ICARUS

Specifications of an HEI Open & Digital I4.0 Training Toolbox

Co-funded by the
Erasmus+ Programme
of the European Union

Document Control

Title:	**Specifications of an HEI Open & Digital I4.0 Training Toolbox**
Issue:	**V3**
Date:	**06.12.2019**
Author:	**Emmanuel Francalanza**
Reference:	**O1-R1 Report: Specifications of an HEI Open & Digital I4.0 Training Toolbox**
Filename:	**ICARUS-O1-R1-v3**
Control:	**Final approved version to be uploaded to project results in PDF format**

Document Signoff

Nature of Signoff	Person	Date	Role
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Reviewer	Catalin Amza	5.03.2020	Project Researcher
Reviewer	Erwin Rauch	28.03.2020	Project Researcher
Reviewer	Pierre Vella	15.03.2020	Project Researcher

Document Change Record

Date	Version	Author	Change Details
06.12.2019	Issue 1 Draft 1	Emmanuel Francalanza	First Issue
26.02.2020	Issue 1 Draft 2	Emmanuel Francalanza	Revision
30.03.2020	Issue 1 Draft 3	Emmanuel Francalanza	Revision

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1. Introduction

In order to develop an effective pedagogic approach and the open and digital training toolbox, which are the main aim of this project, the specific training requirements of HEI educators and learners must first be defined. The project will therefore start by undertaking a study to understand the training requirements of HEI educators and learners. The analysis of this information will lead towards the development of the specification of the HEI Open & Digital I4.0 Training Toolbox, which is the underlying foundation of the other IOs of this project.

The result of this Output will be a report which documents the analysis of the current and future needs of the HEI trainers and learners. This will lead to the development of the ICARUS Digital I4.0 Training Toolbox Specifications which addresses both current and future needs of HEI trainers and learners.

After discussions amongst the ICARUS partners it was decided that the best approach to collect the required information from the stakeholders of this project would be to utilise a questionnaire. This type of data collection method allowed the consortium to reach out to a wide ranging audience and ask about the different aspects required for the Industry 4.0 training toolbox.

Section 2 of this report therefore presents the survey design for identifying the current and future needs of HEI trainers and learners in the field of Industry 4.0. This section presents the survey aim and objectives, the methodology which was utilised, and the rationale behind the survey questions. The survey questions can be found in Appendix I.

The results of the survey can be found in Section 3 of this report. A number of statistical analysis are presented which compare different sample populations and identify if there are differences between the requirements of different users.

Finally in Section 4 the specifications of the ICARUS training toolbox are presented. These specifications are elaborated based on the analysis of the survey results and the needs of the stakeholders of this project. As previously mentioned these specifications will be utilised in the later stages of this project when developing the ICARUS training material.

2. Survey Design for Identifying the Needs of the HEI Trainers and Learners

Survey Aim & Objectives

The aim of this survey was to determine the ICARUS training needs and requirements for HEI trainers and learners. As with any development process it is important to first understand the needs of the users who will be utilising the product or service being developed. Therefore in this project the first step is to properly understand these needs in order to cater for them in the later stages of the project.

Specifically, the following requirements needed to be understood:

- What skills and knowledge is most required in order to bridge the Industry 4.0 gap amongst the different learning groups.
- What are the learning methods preferred by the different learning groups and what learning styles are
- What are the requirements for a mobile training unit capable of demonstrating Industry 4.0 technologies and which can be utilised in tandem with the ICARUS training toolbox.

Skills & Knowledge

The first aspect that needed to be investigated was with respect to the training content itself. If the current skills gap has to be addressed by this project, it is important to understand what the potential learners actually understand to be their lack of knowledge or awareness in certain topics.

In this respect the partnership wanted to understand the potential skills gap with respect to two aspects of Industry 4.0:

- **Industry 4.0 Technology areas**

    The Industry 4.0 technology areas are knowledge and skill aspects related to the development and implementation of Industry 4.0. This is the initial knowledge which is required to start understanding the more advanced and complex applications of Industry 4.0

- **Organizational and Socio Cultural Concepts**

These knowledge aspects such as the Industry 4.0 roadmap, assessment of industrial readiness, key enablers and barriers, operator and sustainability issues in Industry 4.0 are more complex and advanced aspects whose knowledge is typically not readily available. That said, the ICARUS partners that these aspects are fundamental to understand and to truly grasp the real implications of Industry 4.0 beyond what is currently just hype from industry and public policy.

The aim is therefore to develop the specifications for the compendium of learning content on Industry 4.0.

Learning Methods and Styles

In order to understand how it is best to deliver the training content developed by the ICARUS consortium it was decided to investigate the preferred learning methods and the learning styles of the stakeholders. Learning methods are the pedagogic approaches which are utilised to transfer knowledge. These can range from the traditional lecture in HEIs to various forms of digital and online learning. Learning styles refers to the preferential way in which the student absorbs, processes, comprehends and retains information. Learners exhibit various learning styles ranging from the visual to the auditory to the kinesthetic learner. In order to produce a modular toolbox that can be adapted by trainers to suit different learning styles the ICARUS partners decided to investigate the learning styles of the learners. The aim is to develop specifications for a training toolbox which can be adapted based on the learning style of the learner.
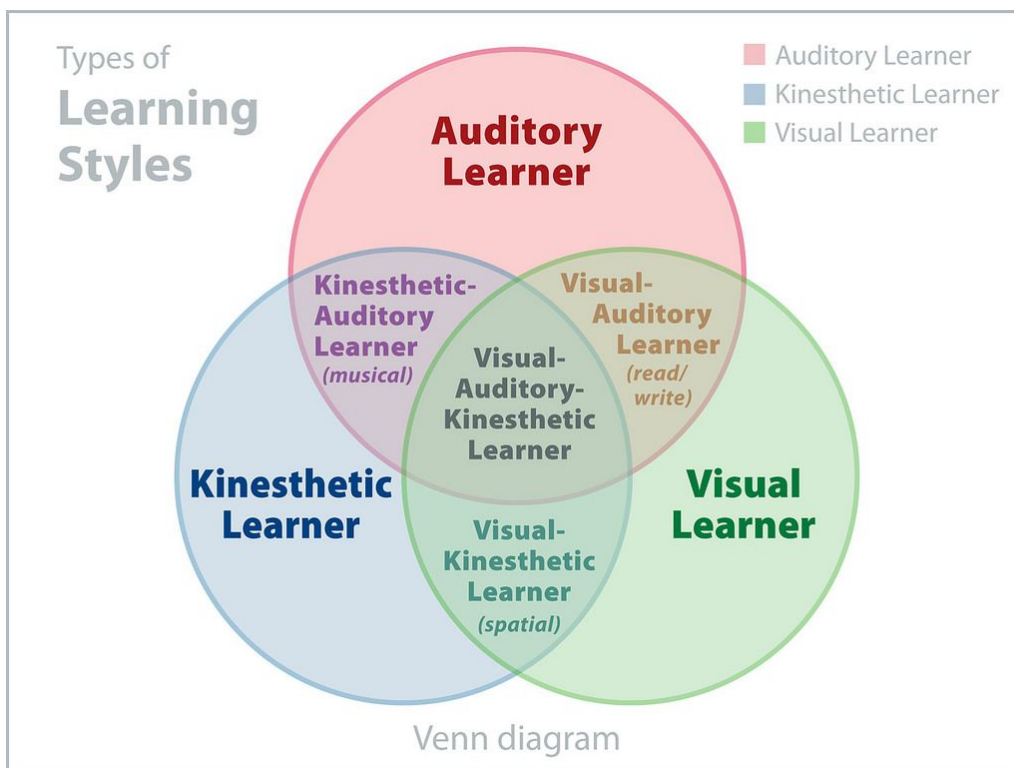
Mobile Training Unit

Another important aspect of this project is the development of a mobile training unit to demonstrate Industry 4.0 technologies as well as to support training. In order to develop a training unit which was suitably adapted to the needs of the trainers the ICARUS consortium needed to understand some of the basic requirements for such a device, such as dimensionality and use. The aim is therefore to develop the specifications for a mobile training unit.

Survey Methodology

During discussions in the first Transnational Project Meeting (TPM-1) the partners determined that the appropriate format of data collection would be via an **online survey**. This would enable all partners to utilise the same format and questions for homogeneity of the data being collected, as well as to facilitate data analysis at a later stage. As lead partner for this work package the UM drafted the survey aimed at understanding the specific current and future training requirements of a sample of HEI trainers and learners. During discussions amongst the partners it was decided that the survey should utilise close ended questions in order to make it possible to quantitatively analyse the data once collected.

As shown in the below image the online survey was implemented using the Google Forms platform, which is a free to use service.

This draft survey was circulated with all the partners for their feedback and comments and updated accordingly. Once the draft survey had been discussed and agreed upon by all partners a final version was created.

Participants

It was also agreed that the ICARUS partners would aim to gather in total amongst all partners/countries between 200 and 250 survey responses. This would provide a

TG1 (Trainers)
Aim: 10-15 per partner

TG2 (Past HEI)
Aim: 10-15 per partner

TG3 (Current HEI)
Aim: 25-30 per partner

In order to collect the data the ICARUS survey was distributed via several means. This included direct email to academics and students (TG1 and TG3), as well as posting to the ICARUS Facebook page to reach out to past HEI students (TG2), as shown in the figure below.

Research Ethics and Data Protection

Since data is being collected from participants of this study the UM submitted a self-assessment on Ethics & Data Protection. Since no personal, identifying data is being collected no ethical or data protection issues were raised. The Ethics and Data Protection

form (See Appendix II) was also submitted to the Faculty of Engineering Research and Ethics Committee for records.

Survey

Questionnaire Introduction

As shown in the Figure below, the first part of the survey started with an introduction to the ICARUS project and the aims and objectives of this survey.


Part 1 - Participant Background

In order to carry out some statistical analysis and comparison between target groups, and also to ask relevant questions to the different respondents Part 1 of the survey collected the participants' background. Participants were therefore asked if they were current or past engineering students (TG2 & 3), or if they were HEI academics. Participants were also asked for their country such that it could be confirmed if there were any specific differences between countries.

Part 2 - Mobile Training Unit

The second part of the survey was dedicated to answering questions about the needs for the mobile training unit. This part of the questionnaire was only available to those who responded as academics/lecturers in the first part of the survey, since they would be the main users of this setup. Since the questions were relating specifically to the Mobile Training Unit, a conceptual image was developed in order to give participants an idea of the components/general configuration of the setup.
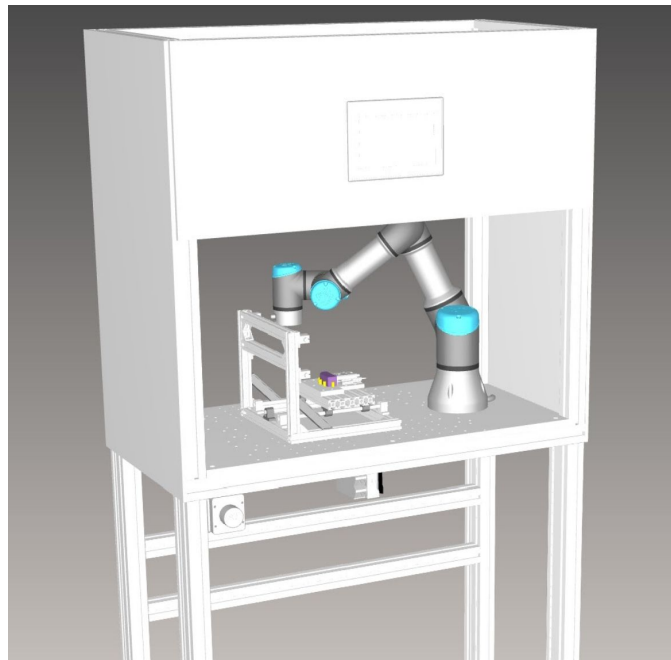
Participants were asked if they would be willing to use such a setup in their classes, if they would need it to be portable, and if yes would they need to transport it outside of their institutions and how.

Part 3 - Industry 4.0 Skills & Knowledge

Part 3 of the online survey investigated the current Industry 4.0 knowledge of the respondents. They were asked how knowledgeable they felt with respect to several industry 4.0 technology areas (e.g. big data analytics, collaborative robotics, cybersecurity, etc.) and Industry 4.0 organisational concepts. A likert scale ranging from 5 - Very knowledgeable, to 1 - Not knowledgeable was utilised in order to quantify the responses.

Part 4 - Learning Method

The next part focused on the preferred learning methods of the participants. A number of diverse learning methods from e-learning to laboratory and group work were presented to the

participants. Since the ICARUS project aims to develop a digital toolbox, participants were also asked which elements of an e-learning system would make it more engaging for them.

Part 5 - Learning Style

Finally through the use of a number of short questions Part 5 aimed at understanding what are the different learning styles of the learners interested in the ICARUS content. The method used was based on the Index of Learning Styles (ILS) by Felder and Silverman. The ILS is a method which assess learning styles on four dimensions of a learning model:
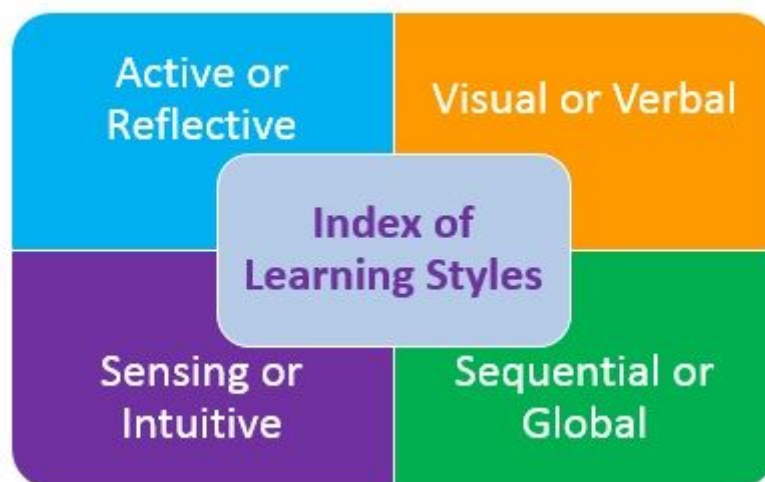
The ILS questionnaire (40 questions) results create a profile that indicates a learner's preferences. A person's learning style profile provides an indication of probably strengths and possible tendencies. According to Felder and Silverman the model has four dimensions of learning styles. Each of the four scales of the index of learning styles has two opposite preferences.

Since this final part of the questionnaire was quite intensive in the number of questions that needed to be answered it was decided by the ICARUS partners that this would be made elective to the respondent whether they wanted to participate in this final set of questions. In this way if the respondents had time constraints and could not continue answering the questions the previous responses would not be lost.

Questionnaire Closure

Once the respondents submitted their responses they were thanked for taking time to participate in this survey and for supporting the ICARUS Erasmus+ project. They were also asked to provide their email address so that the ICARUS partners may keep them updated with the project results, and also with events being organised by the ICARUS consortium.

3. Industry 4.0 Training Needs in HEI

Results of Part 1 - Participant Background

Q1: What is your current academic background?

- 🔵 Current Undergraduate Engineering Student
- 🔴 Current Postgraduate (Masters) Engineering Student
- 🟠 Current Postgraduate (PhD) Engineering Student
- 🟢 Past engineering student employed in Industry
- 🟣 Lecturer/Professor in an Engineering Faculty

Q2: Country of residence

- 🔵 Malta
- 🔴 Sweden
- 🟠 Italy
- 🟢 Portugal
- 🟣 Romania
- 🔵 Spain
- 🩷 Germany
- 🟢 Switzerland

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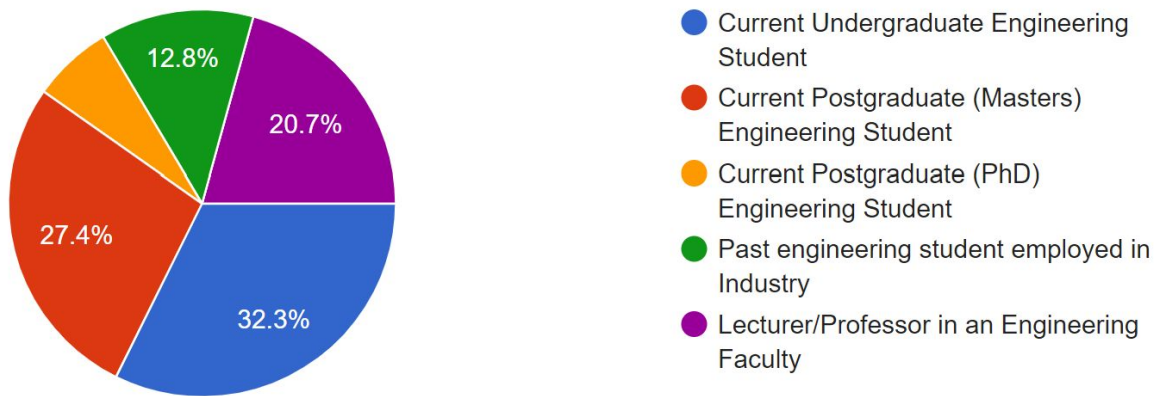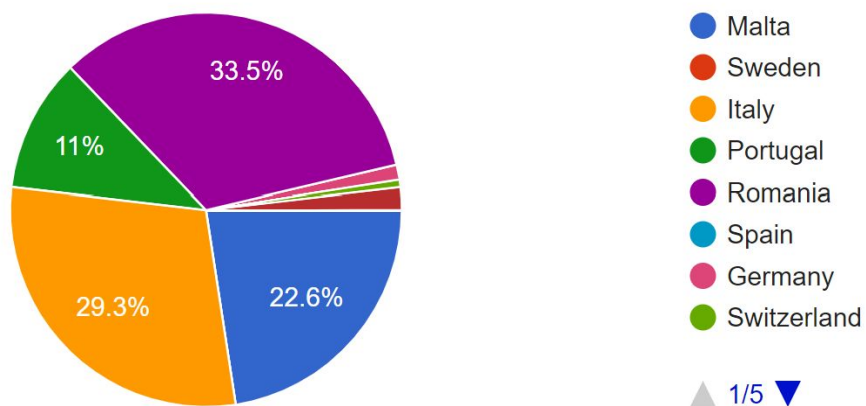
Results of Part 2 - Mobile Training Unit

Q3: Would you prefer an active or passive demonstrator?

Q4: Would you need to transport this equipment out of your Faculty/University?

Q5: If you answered yes to Q4, would you need to transport this equipment in your personal vehicle or in a Faculty/Rental van.

Results of Part 3 - Industry 4.0 Skills & Knowledge

Q3: How knowledgeable are you in Industry 4.0 Technology Areas?

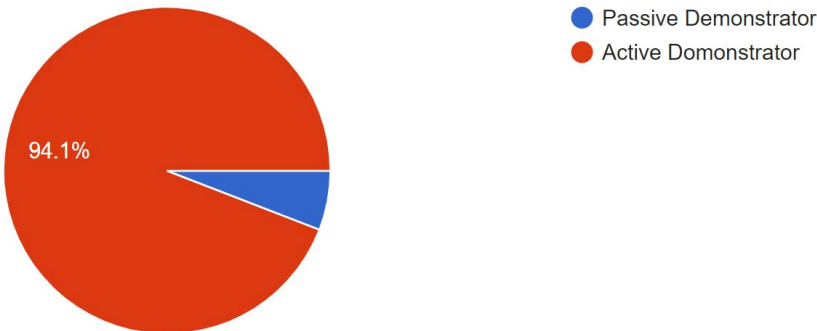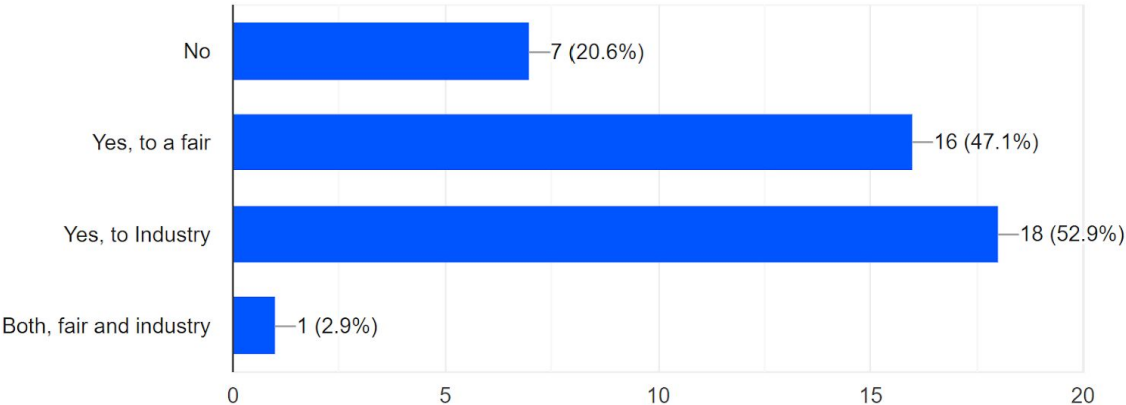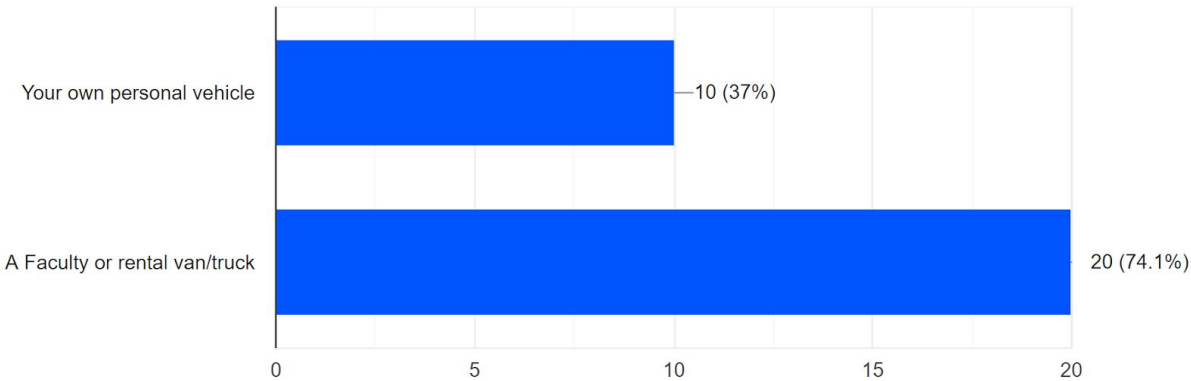|	Average (1-5)	1 - - - 5
Big Data Analytics	2.56	
Autonomous & Collaborative Robotics	2.93	
Simulation	3.16	
Horizontal and Vertical Data Integration	2.42	
IIoT	3.23	
Cybersecurity	**2.36**	
Cloud Computing	2.64	
Additive Manufacturing	**3.64**	
Augmented & Virtual Reality	3.26	

Q4: How knowledgeable are you in Industry 4.0 organisation and social concepts?

	Average (1-5)	1 - - - 5
Digital Transformation in Industry 4.0	**3.16**	
Change management in Industry 4.0	2.93	
Work 4.0 and Operator 4.0	2.81	
Cyber Security Issues in Industry 4.0	**2.38**	
Training concepts for Industry 4.0	2.68	
Sustainability and Ethics in Industry 4.0	2.91	

Comparative Analysis between Target Groups:

	Trainers	Past Students	Current Students
Big Data Analytics	**2.74**	**2.93**	**1.57**
		Skills Gap	
Autonomous & Collaborative Robotics	**2.89**	**2.36**	**1.97**
	Skills Gap		

Results of Part 4 - Learning Method

Q5: Preferred Learning Method

	Average (1-5)	1 - - - 5
E-Learning	3.41	
Face-to-Face Lecturer	4.09	
Face-to-Face Group Work	3.86	
Laboratory Work	**4.23**	
Case Studies	3.99	
Online Collaborative Work	**3.10**	

Q6: Which elements of an e-learning system would make it more engaging?

	Average (1-5)	
Complementary Images	4.26	
Interaction with Trainer	4.09	
Inclusion of Audio Clips	3.78	
Complementary Video	**4.28**	
Online Quizzes	3.87	
Availability on Phone	**3.51**	

Appendix I - Survey Questionnaire

Part 1 - User Information

1. Country

Drop Down?

2. Target Group

Current Engineering Student
Working in Industry and Following an MSc
Past Engineering Student
Lecturer

Part 2 - Mobile Training Unit

3. Would you prefer a passive demonstrator where students watch or would you prefer an active experiment unit where students interact with the equipment?

4. Would there be the need to transport this equipment out of your Faculty/University? For example to take to a fair, or to Industry.

5. Would there be the need to transport this equipment out of your Faculty/University? For example to take to a fair, or to Industry.

Part 3 - Industry 4.0 Skills & Knowledge

6. Rate the following Technologies in terms of their importance for your future work and career:

- Big Data Analytics
- Autonomous & Collaborative Robotic
- Simulation
- Horizontal And Vertical System Integration
- The Industrial Internet Of Things
- Cybersecurity
- Cloud Computing
- Additive Manufacturing
- Augmented & Virtual Reality

7. Rate the following soft skills in terms of their importance for your future work and career:

- Collaboration
- Problem Solving
- Communication
- Leadership
- Self Learning

Part 4 - Learning Method

8. What learning methods do you prefer?
- Case Studies
- eLearning
- Teacher Centred (Lecture)
- Group Work
- Laboratory Work
- Online Collaborative Work

9. Which elements of an e-learning system would make it more engaging for you:
- Good Images
- Interaction with Trainer
- Audio
- Video
- Quizes
- View from Phone

Part 5 - Learning Style

Choose the answer which best explains your preference and circle the letter(s) next to it. Please circle more than one if a single answer does not match your perception. Leave blank any question that does not apply.

1. I need to find the way to a shop that a friend has recommended. I would:
a. find out where the shop is in relation to somewhere I know.
b. ask my friend to tell me the directions.
c. write down the street directions I need to remember.
d. use a map.

2. A website has a video showing how to make a special graph or chart. There is a person speaking, some lists and words describing what to do and some diagrams. I would learn most from:

a. seeing the diagrams.
b. listening.
c. reading the words.
d. watching the actions.

3. I want to find out more about a tour that I am going on. I would:
a. look at details about the highlights and activities on the tour.
b. use a map and see where the places are.
c. read about the tour on the itinerary.
d. talk with the person who planned the tour or others who are going on the tour.

4. When choosing a career or area of study, these are important for me:
a. Applying my knowledge in real situations.
b. Communicating with others through discussion.
c. Working with designs, maps or charts.
d. Using words well in written communications.

5. When I am learning I:
a. like to talk things through.
b. see patterns in things.
c. use examples and applications.
d. read books, articles and handouts.

6. I want to save more money and to decide between a range of options. I would:
a. consider examples of each option using my financial information.
b. read a print brochure that describes the options in detail.
c. use graphs showing different options for different time periods.
d. talk with an expert about the options.

7. I want to learn how to play a new board game or card game. I would:
a. watch others play the game before joining in.
b. listen to somebody explaining it and ask questions.
c. use the diagrams that explain the various stages, moves and strategies in the game.
d. read the instructions.

8. I have a problem with my heart. I would prefer that the doctor:
a. gave me something to read to explain what was wrong.
b. used a plastic model to show me what was wrong.
c. described what was wrong.
d. showed me a diagram of what was wrong.

9. I want to learn to do something new on a computer. I would:
a. read the written instructions that came with the program.
b. talk with people who know about the program.
c. start using it and learn by trial and error.
d. follow the diagrams in a book.

10. When learning from the Internet I like:
a. videos showing how to do or make things.
b. interesting design and visual features.
c. interesting written descriptions, lists and explanations.
d. audio channels where I can listen to podcasts or interviews.

11. I want to learn about a new project. I would ask for:
a. diagrams to show the project stages with charts of benefits and costs.
b. a written report describing the main features of the project.
c. an opportunity to discuss the project.
d. examples where the project has been used successfully.

12. I want to learn how to take better photos. I would:
a. ask questions and talk about the camera and its features.
b. use the written instructions about what to do.
c. use diagrams showing the camera and what each part does.
d. use examples of good and poor photos showing how to improve them.

13. I prefer a presenter or a teacher who uses:
a. demonstrations, models or practical sessions.
b. question and answer, talk, group discussion, or guest speakers.
c. handouts, books, or readings.
d. diagrams, charts, maps or graphs.

14. I have finished a competition or test and I would like some feedback. I would like to have feedback:
a. using examples from what I have done.
b. using a written description of my results.
c. from somebody who talks it through with me.
d. using graphs showing what I achieved.

15. I want to find out about a house or an apartment. Before visiting it I would want:
a. to view a video of the property.
b. a discussion with the owner.
c. a printed description of the rooms and features.
d. a plan showing the rooms and a map of the area.

16. I want to assemble a wooden table that came in parts (kitset). I would learn best from:
a. diagrams showing each stage of the assembly.
b. advice from someone who has done it before.
c. written instructions that came with the parts for the table.
d. watching a video of a person assembling a similar table.

Questionnaire Closure

Thank you for taking this survey and for supporting the ICARUS Erasmus+ project. Should you wish to remain updated with our progress please enter your email below so that we may keep you updated with the project results, and also with events being organised by the ICARUS consortium.

Project Partners:

ICARUS - AN INNOVATIVE HIGHER EDUCATION INSTITUTION TRAINING TOOLBOX TO EFFECTIVELY ADDRESS THE EUROPEAN INDUSTRY 4.0 SKILLS GAP AND MISMATCHES

Project Nr: 2019-1-MT01-KA203-051265