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Analysis of Human Skills in Industry 4.0

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INTRODUCTION

Industrial companies, subject to constant competitive pressure change, are becoming faster and more unpredictable. It has considerable consequences on their investments and their competitiveness, highly dependent on knowledge, skills and creativity of their workforce. In recent years, significant progress in the digital domain confirms that we are entering the era of the "4th industrial revolution". The rise of robotics, automation and artificial intelligence has made technology a big challenge for industrials to prepare their present and future workforce to thrive in this changing world.

INTRODUCTION

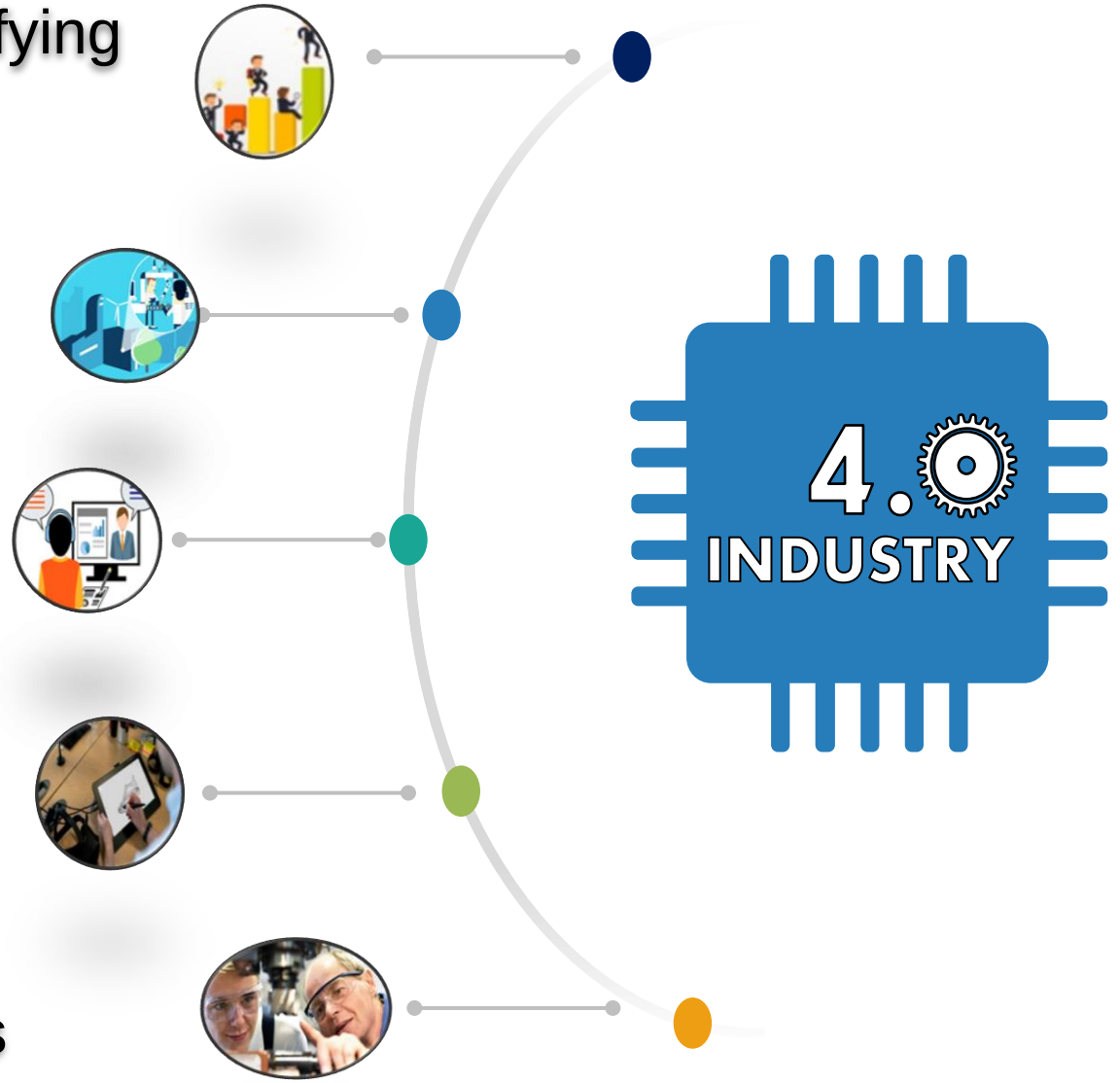
* the challenges that companies face in qualifying employees with the necessary skills,

*new learning approaches to tailor engineering education to the industry 4.0.

*specific modules to integrate them into teaching programs and adapt them to Industry 4.0.

* the transformation of education itself according to the needs of Industry 4.0.

*new concepts of learning factories to allow students to discover production environments of type 4.0

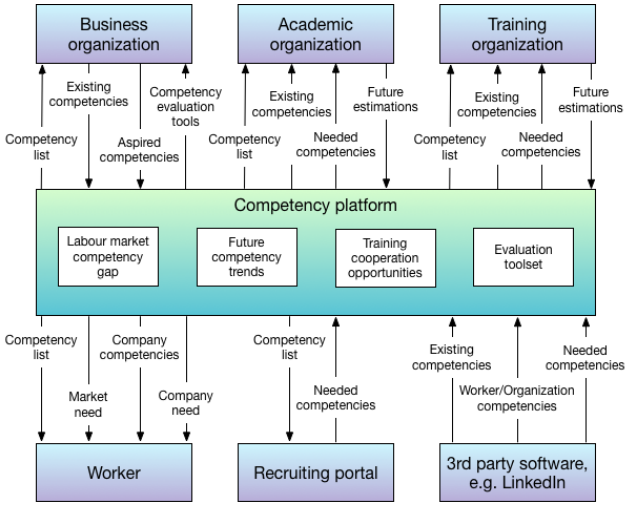


THE ISSUES AND CHALLENGES RELATED TO SKILLS FACE INDUSTRY 4.0

In a globalized world with highly interconnected processes, companies are faced to an increasing number of challenges, particularly in terms of adapting their skills to the automation and digitization underway. In this context, research of great importance and surveys are carried out to find solutions to face the challenges of Industry 4.0.

THE ISSUES AND CHALLENGES RELATED TO SKILLS FACE INDUSTRY 4.0

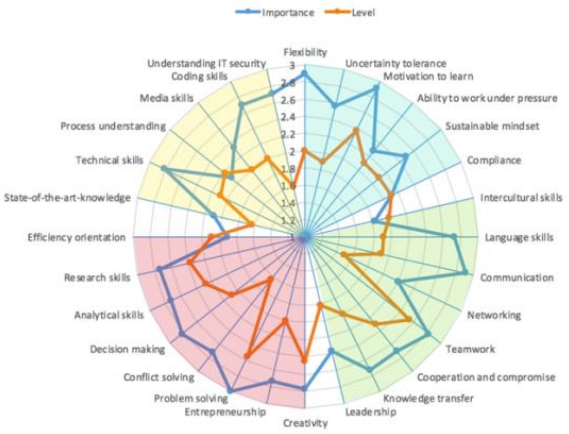
Kusmin et al. 2017 presents a case study of an Estonian ICT company, Proekspert,



where the author defines the skills needed in the context of Industry 4.0 to explore how workers can be included in the future planning process.

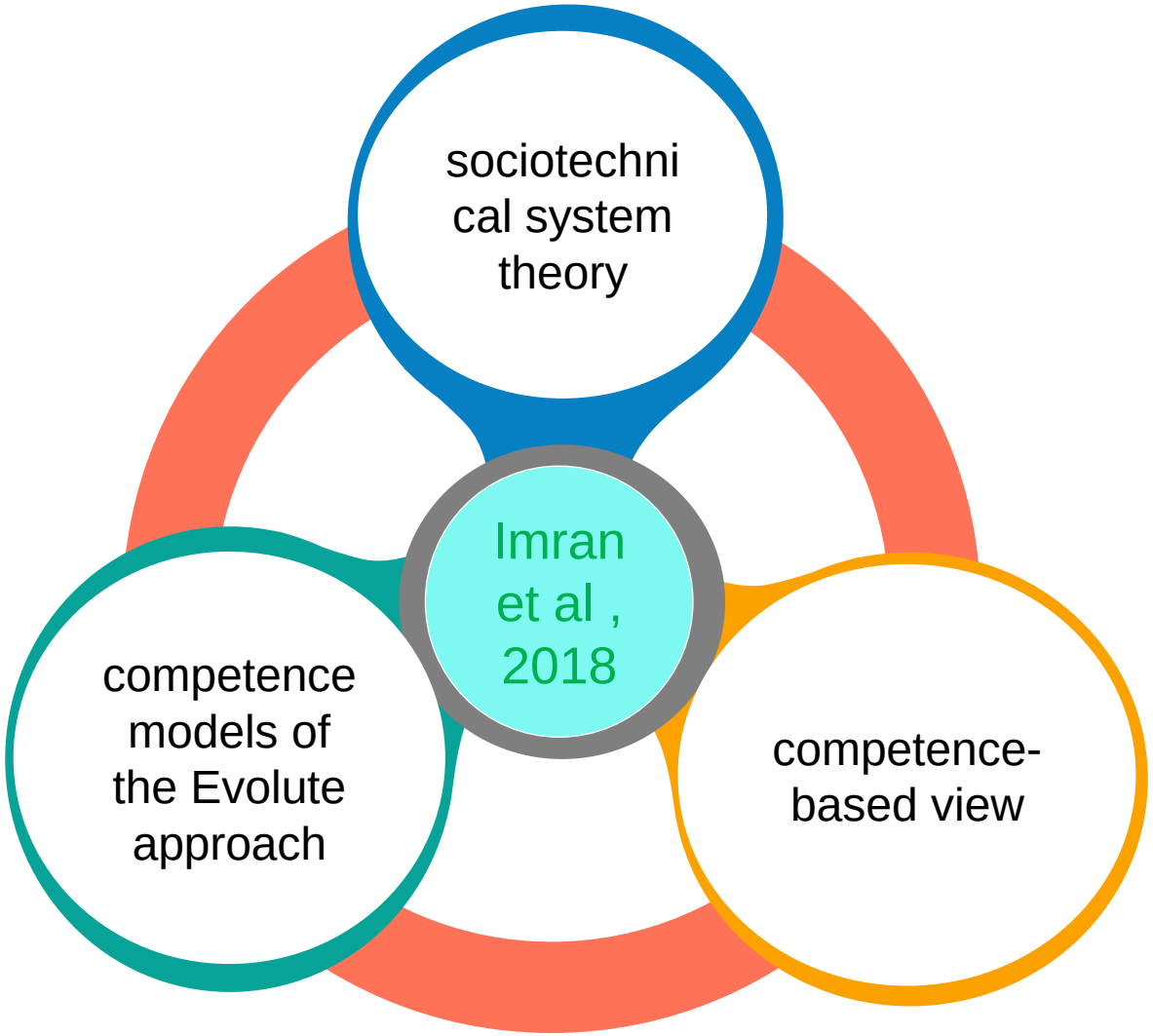
It will help inform the design and development of a unified platform to define and plan the competencies around which a fruitful dialogue of all stakeholders can take place.

It is based on the creation of a prototype instrument to map the perceived skills gap.



THE ISSUES AND CHALLENGES RELATED TO SKILLS FACE INDUSTRY 4.0

is the qualification of future employees with the skills necessary to act and work in the transformed work environment.



THE ISSUES AND CHALLENGES RELATED TO SKILLS FACE INDUSTRY 4.0

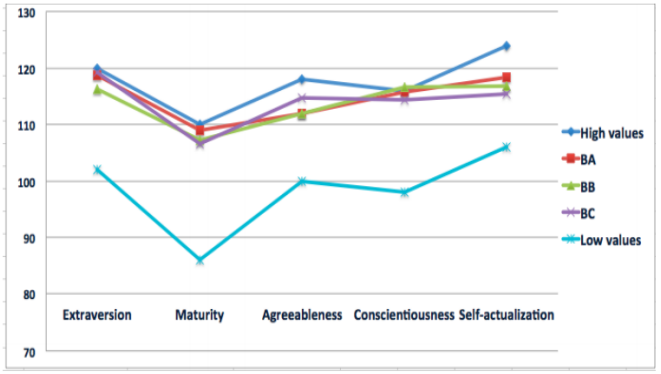


Fig. 3. Comparative average values reported at low and high values for all the five dimensions of ABCD-M

after the application of a complex psychological evaluation system Abcd-M based on a lexical approach system compatible with the Big Five personality traits (OCEAN model) on successive series of students, from Politechnica University in Bucharest.

Cotet et al, 2017 describe a methodology, centered on a mapping of skills and personal qualities necessary to assess the specificity required by the industrial environment 4.0.

THE ISSUES AND CHALLENGES RELATED TO SKILLS FACE INDUSTRY 4.0

Kravcik et al. 2018, provide technological support to help them plan:

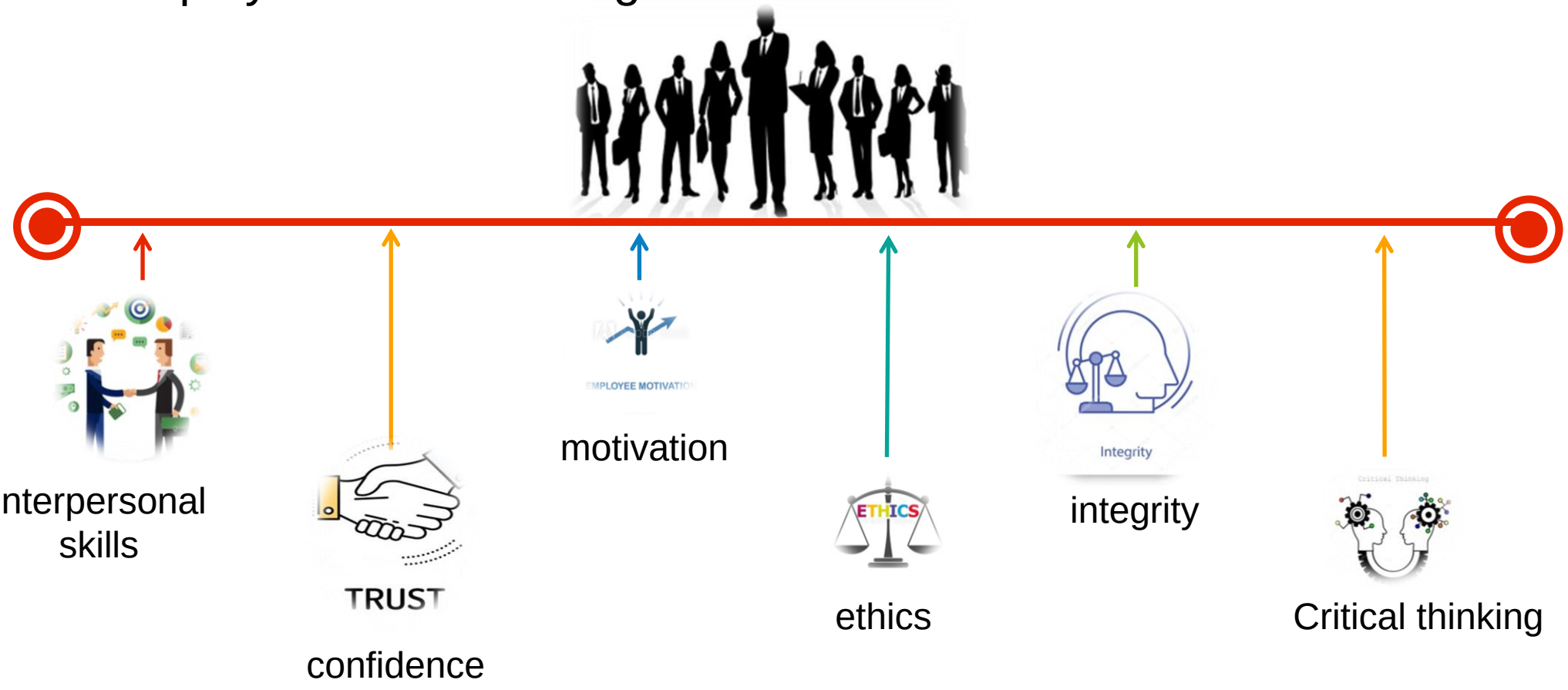
- **plan**
- **direct**
- **monitor the transition process**
- **develop their employees**

This fact belongs to the objective of the ADAPTION project.

A project that aims to individually support SMEs in their transition to Industry 4.0. Its approach is based on models of progress and maturity, taking into account technical, organizational and personal aspects.

THE ISSUES AND CHALLENGES RELATED TO SKILLS FACE INDUSTRY 4.0

in a survey addressed by J. Foutty, 2009, where young workers indicate that the main skills employers need for long-term success are:



INVESTIGATION TO UNVEIL THE REQUIRED SKILLS BY INDUSTRY 4.0

M. Pinzone. 2017, based on a qualitative methodology, to identify technical skills related to 5 organizational areas affected by Industry 4.0

- operations management
- supply chain management
- product-service innovation management
- data science management
- IT-OT integration management

new perspectives relevant to the identification of the needs for recycling, improvement and development of future industrial human capital.

INVESTIGATION TO UNVEIL THE REQUIRED SKILLS BY INDUSTRY 4.0

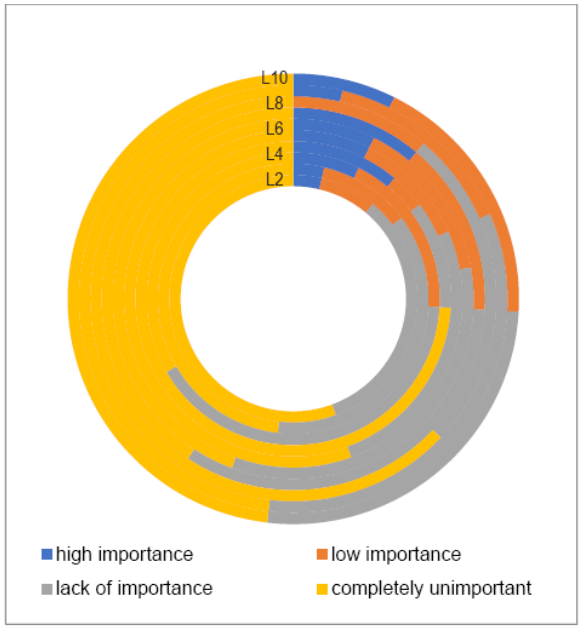


Figure 4.Importance of Employees competences for Industry 4.0 in polish manufacturing companies.

Kasacka et at.2017, in order to diagnose the willingness of Polish companies to implement the concept of Industry 4.0, The authors deduce that the essential soft skills of employees in a modern business will be primarily focused on understanding problems and concepts from other disciplines and being open to change and novelty, they argued that communication skills which are also intercultural, often with the use of virtual tools, will be more important.

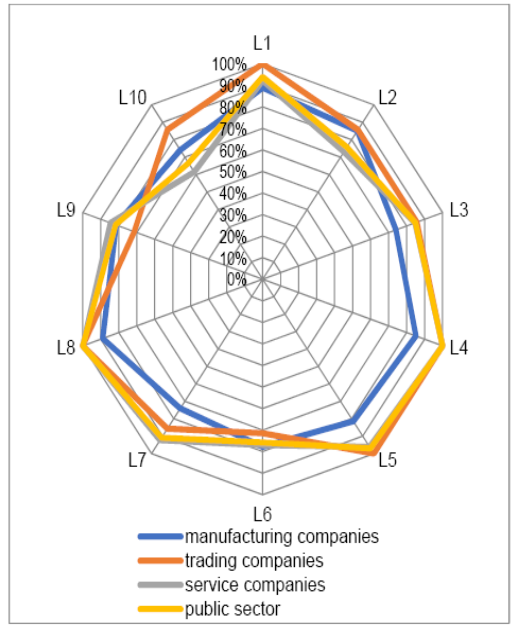


Figure 3. Importance of Employees competences for Industry 4.0 in Polish companies in accordance to the type of business activity.

INVESTIGATION TO UNVEIL THE REQUIRED SKILLS BY INDUSTRY 4.0

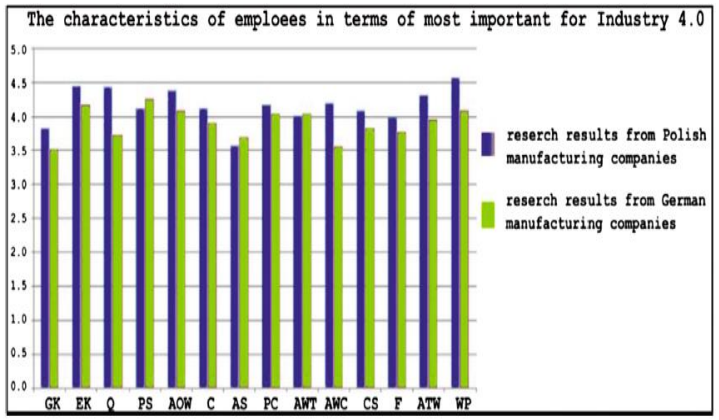


Fig. 1. The most-important characteristics of employees for Industry 4.0. research results from German and Polish manufacturing companies

For the same reason, Patalas et al. 2017, collected data from directors of 85 manufacturing companies, asked to rate employee characteristics according to the most important for Industry 4.0

this study shows the importance of skills, as well as employee characteristics, in the context of the ability to absorb and use new technologies in Industry 4.0

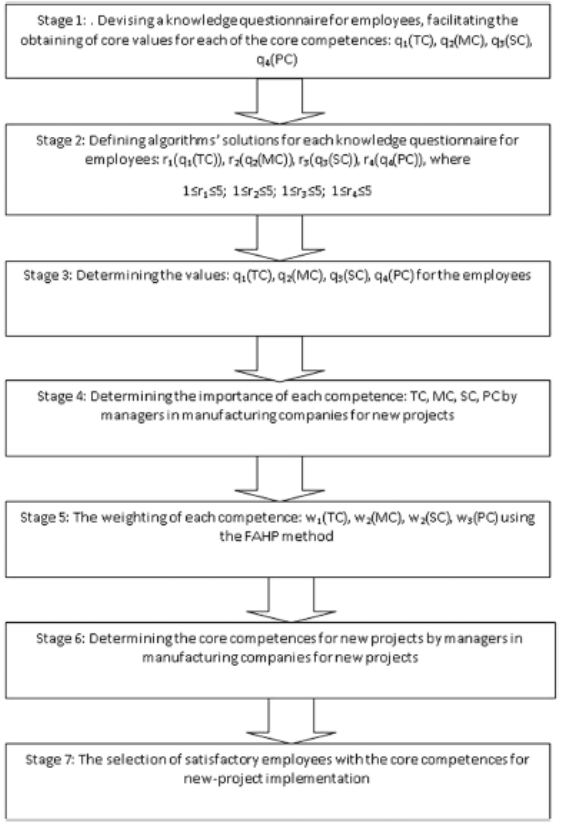


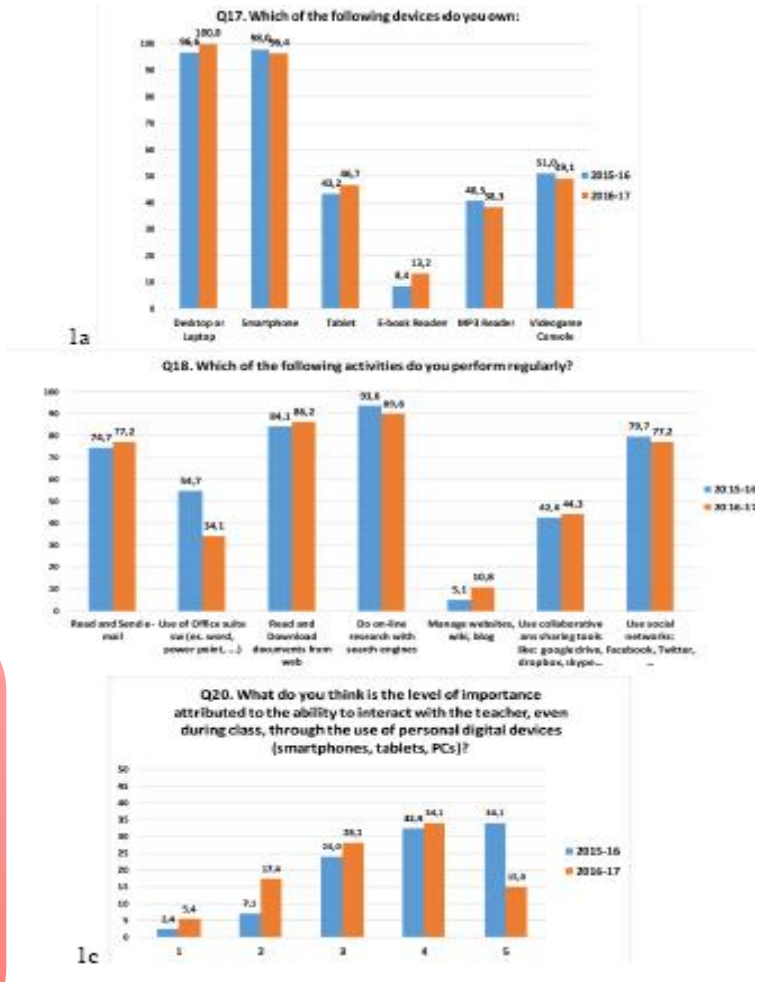
Fig. 3. The concept of an Intelligent system for core-competence identification for Industry 4.0

They got to build an intelligent system to support the selection process of satisfactory employees with the basic skills for the implementation of new projects in Industry 4.0.

INVESTIGATION TO UNVEIL THE REQUIRED SKILLS BY INDUSTRY 4.0

developed by Motyl et al. 2017, at the level of three Italian universities to have an answer to a fundamental question:

"Are our engineering students and teachers really ready for the Industry 4.0 framework?".



the need to create a broader and better structured knowledge of the basic concepts related to this new industrial revolution. Then, this knowledge should be improved and integrated, taking into account the revision of the educational content of the courses, particularly with regard to technical subjects.

INVESTIGATION TO UNVEIL THE REQUIRED SKILLS BY INDUSTRY 4.0

Kozlov et at. 2019

POLYTECH
Peter the Great St.Petersburg Polytechnic University

The status of use of digital technologies and advanced means of communication by students during their studies and their preparation to work for the future digital industry

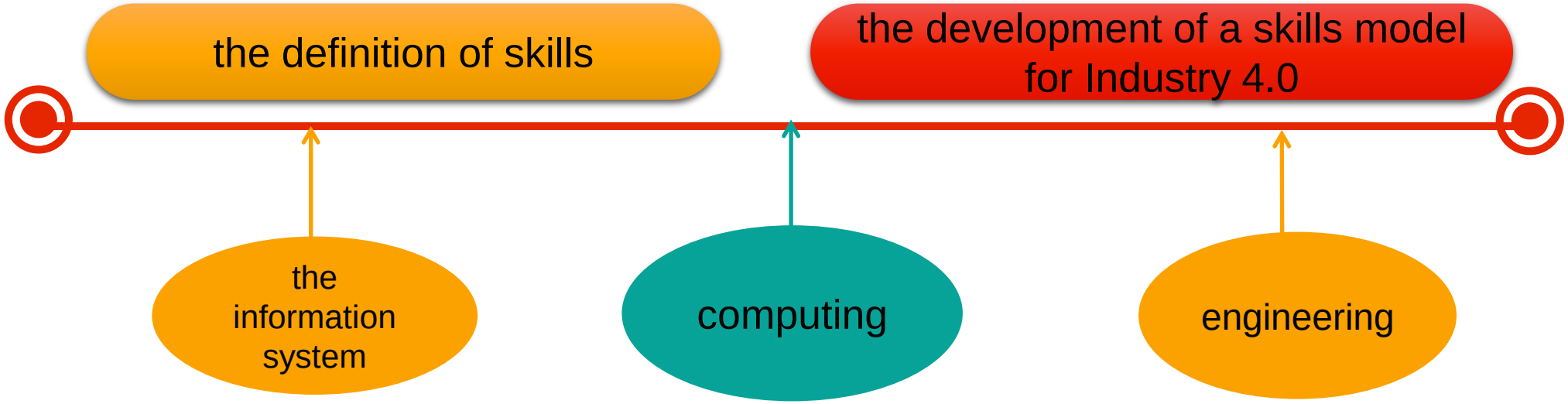
30 to 35% of trainees do not actively use the latest means and communication skills of information technology.

training of university professors in the field of computer science

as well as the development of more mobile applications, practical for use by students during their studies.

INVESTIGATION TO UNVEIL THE REQUIRED SKILLS BY INDUSTRY 4.0

L. Prifti. 2019

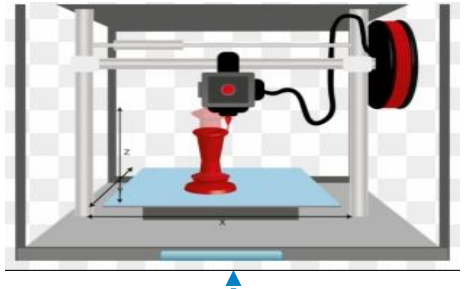


the authors propose a competency model for the professions and develop a curriculum with content that can be applied in these areas of education.

A competency-based curriculum was developed, following a structured didactic approach, for this purpose the SHL competency framework was used, therefore 69 assessed competencies were extracted.

NEW TECHNOLOGIES FACING THE CHALLENGES OF INDUSTRY 4.0

Additive Manufacturing



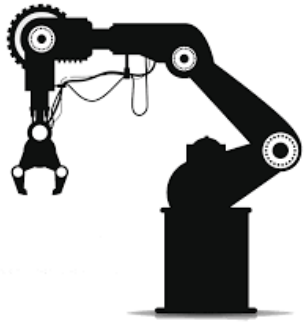
Simulation

Cloud Computing

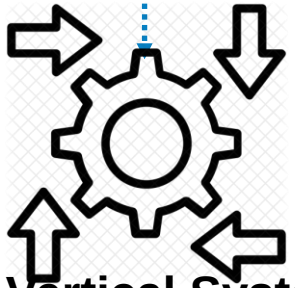
Big Data and Analytics

Augmented Reality

Autonomous Robots



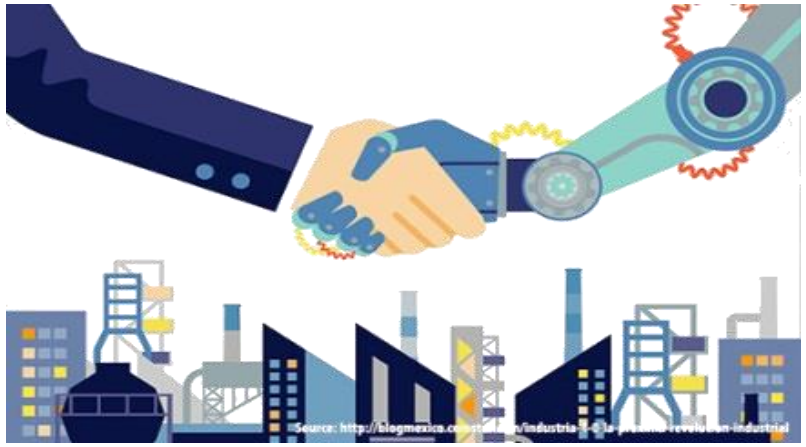
Cybersecurity



Horizontal and Vertical System Integration

THE COURSE TOWARDS ADAPTING HUMAN SKILLS TO INDUSTRY 4.0

The 4th revolution aims to push the industry to move towards connected factories where man and machine collaborate throughout the production process. The digitization of industry requires the rehabilitation of infrastructure and the invention of new methods and processes.



For these reasons, the industry calls university education and research to help them to adapt and qualify their workers according to the needs of Industry 4.0.

THE COURSE TOWARDS ADAPTING HUMAN SKILLS TO INDUSTRY 4.0

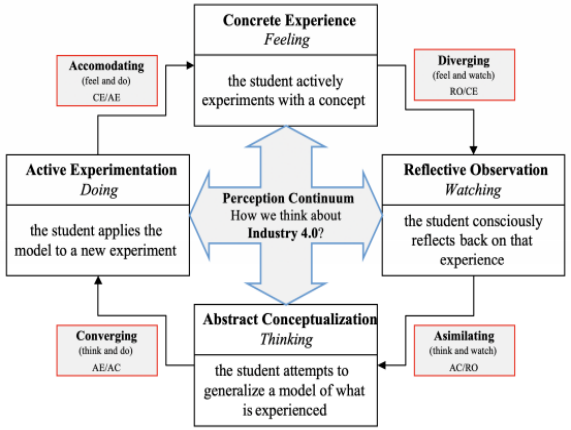


Figure 2. Kolb's learning styles model and experiential learning theory.

Coskum et al. 2019, introduce a roadmap consisting of three pillars outlining the changes / improvements to be made in the areas of curriculum development, laboratory concept and student club activities.

The researchers use a circular model of a four-step experiential learning cycle developed by Kolb. This model is selected as the most appropriate learning theory to adapt engineering education to the vision of Industry 4.0.

Gabor et al. 2017, presents a concept on the development of an information system in order to formalize the reflections of the experts via business scenarios.

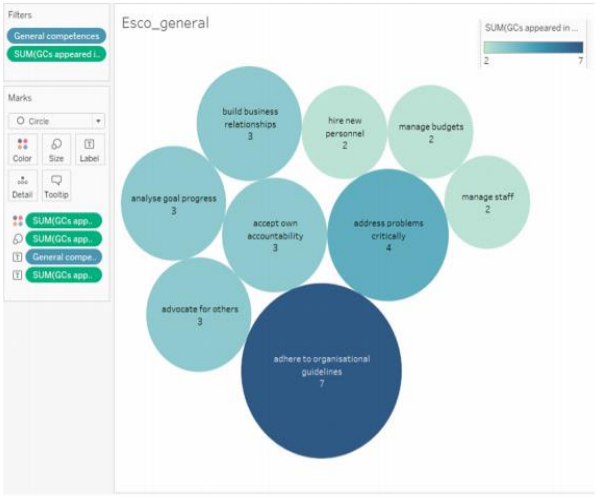


Fig. 2. The distribution of general competences

A system that offers the possibility of testing future scenarios on the effects of technological change on the labor market and determines the skill sets to be analyzed.

THE COURSE TOWARDS ADAPTING HUMAN SKILLS TO INDUSTRY 4.0

For their part, Lee et al. 2019, to conduct a comparative study of two engineering university courses to present the difference between the effect of virtual reality (VR) based education and traditional education on robotics learning.

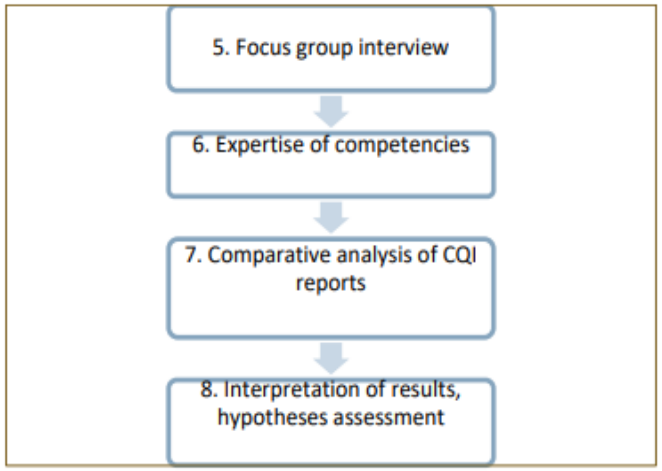


Figure 3. Second step of the research.

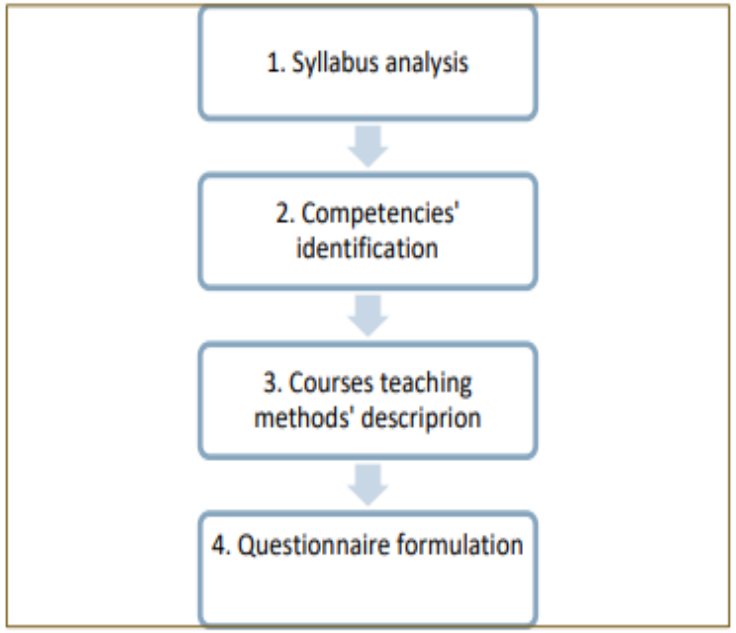


Figure 2. First step of research.

They also analyzed the effect of classroom VR training and found that the Channel Quality Indication (CQI) report had a significant impact on the performance of the teacher's education system.

THE COURSE TOWARDS ADAPTING HUMAN SKILLS TO INDUSTRY 4.0

S. Jaschke. 2014, focuses on the facilitation of (mLearning) mobile learning processes in vocational technical education and engineering as well as its integration into the learning of employment scenarios in Industry 4.0.

learning processes can be triggered by cyber-physical data systems of work processes. This allows mobile training on work scenarios.

L'auteur a proposé d'utiliser des extraits de compétences au lieu de documents complets facilement accessibles via QRCodes, NFC ou des données de processus.

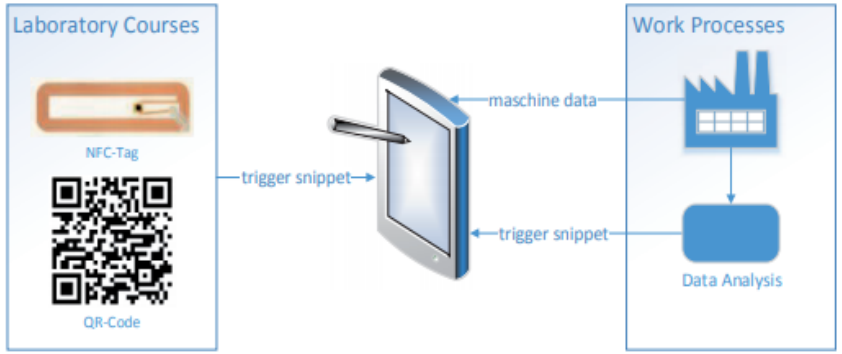
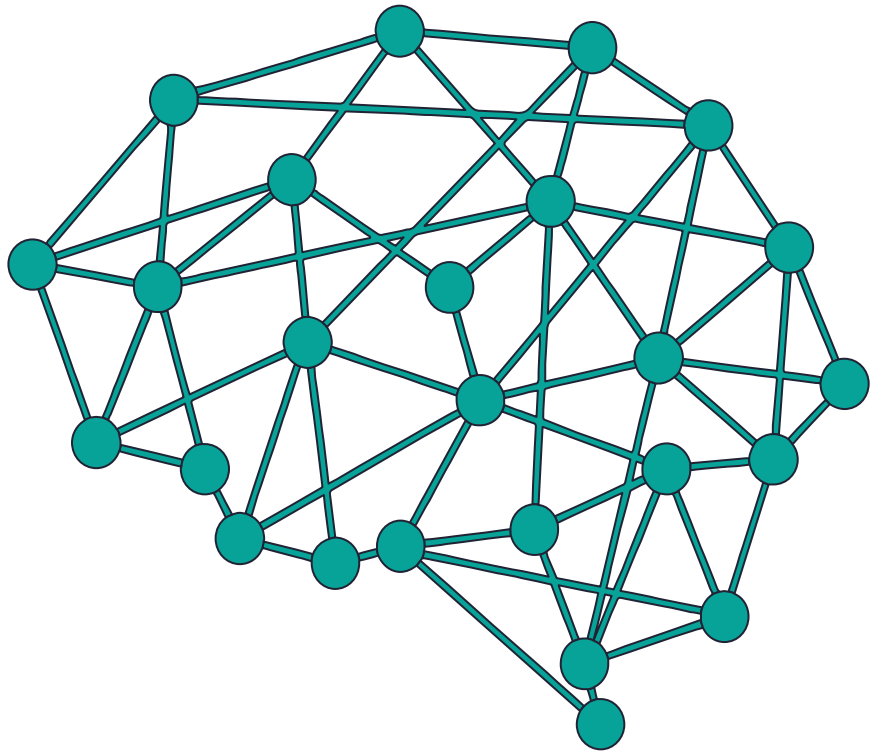


Fig. 2. Trigger snippets by tags and process data

SKILLS APPROACH

All of these challenges require continuous innovation and learning, which depends on the people and capabilities of the business. Appropriate management approaches can play a critical role in developing dynamic capacities and an effective learning and innovation climate.



SKILLS APPROACH

karre et ai. 2017, emphasizes the important role of a learning factory (LeanLab) to improve university education, company training and practical research in the fields of industrial engineering and logistics.

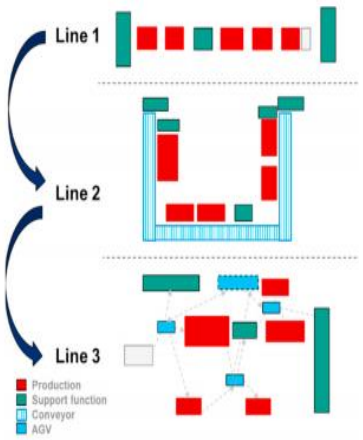


Fig. 1. Layout transformation.

Schallock et al. 2018, describes the design of an Industry 4.0 learning factory that meets the growing demand for future skills from production staff. But it focuses on soft skills such as decision making, group work, and performance monitoring.

Contreras et al.1018, presented a learning model based on serious games, designed for industrial production plants, as a viable alternative for the development of professional skills.

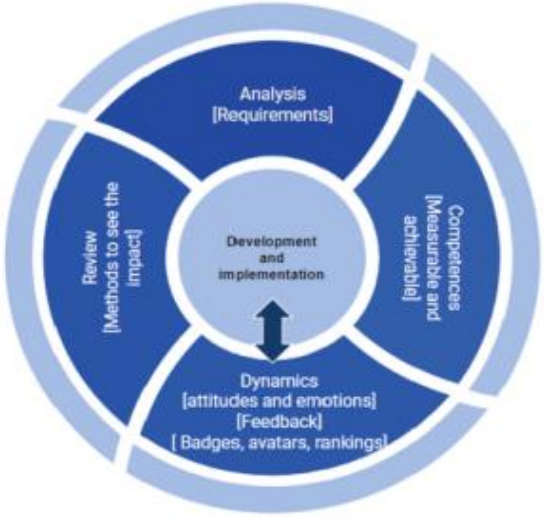


Fig. 3. Fundamental components of the serious games in the Development and implementation stage.

SKILLS APPROACH

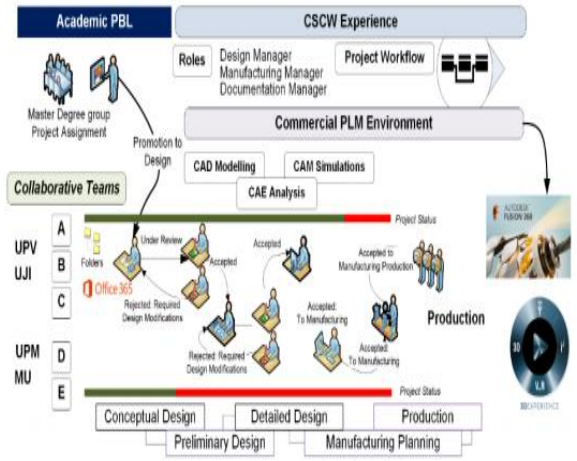


Fig. 2. CSCW Project Based Learning with PLM platforms.

Vila et at.1017, offer project-based learning (PDB) as an approach to provide a learning experience that facilitates the development of Industry 4.0 skills and competencies.

They use Autodesk's Fusion 360 and Dassault Systems' DExperience applications, which have features suitable for implementing collaborative project-based learning.

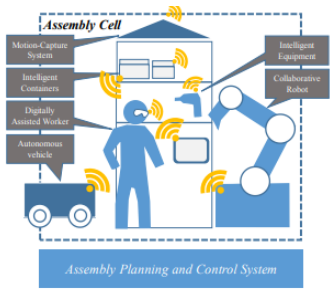


Figure 1: Assembly cell concept for the TU Wien Pilot Factory

Erol et al. 2016, makes the abstract vision of Industry 4.0 more tangible by using a Learning Factory approach in combination with scenario-based learning.

The TU Wien Industry 4.0 pilot plant served as the basic infrastructure for the implementation of this concept.

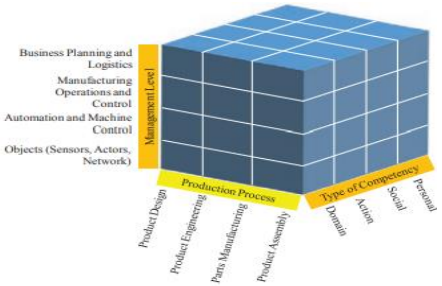


Figure 2: Problem area-competency cube

They are based on the RAMI4.0 architecture model, to create a "problem skills cube" serving as a benchmark for the targeted development of problem-specific skills and teaching formats.

TECHNISCHE UNIVERSITÄT WIEN

SKILLS APPROACH

The makerspace, a type of science, technology, engineering and mathematics (STEM) creation space, where students must combine skills and knowledge in the fields of science, technology, engineering and mathematics to create , build and revise a product.

Abdurrahman. 2018, developed a model called Heat STEM Makerspace that could be used to stimulate creative thinking, critical thinking and problem solving. The design model could guide the teacher to help students explore their best STEM potential.

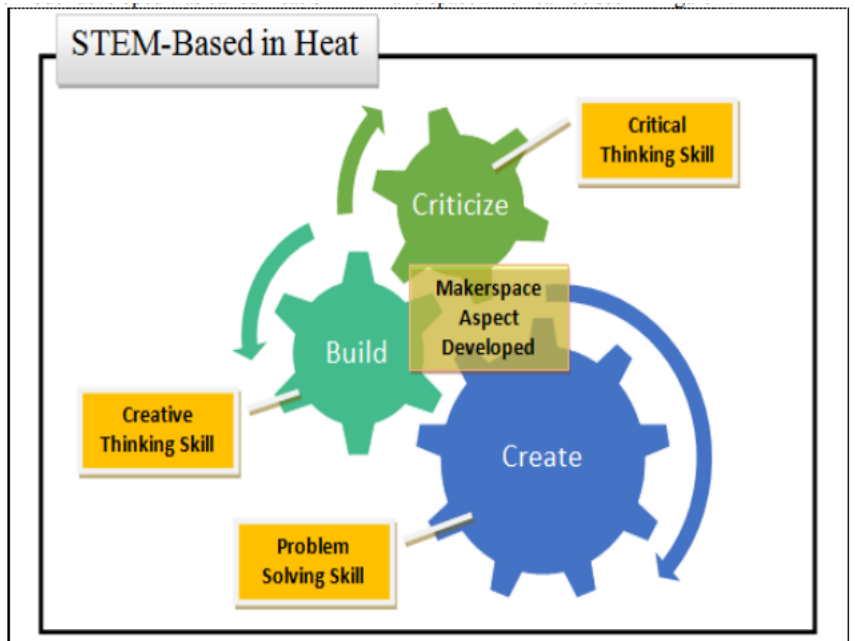


Figure 1 Heat STEM Makerspace Model

SKILLS APPROACH

M. Tsourma. 2019, presents a concept of gamification suitable for application in Industry 4.0 environments within the framework of knowledge sharing,

(a) (b)

Figure 8. *Screenshots of the Augmented Gamification Tracker, demonstrating: (a) achievement progress and tracking screen; and (b) unlock notification*

through this platform, workers can raise discussions about certain problems, such as solutions to failures of running systems " automation, publish multimedia content related to training on certain procedures and also answer questions from other colleagues.

CONCLUSION

The industrial revolution represents a competitive challenge for all industrial companies, their objective is to reverse paradigms and make industry more communicative and more interactive in order to simplify all operations. Whether in terms of training, maintenance or production, using new technologies, which must be thought out in conjunction with other aspects of competitiveness, and in particular the increase in the skills of human capital at all levels of the company.


Thank You