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SmartDIGI project Methodology

1. Introduction

SmartDIGI project is focusing on boosting the participating EIT RIS countries' innovation performance by improving their educational schema and promoting digitalization with respect to Industry 4.0. SmartDIGI aims to support SMEs to test and adopt digital technologies as well as to adopt lifelong learning culture to improve the digital skills of their workforce, essential for the digital transformation of the businesses.

To this end, the activity intends to provide a program, where students, academics, and manufacturing SMEs work together to build skills by co-creating solutions to real manufacturing challenges. Therefore, Teaching and Learning Factory approaches are combined with information open events to apply jointly developed solutions to industrial problems.

Close collaboration among industry and academia can be one of the key factors for the creation of a lifelong learning culture and for the upgrading of skills of the workforce in the manufacturing industry. Therefore, this document presents and promotes the methodology, based on which the SmartDIGI project is implemented. These teaching and learning methods can be universally applied by other academia and industry representatives, who aim to improve their performance by mutual cooperation.

2. SmartDIGI Model

2.1 Training and Learning Actions

2.1.1 Teaching Factory

As defined by the EIT-Manufacturing, a Teaching Factory [1] is a collaboration space where practitioners bring experience from the factory to teach students, while students and faculty bring knowledge from the classroom to teach practitioners. This collaboration is supported with a web conferencing platform and is an ongoing process, with regular sessions and continuous interaction between the factory and the classroom.

The TF paradigm aims to align manufacturing teaching and training to the needs of modern industrial practice. Future engineers need to be educated with a new curriculum in order to cope with the increasing industrial requirements of the factories of the future. The TF paradigm comprises of the relevant

[1] https://www.eitmanufacturing.eu/what-we-do/education/resources/teaching-factory/

educational approach and the necessary ICT configuration for the facilitation of interaction between industry and academia. The TF aims at a **two-way knowledge communication between academia and industry**. Knowledge channels of the paradigm are presented, in the context of this work, within real-life industrial applications. The TF paradigm provides a real-life environment for students and research engineers to develop their skills and comprehend the challenges involved in everyday industrial practice.

2.1.2 Learning Factory

The EIT-Manufacturing introduces the Learning Factories[2] as complex learning environments for the manufacturing context that contain authentic **replicas of real production systems and value chains**, so that participants can learn based on experiences, in a hands-on fashion. They are simplified for didactic reasons and reproduced inside a lab to train students. Learning Factories have been used in universities and industry for many years now.

Unlike a Teaching Factory, students in a Learning Factory do not work on real challenges. Due the didactical nature of Learning Factories, there are different types of Learning Factories that use different type of equipment depending on the focus of the Learning Factory.

Learning Factories have shown to be effective for developing theoretical and practical knowledge in a real production environment. The proposed transformations were based on the definition of three pillars (didactic, integrating and engineering) for the development of a Learning Factory. A proper transformation process may contribute to ease the path towards new manufacturing trends such as industry 4.0 into an academic context that strengths the engineering training process.

especially true for technical competencies where the expert must already have these capabilities.

2.2 "The Training the Trainers" Method

By "training the trainers" we mean to arrange a series of learning sessions with TF organizers that will be part of the TF/LF methodology **aiming at improving the TF/LF implementation**.

Topics could be: selecting challenges and SMEs engagement, facilitating & coaching of innovation teams, problem-solving & ideation methods and open innovation.

Also, this training activity should help to achieve a better implementation of TF/LF activities and to evaluate the success (criteria).

- **Objective:** improving the TF/LF implementation (TF/LF organizers learn about the process)

[2] https://www.eitmanufacturing.eu/what-we-do/education/resources/learning-factory%e2%80%8b/

- Participants: local TF facilitators (consortium partners involved in TFs)

- Description: Process consisting of a series of sessions (at least 3):

1. **Definition**: We follow the step-by-step guide of how to set up a TF. We share in a session **how we are defining the TF**: concerns, support needed, ideas about selection of participants, industrial challenges, the topics (knowledge)… we can have this one in the face-to-face meeting in Prague (before or at the beginning of the definition of the TF pilots).
2. **Implementation**: we share about **tools to work with students** in TFs (for ideation, prototyping, …) we share the **current status** of implementation of the TF. Also, we can share about the results of the TFs, how we **evaluate** them. We could have one or more sessions, at beginning of sept. (During online meetings).
3. **Reflection**: after the implementation, **sharing experience and results**. We share evaluation of TF by students and companies. **Evaluate the process**. (We can have one session during online meetings in November).

   An output here is an update of the How to set up a TF step-by-step guide.

3. Guidelines for Setting up a TF

This is a one-page guide easy to follow that provides guidance of the steps and aspects that need to be considered when creating a Teaching Factory[3]. A TF is collaboration space where practitioners bring experience from the factory to teach students, while students and faculty bring knowledge from the classroom to teach practitioners. So it's theoretically a two-ways learning process, which is supported with ICT means that allows the easy interaction between the factory and the classroom.

Step 1: Design of The Teaching Factory

1. THEMATIC AREA. There are some aspects that need to be defined and first one is the technologies involved in the TF. What kind of knowledge and skills (technological or transversal) do we want to develop in the factory and in the classroom?
2. NEED OF THE INDUSTRY. Then we start designing the TF first of all identifying the real-life industrial challenge or problem that will be brought by the company to the faculty, and/or the knowledge or research results that students from the classroom will bring to the industrial context to teach

[3] Panos Stavropoulos, Alexios Papacharalampopoulos, Harry Bikas, Lydia Athanasopoulou, Anna-Maria Korfiati, et al.. Complementarity of European RIS Territories Towards Manufacturing Educational Products. 22nd IFIP WG 5.5 Working Conference on VIRTUAL ENTERPRISES, PRO-VE 2021, Nov2021, Saint-Etienne, France. 9p, 10.1007/978-3-030-85969-5_70. emse-03350277

practitioners. This needs to be summarized in a simple and standard document that comprises all the information needed (called sometimes Request for Proposals). This step is critical, and although it might demand having several meetings with companies it's time well spent.

3. TARGET AUDIENCE. Who are going to be trained? Specify the students (graduate, post-graduate, professionals…) and also the practitioners from the industrial companies. The definition of the learning needs and the participants would be done together most of the times.
4. ENGAGEMENT OF ACTORS IN THE PILOT
5. DEFINE EVALUATION ASPECTS. Therefore, there is an evaluation of the students that they complete themselves (a self-assessment) and an external evaluation done by a tutor/teacher.
   Also, there is an evaluation of the process of the TF itself aiming at improving any aspect of the TF design and implementation, and for this purpose companies and Universities will fulfil a questionnaire.

Step 2: Preparation of the Pilot

1. PILOT DESIGN AND IMPLEMENTATION PROCESS: Considering the context and the amount of learning objectives now it's the time to set up the number of sessions and interactions with the faculty students and the company professionals. The students will also have some tutorized meetings with the teacher so to have feedback and follow up the progress.
2. MATERIAL DESIGN. In parallel students and professional might follow a learning path of nuggets or other resources to get specific knowledge and skills relevant for the TF objectives. Therefore, there is a selection of nuggets and other learning sources.
3. EVALUATION DESIGN. We define the level of skills and the knowledge that participants will develop, and also the tools that will be used to evaluate the acquisition of those skills and knowledge.
4. CERTIFICATON DESIGN

Step 3: Pilots Implementation

The TF will be implemented as designed and set up in the previous step. It's convenient to follow up the process considering that some unexpected events might occur, therefore having in mind always the TF final objectives.

1. SCHEDULE THE PILOT SESSIONS AND DEFINE COMMUNICATION
2. RUN THE SESSIONS

Step 4: Evaluation

1. DO THE EVALUATION. Self-evaluation of trainees, evaluation of industry's engagement and evaluation of trainees by experts. Evaluate the knowledge acquisition, the development of technical and transversal skills.
2. PROVIDE CERTIFICATION

Step 5: Assessment of the Teaching Factory

1. ASSESSMENT OF THE TF. The last step is the assessment of the TF. This is the assessment if the purpose of the TF has been fulfilled, changes to do to improve the TF.
2. NEXT STEPS.

4. Conclusion

The setup of Teaching Factories and Learning Factories in the partners' regions requires a methodological basis, as well as guidelines for the design and implementation of the pilots. SmartDIGI aims to support SMEs to adopt digital technologies as well as to adopt lifelong learning culture to improve the digital skills of their workforce, essential for the digital transformation of the businesses and the uptake of Industry 4.0 technologies.

SmartDIGI suggests different knowledge exchange schemes in the pilot activities but considering always the need of a close collaboration among industry and academia as one of the key factors for the creation of a lifelong learning culture and for the upgrading of skills of the workforce in the manufacturing industry.

Teaching Factories and Learning Factories are being consolidated in the last years as successful concepts that can be useful tools for bridging the gap of skills in manufacturing. The implementation of new pilots and the development of new elements such as "train the trainers" method help to assure the quality in the definition, implementation and evaluation of TF and LF, reinforce the concept and add more examples to spread the concept across Europe.