Artificial Intelligence in the Policies, Processes and Practices of Vocational Education and Training

Executive Summary

The Erasmus+ funded European project 'Improving the Skills and Competences of VET teachers and trainers in the age of Artificial Intelligence' (Taccle AI) brings together partners from five countries to provide initial training and continued professional development for VET teachers and trainers in Artificial Intelligence.

The project will seek to support VET teachers and trainers in extending and adapting open curriculum models for incorporating AI in vocational education and training. Furthermore, the project will develop an Open Massive Open Online Course in AI in education in English and German, open to all teachers and trainers in VET in Europe.

The course materials will be freely available for other organisations to use for professional development. It follows the tradition of previous successful TACCLE-projects. You can find more information on our website: www.taccleai.eu
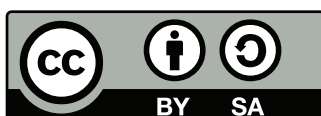
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Report IO 1

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Artificial Intelligence (AI) can be defined as a system that has been designed to interact with the world in ways we think of as human and intelligent. It is important to understand the potential impact of AI on learning, teaching, and education, as well as on policy development. AI is particularly important for vocational education and training as it promises profound changes in employment and work tasks. The greatest implications for VET lies in the changing tasks and roles within jobs, requiring changes in initial and continuing training, for those in work as well as those seeking employment. This will require changes in existing VET content, and the introduction of new programmes such as the design of AI systems in different sectors, and adaptation to new forms of cooperative work with AI.

For VET teachers and trainers, there are many possible uses of AI including new opportunities for adapting learning content based on student's needs, new processes for assessment, analysing possible bottlenecks in learners' domain understanding and improvement in guidance for learners.

Introduction and usage of the AI in the VET processes and systems has made different progress in the project partner countries (Germany, Greece, Italy, Lithuania and UK). In Germany the introduction and application of the AI in the VET is progressing strongly due to the overall development of skills and training in the conditions of Industry 4.0 and strong innovative cooperation between the enterprises and VET providers. The practice of establishing learning factories shows strong work process orientation in the introduction of the AI issues in curricula and training practices. In the UK the introduction and usage of the AI in the VET is more focused on the implementation and application of the different AI solutions that foster acquisition of knowledge, basic and key skills by focusing to the enhancing learning capacities of students by applying AI solutions. In the school-based VET systems in Lithuania, Italy and Greece the integration of AI in VET processes is very fragmented and makes initial steps. Here different initiatives of VET teachers, trainers and students play very important role in fostering usage and implementation of the AI.

This report analyses the implications of AI Technologies for vocational education and training, the impact of this process for employment and labour market, as well as implications for work processes in different occupations such as mechatronic occupations, which are crucial for VET curriculum design and organisation of training processes.

The potential impact of the AI for employment, labour market and society is complex and heterogeneous, including both positive and negative implications, such as emerging of the new challenging, interesting and meaningful work tasks and jobs, liberation from the routine and harmful work, but also enhancing digital Taylorism, task encroachment and automation of the high skilled jobs, digital precarization of work and labour market, increasing skills polarization leading to further exacerbation of the income and socio-economic inequalities. AI can both replace the human workers and enable them to perform more and better. It is expected important impact of the AI to the change of the landscape of existing jobs and labour market structures. Subsequently there is expected impact on the demand of knowledge, skills and competencies. Demand for physical and manual skills and for basic data input and processing will decline, while growth will be strong in demand for interpersonal skills, creativity, and empathy. Advanced IT skills and programming alongside complex information processing skills will also see a surge in demand.

AI facilitates redesigning a production environment into a "smart factory", excelling in high flexibility and versatility with new organisational structures and processes. The integration of intelligent machines and software into the workplace, workflows and workspaces will continue to evolve to enable humans and machines to work together. Artificial Intelligence creates completely new spaces for interaction between machines (e.g. multi-agent systems), as well as between humans and machines. The complementary power of AI and automation through the innovations will increase the performance of humans and could create some new jobs and skill needs, but these trends cannot outweigh the hollowing-out or polarization effect of AI on jobs and skills. It creates the necessity of political intervention and makes the jobs problem a political problem.

AI is at the centre of the different scenarios of the future change of work in the context of digitalization. Gradual upgrading of technologies and work organization including implementation of AI permits smooth and gradual upgrading of skills and qualifications, through involving decentralization and the reintegration of the functions of planning, execution and control of work. AI and related technological solutions also have unlimited (or at least with unknown limitations) capacities for work task encroachment not only in routine work, but also in so called "high-skilled" work processes. It leads to work polarization by erosion of the middle level occupations created by the task encroachment in the related work processes by AI and other technological solutions. AI also becomes an important factor leading to the decentralisation of work organisation and the spread of temporary and project-based forms of work organisation, digitized management of work processes and higher temporal flexibility of work organisation.

One of the key challenges for VET is to identify the work tasks which require complementarity of human work and AI and to provide competencies necessary for handling these tasks. The increasing rate of automation and task encroachment narrows the range of accessible jobs and applicable skills and at the same time decreases the possibilities to obtain new skills needed for the remaining jobs because of fast changing skills needs and intensive competition between the big tech companies, making this know-how and skills an important part of competitive advantage. There is a range of implications of AI for skills needs, starting from rapidly growing demand for advanced technological skills such as programming, increasing demand for key skills and competencies, declining demand for physical and manual skills as well as declining need for basic cognitive skills. The Application and development of AI based technologies challenge the traditional boundaries of disciplines, knowledge and competence areas. There is also increasing demand for systemic understanding and cognition in work processes and technologies, for their planning and design. The widening of the contents of work processes requires holistic understanding of the work and technological processes and abilities to process the systemic data and information of these processes. Decentralisation leads to the saturation of industrial work processes with data. Employees with qualifications at all levels have to be prepared to deal with real time data from production processes and to react to the requirements of the process management and optimization.

In Germany, where the debate has been heavily focused on Industry 4.0, there is a call for higher level technical skills, for instance in programming or preventative maintenance. In the Anglo-Saxon countries, the discourse suggests we should be teaching the skills and competences that computers (and AI) are not good at: communication skills, teamwork, decision making etc (it is notable that these used to be commonly referred

to as soft 'skills).' What does seem likely is that there will be a need for more learning opportunities for those already in work (Lifelong Learning) and also retraining for those whose jobs do disappear as a result of the changing technologies.

Industrial work will need to be redesigned to ensure that workers are sufficiently skilled to work alongside complex machines. Therefore, a shift to advanced technical skills such as programming, quality control and better coordination is necessary. Social, emotional and higher cognitive abstract skills such as creativity and complex information processing will also increase. A change in the curriculum towards an action orientation with high practical application is becoming increasingly important.

AI applications in the vocational education and training concern different forms of learning and training, but their application in the work-based learning is particularly important and interesting. Work based training systems can, for example, make use of AI driven recommender engines to help employees access the training they need when they need it. There is potential for AI to support people throughout their learning life course with 'just-in-time' learning individualised to their needs, accessible through multiple interfaces from voice activated technology, to virtual and simulated environments and physical computing embedded within our world.

At an organisational level, the need for updating existing skills and competences will require more lifelong learning, an increase in blended learning programmes combining online and face to face programmes, closer collaboration between educational institutions and companies in the provision of both course based and workplace learning, and the increased use of data from sensors in the working environment.

AI can also be used in the different fields of VET provision, such as learner engagement and recruitment via chatbot applications, to provide information about the labour market, about jobs and occupations, about qualification requirements and about courses and work experience opportunities. Intelligent tutoring systems and the AI supported provision of online learning can also promote engagement with students, not least because they can be accessed anywhere and at any time. AI enhanced systems can provide nudges to learners to encourage them to complete coursework or to remind them of forthcoming deadlines and tasks. AI can also support the delivery of learning materials, for instance providing answers to frequently asked questions or through stimulating and moderating seminar discussions. The use of AI in assessment can greatly enhance the variety of assessment formats. Automatic marking of assessments reduces the load on teachers, allowing a move towards more formative assessments, rather than reliance on manually marked end testing. AI will free up teachers to act more as coaches for students, and instead of 'teaching to the middle ability', teachers will be able to give greater attention to those students who need it, particularly the higher and lower quartiles in terms of confidence and outcomes.