KEY COMPETENCES IN VET AND THE FIELD OF ROBOTICS

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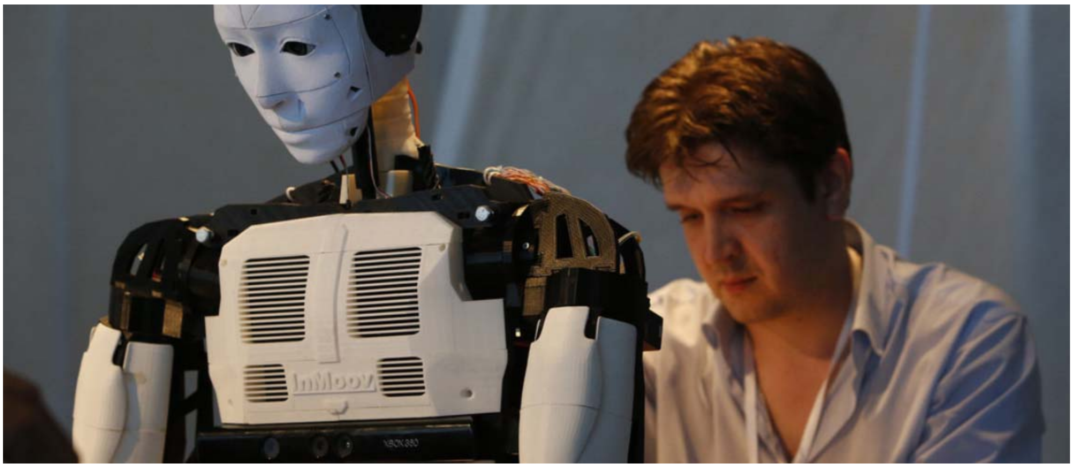

Key competences include knowledge, skills, and attitudes needed by all for personal fulfilment and development, employability, social inclusion and active citizenship. *(Council Recommendation on Key Competences for Lifelong Learning)* [1]

- Literacy
- Multilingualism
- **Numerical, scientific and engineering skills**
- **Digital and technology-based competences**
- Interpersonal skills, and the ability to adopt new competences
- Active citizenship
- Entrepreneurship
- Cultural awareness and expression

Two of the key competences are directly linked to coding and robotic. These competences cover the skills developed under Robot4all project:

- Coding => Digital and technology-based competences
- Robotic => Numerical, scientific and engineering skills & Digital and technology-based competences

The European considered as a priority the digital education and it elaborate and approved ***The Digital Education Action Plan - Action 6 EU Code Week in schools***. The action aims to encourage more primary, secondary and vocational schools to take part in EU Code Week. EU Code Week is a grassroots movement run by volunteers across Europe. The week promotes computational thinking, coding and the creative and critical use of digital technologies.

The goal is to encourage 50% of schools in Europe to take part in EU Code Week by 2020. As part of the Digital Single Market strategy, the Commission supports EU Code Week and other independent initiatives which aim to boost digital skills, including programming, for a range of different target groups. (*Digital Education Action Plan - Action 6 EU Code Week in schools*) [2]

Education in line with the actual level of technology development is an international priority. **The World Economic Forum** debated this topic and stated a list of conclusions for education.

Five years from now, over one-third of skills (35%) that are considered important in today's workforce will have changed. By 2020, the ***Fourth Industrial Revolution*** will have brought us advanced robotics and autonomous transport, artificial intelligence and machine learning, advanced materials, biotechnology and genomics. These developments will transform the way we live, and the way we work. Some jobs will disappear, others will grow and jobs that don't even exist today will become commonplace. What is certain is that the future workforce will need to align its skillset to keep pace. A new Forum report, ***The Future of Jobs***, looks at the employment, skills and workforce strategy for the future. The report asked chief human resources and strategy officers from leading global employers what the current shifts mean, specifically for employment, skills and recruitment across industries and geographies.

What skills will change most? ***Creativity*** will become one of the top three skills workers will need. With the avalanche of new products, new technologies and new ways of working, workers are going to have to become more creative in order to benefit from these changes. Robots may help us get to where we want to be faster, but they can't be as creative as humans (yet).

Whereas ***negotiation and flexibility*** are high on the list of skills for 2015, in 2020 they will begin to drop from the top 10 as machines, using masses of data, begin to make our decisions for us. A survey done by the World Economic Forum's Global Agenda Council on the Future of Software and Society shows people expect artificial intelligence machines to be part of a company's board of directors by 2026.

Similarly, ***active listening***, considered a core skill today, will disappear completely from the top 10. ***Emotional intelligence***, which doesn't feature in the top 10 today, will become one of the top skills needed by all. *(The World Economic Forum)* [3]

Torgny Brogårdh, in the document ***Present and future robot control development — An industrial perspective***, analyses the robotic competence. Robot control is a key competence for robot manufacturers and a lot of development is made to increase robot performance, reduce robot cost and introduce new functionalities. Examples of development areas that get big attention today are multi robot control, safe control, force control, 3D vision, remote robot supervision and wireless communication. The application benefits from these developments are discussed as well as the technical challenges that the robot manufacturers meet. Model-based control is now a key technology for the control of industrial robots and models and control schemes are continuously refined to meet the requirements on higher performance even when the cost pressure leads to the design of robot mechanics that is more difficult to control.

Driving forces for the future development of robots can be found in, for example, new robot applications in the automotive industry, especially for the final assembly, in small and medium size enterprises, in foundries, in food industry and in the processing and assembly of large structures. Some scenarios on future robot control development are proposed. One scenario is that light-weight robot concepts could have an impact on future car manufacturing and on future automation of small and medium size enterprises (SMEs). Such a development could result in modular robots and in control schemes using sensors in the robot arm structure, sensors that could also be used for the implementation of redundant safe control.

Introducing highly modular robots will increase the need of robot installation support, making Plug and Play functionality even more important. One possibility to obtain a highly modular robot program could be to use a recently developed new type of parallel kinematic robot structure with large work space in relation to the robot foot print. For further efficient use of robots, the scenario of adaptive robot performance is introduced. This means that the robot control is optimised with respect to the thermal and fatigue load on the robot for the specific program that the robot performs.

The main conclusion of the document is that industrial robot development is far away from its limits and that a lot of research and development is needed to obtain a more widely use of robot automation in industry. *(Present and future robot control development — An industrial perspective)* [4]

From the industrial perspective the request of skills and competences in robotic and coding will be bigger and bigger. Aiming to face this challenge the educators have to make changes into educational system, to adapt curricula and to improve the teaching philosophy.

The STEM education: is emphasized that the need to prepare students with twenty-first-century skills through STEM-related teaching is strong, especially at the elementary level. Classes in robotics – properly taught – will have an impact on the development of mathematical literacy and scientific-technical information and social competences. At the same time, competence is understood to mean a combination of knowledge, skills and attitudes appropriate to the situation.

Most teacher education preparation programs do not focus on STEM education. The authors' (Schmidt, Fulton 2016) findings suggest that while inquiry-based STEM units can be implemented in existing programs, creating and testing these prototypes requires significant effort to meet PSTs' learning needs[1], and that iterating designs is essential to successful implementation. Other authors (Kim et al. 2015) report a research project with a purpose of helping teachers learn how to design and implement science, technology, engineering, and mathematics (STEM) lessons using robotics. Specifically, pre-service teachers' STEM engagement, learning, and teaching via robotics were investigated in an elementary teacher preparation course.

Gaps between science, technology, engineering, and mathematics (STEM) education and required workplace skills have been identified in industry, academia, and government. Educators acknowledge the need to reform STEM education to better prepare students for their future careers. Jang (2016) pursues this growing interest in the skills needed for STEM disciplines and asks whether frameworks for 21st century skills and engineering education cover all of important STEM competencies[2].

The global urgency to improve STEM education may be driven by environmental and social impacts of the twenty-first century which in turn jeopardizes global security and economic stability (Kelley & Knowles 2016). The complexity of these global factors reaches beyond just helping students achieve high scores in math and science assessments. Friedman (The world is flat: A brief

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[1] Performance Support Tools

[2] Identifying 21st Century STEM Competencies Using Workplace Data (Jang 2016)

history of the twenty-first century, 2005) helped illustrate the complexity of a global society, and educators must help students prepare for this global shift. In response to these challenges, the USA experienced massive STEM educational reforms in the last two decades. In practice, STEM educators lack cohesive understanding of STEM education. Therefore, they could benefit from a STEM education conceptual framework.

ROBOTICS AND CHILDREN

Classes in robotics – properly taught – will have an impact on the development of mathematical literacy and scientific-technical information and social competences. Competence is understood as a combination of knowledge, skills and attitudes appropriate to the situation. What is equally important is the fact that robotics classes can be associated with the implementation of group educational projects (short or long term, inherently interdisciplinary), which are recommended as a form of work with students already at primary school level and required – at high school level.

One of the goals of universal information education is to improve the relevance and importance of computer science as an independent discipline as perceived by students and society (...). Early contact at school with computer science and programming should give students the idea of the richness of this field and its applications in other subjects and areas, and to stimulate interest and motivate the choice of future education and a future career in this direction.

More than 50% teachers understand the important role of the STEM education and the necessity to introduce it the elementary level of education by workshops and other activities. These classes and other STEM education activities could provide successful development of twenty-first-century skills, in particularly key competences. Simultaneously, still open is the question concerning the comprehensive STEM education of prospective teachers pursuing pedagogical programmes, in particular in the specialization of early education. *(Educational robots in primary school – teachers' and students' opinion about STEM education for young learners)* [5]

Resources:

1. **Council Recommendation on Key Competences for Lifelong Learning** https://ec.europa.eu/education/education-in-the-eu/council-recommendation-on-key-competences-for-lifelong-learning_en
2. **Digital Education Action Plan** https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en
3. **The 10 skills you need to thrive in the Fourth Industrial Revolution** https://www.weforum.org/agenda/2016/01/the-10-skills-you-need-to-thrive-in-the-fourth-industrial-revolution/
4. **Present and future robot control development — An industrial perspective**; Torgny Brogårdh https://doi.org/10.1016/j.arcontrol.2007.01.002
5. **Educational robots in primary school** – teachers' and students' opinion about STEM education for young learners; Eugenia Smyrnova-Trybulska, Nataliia Morze, Piet Kommers, Wojciech Zuziak and Mariia Gladun. https://files.eric.ed.gov/fulltext/ED571601.pdf