the project will be collected and framed in a didactic guide. It will be handed out to every participant before the end of the project and sent by email or posted to every participant of the other focus groups and dissemination activities held during project.

**The main target groups of the project are:**

- VET students in the field of agriculture in Turkey, North Macedonia and Hungary;
- Agricultural advisors in public and private sector in Turkey, North Macedonia and Hungary;
- Policy makers in the Ministry of Agriculture and Ministry of Education in Turkey and North Macedonia;
- VET training centres for ICT education in all partner countries;
- Additional extension service providers in the field of agriculture (private advisors, NGOs providing advisory services, etc.);
- The entire farming community in all partners' countries;
- University students and professors in the field of agriculture in all partner countries.

## Background of Farming 4.0 Curriculum

Rising demand for bigger yields and higher environmental protection has put pressure on the agricultural sector to “produce more with less”. Smart farming or “farming 4.0” could hold the key. In Europe, precision agriculture (PA) and the integration of digital technology are set to become the most influential trends in the sector, as a growing number of farmers start to adopt digital technologies to run their businesses. According to the machinery industry in Europe, 70 to 80% of new farm equipment that is currently sold has some components of PA technology inside. There are 4,500 manufacturers, producing 450 different machine types with an annual turnover of €26 billion. The sector also employs 135,000 people. However, the uptake of precision farming in Europe is still very low. For instance, only 35% of new fertiliser spreaders are sold with a precision weighing instrument included, which is essential for adjusting the quantity and direction of spread. Precision farming can potentially help farmers produce higher yields, reduce crop damages and spend fewer inputs such as water, fuel and fertiliser. The European Joint Research Centre estimates that PA can make a huge contribution to CO2 saving in European agriculture until 2030.

Implementing innovations in the rapidly changing agriculture sector requires competence and continuous training on ICT issues. Similarly, in the process for finding a solution for today’s global agricultural challenges such as food safety and food security, ICTs also play a crucial role. These types of technologies are the crucial tool for connecting findings and innovations from different industries.

Because of the existing trends in agriculture and technology, the importance of digital farming will undoubtedly increase in the coming years. As a greater number of producers adopt precision agriculture technologies in their operations and a greater number of companies create and market solutions to meet this demand, there is a need for quality programs in VET that will combine agriculture and technology.

## Training Methodology

The introduction of ICT into the education process brings many benefits. Changing perceptions of learning from a conventional teacher-student relationship to a relationship where the teacher is only a support for the full understanding of a specific subject, encourages the advancement and development of many e-learning platforms.

The main training method recommended within Farming 4.0 training activities is **blended learning.** With this method the most of the course activities are done **online**, although some **face-to-face** instructional activities **(**intensive face-to-face sessions or short-term face-to-face residencies**)** are still required**,** such as lectures, discussions or other in-person learning activities. In other words, blended learning means meaningful didactic interconnection of traditional pedagogical methods with the use of e-learning, which in principle means combining the following three phases of the learning process into an optimally functioning unit:

1. Live lectures;
2. Workshops and exercises, computer-aided tests;
3. Self-study, also with computer support.

Blended learning offers immense advantages to students – they benefit from the structured practices of the classroom while learning at their own pace, owing to the adaptive and personalized nature of online learning. Each student has a range of different strengths and requirements and a blended learning approach allows tutors to acknowledge this. When they are given the ability to use tools from both traditional and digital spheres, tutors are able to present the necessary information in a range of different ways designed to suit the varying learning styles of their students.

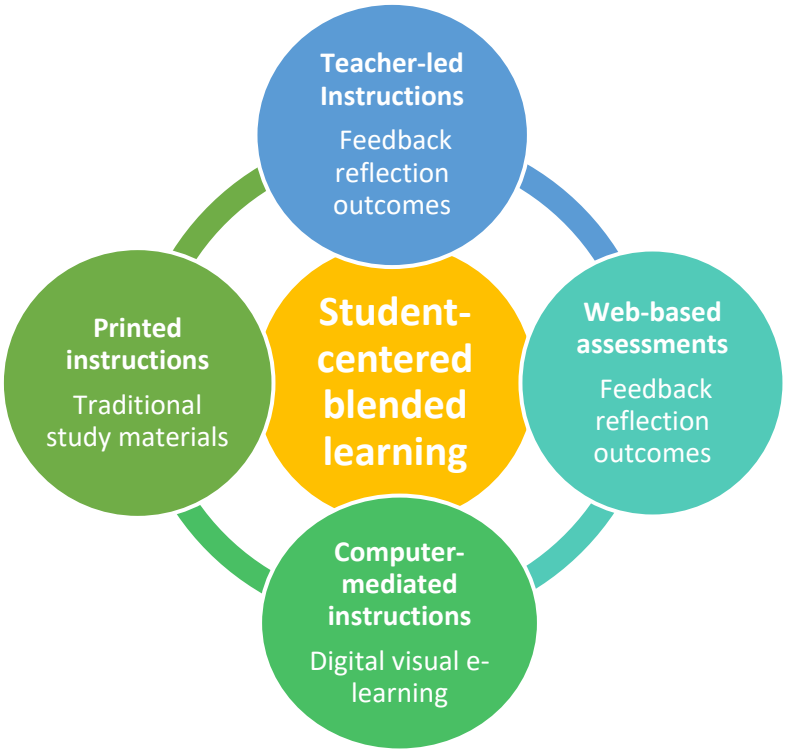


*Fig. 1 Elements of blended learning. Source:* http://lifeisapieceofpi.blogspot.com/2014/11/blending-my-classroom.html

In this way, opportunities are created for introducing the distance form of study, thus wiping out the time and space boundaries of access to the study materials. At the same time, it can be as effective as traditional training but at a lower cost. Developing e-learning programs is more expensive than preparing classroom materials and training the trainers, especially if multimedia or highly interactive methods are used. However, delivery costs for e-learning (including costs for web servers and technical support) are considerably lower than those for classroom facilities and instructors, including the time spent for travellingand th absence from work while attendingclassroom sessions. Moreover, e-learning reaches a wider target audience by engaging learners who have difficulty attending a conventional classroom training.

Blended learning provides wide opportunities for enhancing lectures with certain degree of transformation in learning and teaching approaches. It represents a new design of learning experiences and educational environment.

Blended learning involves the following key aspects:

- rethinking the course design to optimize student engagement;
- integrating face-to-face and online learning;
- replacing traditional class contact hours.*(Garrison & Vaughan 2008)*

Some online activities can be implemented before the face-to-face activities – the aim is to get students to an equal level of knowledge before face-to-face activities, or to try to find out differences in their knowledge level. The student can prepare himself / herself for a lecture in this way and the lecturer can adapt the material according to the students' needs.

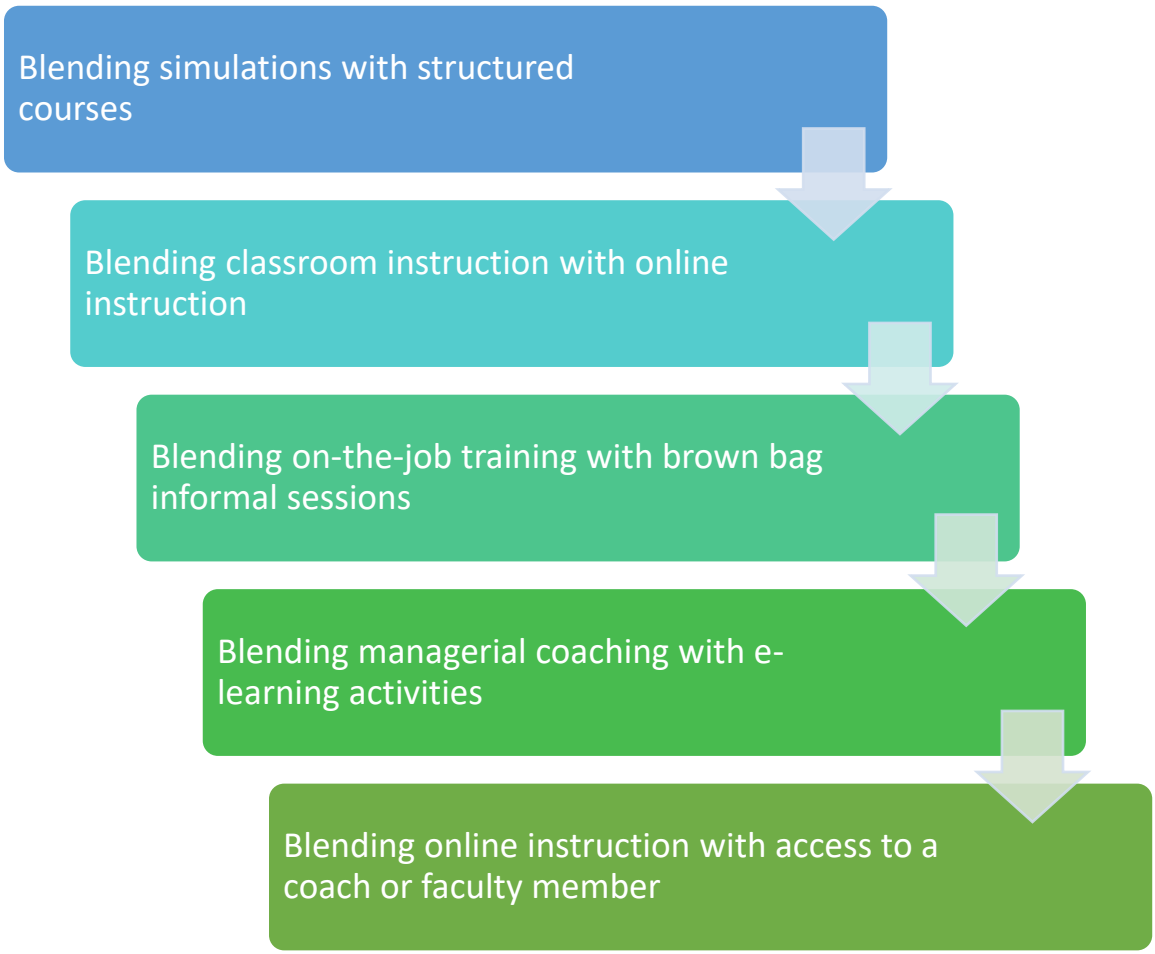


*Fig. 2 Use of two or more distinct methods of training. Source: Elliot Masie 2002*

E-learning materials combined with classroom lectures help students practice newly acquired knowledge and subsequently validate it. According to Malá (2011), e-learning supports the teaching process in the following aspects:

- presenting study materials;
- controlling the mastery of new study materials;
- analysing and co.rrecting mistakes;
- doing exercises,

### Skills

A training program may aim at developing different types of skills:

- cognitive skills, which can involve knowledge and comprehension (e.g. understanding scientific concepts), following instructions (procedural skills), as well as applying methods in new situations to solve problems (thinking or mental skills);
- interpersonal skills (e.g. skills needed for active listening, presenting, negotiating, etc.);
- psychomotor skills, involving the acquisition of physical perceptions and movements (e.g. sporting or driving a car).

Most e-learning courses are developed to build cognitive skills; the cognitive domain is the most suitable for e-learning. Within the cognitive domain, thinking skills may require more interactive e-learning activities because those skills are learned better “by doing”.

Learning in the interpersonal domain can also be addressed in e-learning by using specific methods. For example, interactive role playing with appropriate feedback can be used to change attitudes and behaviours.

## Most important questions when choosing a learning method

Some questions to ask when choosing between e- learning, face-to-face instruction or other types of informal or on-the-job learning include:

- What is the relative cost of each type of training?
- Is learning best delivered in one unit or spread out over time?
- Does it address a short-term or a long-term learning need?
- Do participants have access to needed computer and communications equipment?
- Are participants sufficiently self-motivated for e-learning or self-study modes of learning?
- Do target participants’ time schedules and geographic locations enable classroom-based learning or other types of synchronous learning?

## Model for training activities

In the training of the Farming 4.0 project, it was decided to go with both printed materials (*Handbook*) and online learning to ensure easy and extended access to training materials (people living in rural areas do not always have access to the Internet).

The following teaching and learning strategies, methods and techniques shall be applied in the **face-to-face part of the training program**:

- Verbal lecture
- Small group discussion
- Peer–to-peer learning
- Demonstrative teaching
- Study visits - good practice examples
- Questions and answers

The proposed **e-learning platform** is based on the free and open-source learning management system (LMS) Moodle, with customizable management features, which is widely used to create online courses for educators and trainers to achieve learning goals. This is a web-based learning system where study materials are accessible to students on the Internet. LMS is a web-based software application or technology that serves to plan, implement and evaluate specific lessons.

**The e-learning platform will contain:**

- interactive materials
    - it may consist of several interactive lessons / books
    - each lesson / book consists of screens on which the content elements can be displayed: text, animation, video, audio, questions or tests
- simple study materials
    - materials without interactive elements, e.g. PowerPoint presentations, audio or video materials. Materials without interactive elements allow students to only view, read or listen to the content of the lesson.
- other tools
    - they may contain answers to specific questions about practice
    - they can help with complex solutions

- glossary with the terms and definitions linked to the training content
- online evaluation questionnaire that is used to obtain feedback from course participants on the form and content of the course


*Fig. 3 E-learning concept. Source:* https://fahiezan.wordpress.com/week-3/

## Training content

The training content is designed for wide spectrum of audience including VET students in the field of agriculture, agricultural advisors, VET centres for ICT, extension service providers in the field of agriculture agricultural area, university students and professors in the area of agriculture and the entire farming community. In general, training content can be modified and adjusted according to the type of audience, educational goals, actual needs or other factors (learning environment, equipment used in learning process or lecturer´s skills and experiences).

It is proposed to organize the training content in several modules, as shown in Figure 4.

1.1. What is Agriculture 4.0?

1.2. Data Sources

1.3. Digital Farm management systems and equipment

1.4. Data integration

1.5. Traceability systems

In order to to achieve a high level of interest and performance, the training materials should be in compliance with the definitions for the trainees' achievements (EQF – European Qualifications Framework definitions).

**EQF – European Qualifications Framework definitions**

| | |
|---|---|
| Learning outcomes | Statements of what a learner knows, understands and is able to do on completion of a learning process and which are defined in terms of knowledge, skills and competence. |
| Knowledge | 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 European Qualifications Framework, knowledge is described as theoretical and/or factual. |
| Skills | The ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualifications Framework, 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). |
| Competence | The proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development. In the context of the European Qualifications Framework, competence is described in terms of responsibility and autonomy. |

Source: www.cedefop.europa.eu

## Chapter 1: What is Agriculture 4.0?

| | | |
|---|---|---|
| **Learning outcomes** | **The learner/representative has knowledge about:** | • Agriculture 4.0/Farming 4.0/Future Farming/ Precision agriculture<br>• Historical phases of agricultural development |
| | **The learner is able to:** | Understand the process of agricultural development |
| | **The learner is competent in:** | Distinguishing different types of contemporary agricultural production |
| **General chapter contents:** | • Agriculture 4.0/Farming 4.0/Future Farming<br>• A quick overview of the phases in agricultural production<br>• Precision agriculture<br>• Smart farming/connected Farming | |

## Chapter 2: Data sources

| | | |
|---|---|---|
| **Learning outcomes** | **The learner/representative has knowledge about:** | Different sources of data |
| | **The learner is able to:** | Understand the various data sources and their applications |
| | **The learner is competent in:** | Choosing different types of data sources for different purposes |
| **General chapter contents:** | • 2.1 Sampling<br>▪ Sampling technologies<br>○ 2.1.1 Soil sampling<br>▪ Grid based (systematic) soil sampling<br>▪ Management zone based soil sampling<br>▪ Crops sampling<br>○ 2.1.2 Live-stock sampling<br>○ 2.1.3 Production sampling (plant production, live-stock)<br>• 2.2 Remote Sensing<br>▪ Sensors<br>○ 2.2.1 Soil sensing technologies | |

| | |
|---|---|
| | ▪ Spectroradiometer<br>▪ Frequency-domain reflectometry FDR / Capacitance (Frequency)<br>▪ Penetrometer<br>○ 2.2.2 Crop sensing technologies<br>▪ Sensors for plant protection<br>○ 2.2.3 Livestock sensors<br>○ 2.2.4 Sensors for Agricultural Machines<br>○ 2.2.5 Environmental (meteorology)<br>▪ Meteorology / climate based controls<br>▪ Soil moisture sensors<br>▪ Other sensors<br>• 2.3 UAVs (unmanned aerial vehicles)<br>• 2.4 Open sources<br>▪ Remote sensing<br>▪ Modern remote sensing technologies as an essential tool in agriculture<br>▪ Remote sensing methods<br>▪ Advantages of Remote Sensing Data Collection<br>▪ The most common operations supported by remote sensing technologies in agriculture<br>○ 2.4.1 Satellite data<br>▪ The missions of the Sentinel satellites<br>▪ Use of satellite imagery in agriculture<br>○ 2.4.2 Orthophoto<br>○ 2.4.3 Weather data and forecast<br>○ 2.4.4 Market data and business data |

## Chapter 3: Digital farm management systems and equipment

| | | |
|---|---|---|
| **Learning outcomes** | **The learner/representative has knowledge about:** | • Digital farm management systems and equipment<br>• Intelligent machines and their application in precision agriculture<br>• Types of software systems used in precision agriculture |
| | **The learner is able to:** | Understand the objectives of different types of precision agriculture technologies and software and information systems |
| | **The learner is competent in:** | |
| **General chapter contents:** | • 3.1 Digital farm management systems and equipment<br>▪ Sectors of precision agriculture<br>○ 3.1.1 Machines (tractors, harvesters, seed-spray-irrigation-fertilizer machines)<br>▪ 3.1.1.1 Tractors - Soil tillage<br>▪ 3.1.1.2 Seeders, sowing control system<br>▪ 3.1.1.3 Seed-spray-irrigation-fertilizer machines - Nutrition and conservation<br>▪ 3.1.1.4 Harvesters<br>• Autopilots<br>○ 3.1.2 Variable Rate Technology<br>▪ Site-specific nutrient management<br>▪ Variable Rate Technology (VRT)<br>○ 3.1.3 IoT<br>○ 3.1.4 Yield mapping and monitoring<br>• 3.2 SW and systems<br>○ 3.2.1 Geographical Information Systems (GIS) | |

| | |
|---|---|
| | ○ 3.2.2 Enterprise information systems (ERP, DSS, planning, business, etc.)<br>▪ Enterprise information systems<br>▪ Enterprise resource planning (ERP)<br>▪ ERP Solution to Precision Agriculture<br>▪ Decision Support Systems (DSS)<br>○ 3.2.3 Specialized information systems (plant production, livestock)<br>▪ Farm Management Information Systems (FMIS)<br>▪ Agricultural production management<br>• 3.3 Services |

## Chapter 4: Data integration

| | | |
|---|---|---|
| **Learning outcomes** | **The learner/representative has knowledge about:** | The importance and the obstacles for various types of data and its integration |
| | **The learner is able to:** | Acknowledge and distinguish different types of data |
| | **The learner is competent in:** | Taking more careful approach in choosing the correct type of data and integrate it accordingly |
| **General chapter contents:** | The agriculture sector has its own data complexities and challenges, some of which may be specific to the sector, therefore there is an essential need for data integration. | |

## Chapter 5: Traceability systems

| | | |
|---|---|---|
| **Learning outcomes** | **The learner/representative has knowledge about:** | Traceability systems |
| | **The learner is able to:** | Understand the importance and the principles of traceability system in 21st century |

| | | |
|---|---|---|
| | **The learner is competent in:** | Acknowledge the principles of different types of traceability systems |
| **General chapter contents:** | The International Organization for Standardization (ISO) and Codex Alimentarius Commission (CAC) defines traceability as the “ability to follow the movement of a feed or food through specified stage(s) of production, processing and distribution”.<br>Food safety and public health concerns have forced food producers and processors to adopt preventive measures for product identification and traceability. | |

## Results of pilot testing experience

**Here we should include the results of the pilot testing that will be implemented within Farming 4.0 project.*

| **Question** | **Responses** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Gender** | **Male** | **Female** | | | | | |
| Number | 10 | 0 | | | | | |
| % | **100** | **0** | | | | | |
| **Country and city/town of origin?** | Republic of North Macedonia | | | | | | |
| | Turkey | | | | | | |
| **Occupation** | **Farmer** | **Trainer / Teacher** | **Student** | **Other** | | | |
| Number | 5 | 5 | 0 | 0 | | | |
| % | **0.5** | **0.5** | **0** | **0** | | | |
| **What is your last education?** | **University PhD.** | **University MSc.** | **University Bc.** | **Secondary School** | **Primary School** | **Other** | |
| Number | 1 | 0 | 7 | 2 | 0 | 0 | |
| % | **0.1** | **0** | **0.7** | **0.2** | **0** | **0** | |
| **How skilled are you in using a PC, or other internet related applications and platforms?** | **4/excellent** | **3/independent user** | **2/average skilled user** | **1/basic skilled user** | | | |
| Number | 3 | 5 | 2 | 0 | | | |
| % | **0.3** | **0.5** | **0.2** | **0** | | | |
| **Have you ever attended an E-Learning course?** | **Yes** | **No** | | | | | |
| Number | 5 | 5 | | | | | |
| % | **0.5** | **0.5** | | | | | |
| **The E-Learning platform is easy to use and handle** | **strongly agree (4)** | **agree (3)** | **partially agree (2)** | **strongly disagree (1)** | **Average** | | |
| | 3 | 7 | 0 | 0 | **3.3** | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **The E-Learning platform is attractive and interactive** | **4/strongly agree (0)** | **agree (3)** | **partially agree (2)** | **strongly disagree (1)** | **Average** | | |
| | 2 | 8 | 0 | 0 | **2.4** | | |
| **The E-Learning platform makes studying easier** | **strongly agree (4)** | **agree (3)** | **partially agree (2)** | **strongly disagree (1)** | **Average** | | |
| | 3 | 3 | 4 | 0 | **2.9** | | |
| **The E-Learning platform is reliable (no disturbances, no slow connections, etc.)** | **strongly agree (4)** | **agree (3)** | **partially agree (2)** | **strongly disagree (1)** | **Average** | | |
| | 3 | 7 | 0 | 0 | **3.3** | | |
| **The topics described are relevant for me** | **strongly agree (4)** | **agree (3)** | **partially agree (2)** | **strongly disagree (1)** | **Average** | | |
| | 4 | 5 | 1 | 0 | **3.3** | | |
| **The content of the modules was easy to understand** | **strongly agree (4)** | **agree (3)** | **partially agree (2)** | **strongly disagree (1)** | **Average** | | |
| | 5 | 4 | 1 | 0 | **3.4** | | |
| **The content of the modules was useful and inspiring** | **strongly agree (4)** | **agree (3)** | **partially agree (2)** | **strongly disagree (1)** | **Average** | | |
| | 4 | 6 | 0 | 0 | **3.4** | | |
| **I liked how the content was presented** | **strongly agree (4)** | **agree (3)** | **partially agree (2)** | **strongly disagree (1)** | **Average** | | |
| | 6 | 4 | 0 | 0 | **3.6** | | |

| **What did you like the most about e-learning platform?** | **User environment** | **Interactivity** | **Easy-to-understand contents** | **Glossary** | **Tests** | **Videos** | **Animations/graphics** |
|---|---|---|---|---|---|---|---|
| Number | 5 | 6 | 8 | 2 | 4 | 10 | 9 |
| % | **0.5** | **0.6** | **0.8** | **0.2** | **0.4** | **1** | **0.9** |
| **Which modules did you like the most?** | **What is Agriculture 4.0?** | **Data sources** | **Data farm management systems and equipment** | **Data integration** | **Traceability systems** | | |
| Number | 7 | 8 | 9 | 4 | 4 | | |
| % | **0.7** | **0.8** | **0.9** | **0.4** | **0.4** | | |
| **Do you have any suggestions that would help us improve these modules? (Was anything missing/ hard to understand/ not elaborated enough?)** | | | | | | | |
| **Which (if any) part or aspect of the e-learning platform did you particularly like or find useful?** | | | | | | | |
| | | | | | | | |

The questionnaire was developed for user experience and usefulness assessment of the E-learning platform. The involved participant in the questionnaire were farmers (5) and trainers (5) from N.Macedonia and Turkey. Most of the respondents had Bachelor degree and were independent users regarding ICT skills.

For the question “The E-Learning platform is attractive and interactive” all of the users answered positively (2 strongly agree, 8 agree).

For the question” The E-Learning platform makes studying easier” 4 of the involved participant partially agree that the E-learning platform makes studying easier.

For the question “The E-Learning platform is reliable (no disturbances, no slow connections, etc.)” all of the users of the platform that were involved in the questionnaire responded that the platform is reliable.

For the question “The topics described are relevant for me” all of the users of the platform that were involved in the questionnaire responded that the presented topics were relevant for them.

For the question “The content of the modules was easy to understand” all of the users of the platform that were involved in the questionnaire responded that the content is easy understandable.

For the question “The content of the modules was useful and inspiring” all of the users of the platform that were involved in the questionnaire responded that the presented content was useful and inspiring.

For the question “I liked how the content was presented” all of the users of the platform that were involved in the questionnaire liked the presented content.

For the question “What did you like the most about e-learning platform?” the most likeable form of the content were videos (10) and Animation/graphics (9).

For the question “Which modules did you like the most?” The users of the platform that were involved in the questionnaire responded in the following order:

1. Data farm management systems;

2. Data sources;

3. What is Agriculture 4.0;

4. Data integration and Traceability

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