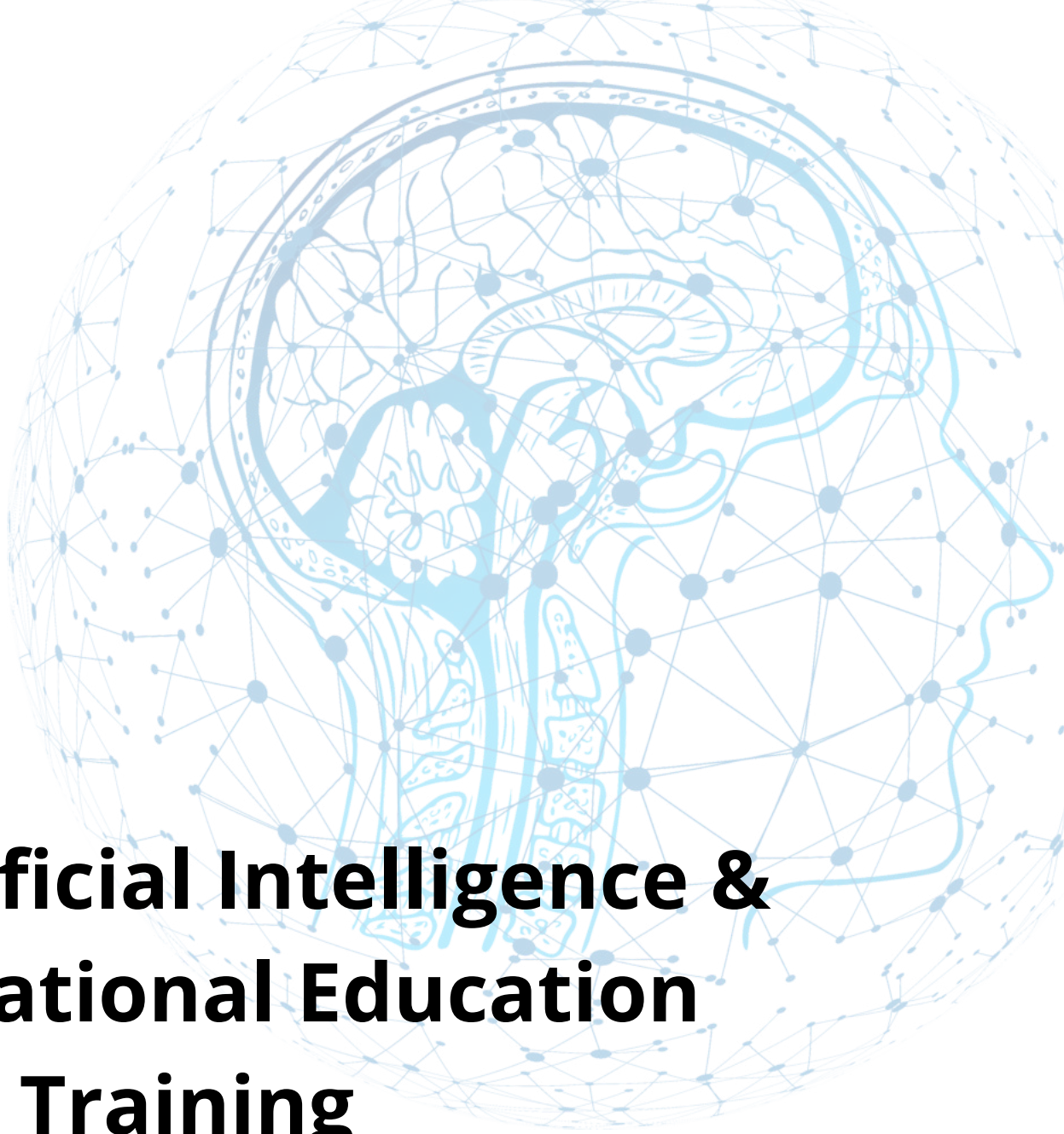

Artificial Intelligence & Vocational Education and Training

HOW TO SHAPE THE FUTURE.

TACCLE AI
Improving skills and competences of VET teachers and trainers in the age of Artificial Intelligence

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

The Erasmus+ funded European project 'Improving the Skills and Competences of Vocational Education and Training (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 VET. Furthermore, the project has developed a 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 are 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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Artificial Intelligence & Vocational Education and Training

How to shape the future.

Policy recommendations

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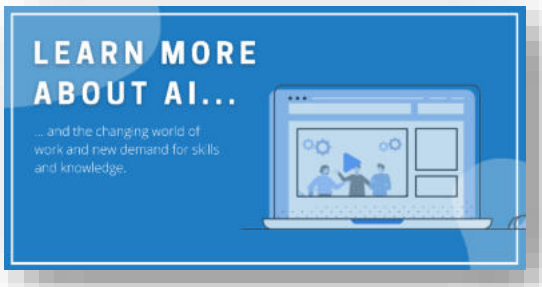
1. Context: AI, Automation and Vocational Education and Training

The term Artificial Intelligence (AI) is associated with both expectations and concerns. And both are justified. At present, AI is often used as a kind of catch-all term; it can mean anything and nothing. It is urgently necessary to differentiate much more clearly what is meant by AI when we speak of it. Basically, AI is only a subfield of computer science that combines various methods and procedures.
AI as a subfield of computer science has existed since the 1950s. The current progress in the field of AI is fuelled by the availability of data, more powerful computers and new algorithms. Machine learning methods in particular are responsible for the current hype. In reality, we should speak more often today of machine learning instead of AI.

Machine learning allows a machine to deliver meaningful results without explicitly telling it what to do beforehand. As a consequence, tasks previously performed by humans can now potentially be completely taken over or assisted by computers and computer-assisted machines. Against this backdrop, there is a change in work and business processes across all sectors, which entails changed professional competence requirements. This is often accompanied by the fear that human labour will be replaced on a large scale and that occupations will disappear. In scientific discourse, the prevailing view is that occupational activities will change, some jobs will disappear as a result, but new occupations will also emerge. In this context, there is increasing reference to *augmentation*. This means that human activities will be supplemented by machines. Therefore, it is not necessarily about complete substitution, but about the use of AI-based applications or machines to redesign work. Economic gains are certainly the driving factors on the part of industry and companies. However, potentials can also be identified from the employee's point of view, e.g. when it comes to physically demanding work or tiring routine tasks. Whether tasks are taken over depends on whether human labour is better, what is more economical, and the complexity of tasks, but also whether it is ethically justifiable. This brings us to one of the central areas in the discussion about AI, namely the legal and ethical framework around the development and deployment of AI. This partly lags behind the development of applications. The EU did not adopt a legal framework until 2021. Questions raised include what is AI allowed to do, and what is it not and how should AI-based applications be designed and who is responsible? These are central questions in the ethical debate around AI.

To equip more people with knowledge about AI to secure employability of workers, to discuss social implications more deeply and to design the future as we want to have it, are central goals according to the European Union. Therefore, education is understood as a key element to deal with these changes. We agree with that request. However, the education sector is caught in a double tension. On the one hand, (young) people have to be prepared for changed working environments. On the other hand, educational institutions and their pedagogical staff are also under pressure to adapt due to the development of the latest digital educational technologies. Especially in vocational education and training, this double tension is high. Yet VET teachers and trainers are responsible for training the workforce of the future in which AI and automation seems likely to play such a big role. And of course, it will be VET teachers and trainers who will design and deliver continuing professional development to upgrade the skills and knowledge of the present workforce and provide retraining for those displaced by the impact of AI and automation on workforce labour demands. This implies that VET teachers and trainers need appropriate training as well to fulfil this task.

Looking in detail at the changing world of work, asking to what extent future jobs are threatened by AI and automation and which jobs in particular was one task of the European project ***TACCLE AI – Improving skills and competences of VET teachers and trainers in the age of Artificial Intelligence***. It looks at requirements for new skills and knowledge arising from AI and poses the question of how humans and AI can work together. In addition, the project partners from five European countries examined the growing use of AI in vocational education and training including for recruiting and motivating students, for creating learning content, for assessment and for administration. Furthermore, the Taccle AI partners asked how the reform of existing curricula, qualifications and continuing professional development of teachers and trainers can be designed in the near future. The knowledge and experiences gained from this research were the basis for a newly designed Massive Open Online Course[1] on Artificial Intelligence and VET. This course is primarily aimed at VET teachers and trainers.



However, in order to take up the topic of AI in VET it is also necessary to inform VET providers about changing developments due to the rise of Artificial Intelligence. Therefore, we summarize in this report the results and experiences from the *Taccle AI project* and particularly address VET providers. In the following section we present our central policy recommendations. In the third part we discuss and derive how we came to the recommendations by giving insights from the project. As the use of AI in work processes or educational contexts raises many ethical issues, we consider that as a major and comprehensive dimension in the context of AI. Due to this we start with that dimension in part three.

2. Policy recommendations

I. Update VET curricula to include AI.

Artificial intelligence has the potential to change many areas of life. It is therefore generally important that (young) people are informed about the potential benefits and limitations of AI and can join in the discussion. In addition, they need knowledge of how to act with the latest AI-based technologies. The discussion of ethical and legal issues must be given special priority.

II. Incorporate competences for AI into all initial training programmes for VET teachers and trainers.

If we incorporate AI in VET curricula it is self-evident that we need to include it in training programmes for VET teachers and trainers as well. The extent to which the topic of AI should find

[1] https://mooc.taccleai.eu/

its way in depends on the respective area of learning / vocational field. Nevertheless, it is important that VET teachers and trainers have a basic knowledge of AI in order to assess developments in the labour market and new trends in educational technologies. Knowledge about AI should also be sought beyond professional activities, as AI also affects the everyday lives of VET teachers and trainers.

III. *Encourage and support the development, searchability and sharing of Open Educational Resources for AI in VET.*

Due to the speed of the digital transformation, it is useful to bundle competences and share knowledge. In the field of education, the sharing of Open Educational Resources can support new learning programmes.

IV. *Encourage and support the development of online programmes of Continuing Professional Development for AI in VET.*

Digital transformation opens up the opportunity to make learning more flexible. This is also true for the Continuing Professional Development of teachers and trainers. Applications for digital interaction such as forums, chat groups or shared comments can also promote exchange between VET stakeholders.

V. *Support collaboration between industries, VET schools and training centres …*
… to develop new curricula and training in the use of AI in different occupations.
… to update their own knowledge and competences in the use of AI in different occupations.

In addition to sharing knowledge between educational institutions, it is crucial that all stakeholders involved in VET work more closely together. Educational institutions need to know from companies how the latest technologies are already affecting their business in order to know what to teach.

3. Discussion

3.1. AI and Ethics

Data and AI bias

AI bias is an anomaly in the output of machine learning algorithms. These could be due to prejudices in the design and development of the algorithms or prejudices from the machine learning training data. It can also result from the data collected in interchanges with users. AI systems contain biases due to two reasons:
(1) **Cognitive biases:** These are effective feelings towards a person or a group based on their perceived group membership. More than 180 human biases have been defined and classified by psychologists, and each can affect individuals we make decisions. These biases could seep into machine learning algorithms via either designers unknowingly introducing them to the model or a training data set which includes those biases.
(2) **Lack of complete data:** If data is not complete, it may not be representative and therefore it may include bias. For example, most psychology research studies include results from undergraduate students which does not represent the whole population.
A central question is how to fix biases in machine learning algorithms? Firstly, if the data set is complete, we should acknowledge that AI biases can only happen due to the prejudices of humankind and we should focus on removing those prejudices from the data set. However, it is not as easy as it sounds.

So there are no quick fixes to removing all biases but there are high level recommendations from consultants like Mckinsey[2] highlighting the best practices of AI bias minimization:

1. **We should fully understand the algorithm and data** to assess where the risk of unfairness is high.
2. **We should establish a debiasing strategy** that contains a portfolio of technical, operational and organizational actions:
    - **Technical strategy** involves tools that can help you identify potential sources of bias and reveal the traits in the data that affects the accuracy of the model
    - **Operational strategies** include improving data collection processes using internal "red teams" and third party auditors. You can find more practices from Google AI's research on fairness[3].
    - **Organizational strategy** includes establishing a workplace where metrics and processes are transparently presented
3. **As we identify biases in training data, you should consider how human-driven processes might be improved.** Model building and evaluation can highlight biases that have gone noticed for a long time. In the process of building AI models, companies can identify these biases and use this knowledge to understand the reasons for bias. Through training, process design and cultural changes, companies can improve the actual process to reduce bias.
4. **Decide on use cases where automated decision making should be preferred** and when humans should be involved.
5. **Research and development** are key to minimizing the bias in data sets and algorithms. Eliminating bias is a multidisciplinary strategy that consists of ethicists, social scientists, and experts who best understand the nuances of each application area in the process. Therefore, companies should seek to include such experts in their AI projects.
6. **Diversity in the AI community** eases the identification of biases. People that first notice bias issues are mostly users who are from that specific minority community. Therefore, maintaining a diverse AI team can help you mitigate unwanted AI biases.

Gender-equitable and inclusive AI

The issue of bias is a central challenge when developing gender-equitable and inclusive AI systems. For example, to train an AI-based recruiting system, we feed it with data already collected in the last years (training data). Let's assume that there have been few women employed in the company so far and that this can be seen in the data. Then the self-learning algorithmic system will reproduce this state. The consequence is that female applicants will still not be suggested to the recruiters. Existing inequalities are thus further manifested. This so-called gender data gap can be found in many fields and to close this gap is one of the biggest challenges for gender-equitable and inclusive AI-systems. To do so and to avoid these gender inequalities in AI applications and the digital world, we need to tackle gender inequalities in the real world.
To build gender-equitable AI systems, it is crucial to have diverse and heterogeneous AI developing teams because these people are accountable for the algorithms and therefore responsible for the decisions of the AI system. According to the Global Gender Gap report 2020[4] only 26 percent of workers in data and AI roles are female. It is therefore of particular importance to improve the representation of women in technical roles. Education plays a crucial role on that pathway. STEM education and careers for girls and women needs to be improved. Existing women in that branch needs to be more visible to function as role models. Young girls need to see that working in AI-related fields is a possible pathway

[2] https://www.mckinsey.com/featured-insights/artificial-intelligence/tackling-bias-in-artificial-intelligence-and-in-humans
[3] https://ai.google/responsibilities/responsible-ai-practices/?category=fairness
[4] Global Gender Gap report 2020: https://www3.weforum.org/docs/WEF_GGGR_2020.pdf

for their future. In the discussion about AI principles for women, we should be aware that women are a heterogeneous group (e.g. racial, ethnic or religious minority women; younger and older women). That means they are often not only discriminated as women but also, for example, because of their ethnic background and many more. Furthermore, the debate should highlight "the importance of understanding gender as non-binary to ensure that gender equality principles for AI are inclusive as possible. (UNESCO 2020, p.8).

However, it is important that not only women or other disadvantaged groups put the topic of gender-equality and inclusiveness on the agenda. Everyone needs to be aware of these issues and consider it when developing or deploying AI-systems. One example of how to equip a wider community with knowledge about AI and its limitations and implications is the online course Elements of AI[5]. The course is available in many European languages and can be used without a fee. In the member countries are also more and more courses and platforms available to deepen knowledge on AI[6].

AI, Ethics and education

The development and use of Artificial Intelligence in education is part and parcel of the digital transformation of all facets of our societies. The AI-powered digitalization of learning is not only about digital transmission of 'traditional' forms of knowledge[7]. It is also increasingly about the digitalization of knowledge production and representation, driven by machine learning and increasingly powerful algorithms. UNESCO says "(…) the rapid growth of human-AI collaboration and the digital transformation of our societies have profound implications for what it means to be human and how we relate to each other and to technology. The traditional conceptions of humanism need to be reframed, the design and use of technology should be in the service of people to enhance human capacity, protect human rights and ensure sustainable development. More fundamentally, a humanistic approach should frame technological innovation as a digital public good for all and as part of the global commons that must be freely accessible to all."

Such considerations give rise to the many ethical concerns and issues about the increasing development and implementation of AI in education. These include issues centred on data and algorithms, on pedagogical choices, on inclusion and the 'digital divide', on privacy, and on equity in terms of gender, disability, social and economic status, ethnic and cultural background, and geographic location.

There are increasing concerns about the large volumes of personal data being collected by AI applications in education – a process that has been called 'dataveillance'[8] . This raises questions about who owns the data and about the privacy and use of such data.

The EU working group on AI in Education has identified the following issues for the use of AI in education[9]:

- AI can easily scale up and automate bad pedagogical practices
- AI may generate stereotyped models of student's profiles and behaviours and automatic grading
- Need for big data on student learning (privacy, security and ownership of data are crucial)
- Skills for AI and implications of AI for systems requirements
- Need for policy makers to understand the basics of ethical AI.

[5] https://www.elementsofai.de/
[6] https://ki-campus.org/ (Germany)
[7] https://en.unesco.org/sites/default/files/ai-in-education-forum-2021-cn-en.pdf
[8] Lupton & Williamson (2017)
[9] European Commission (2020)

A study into the use of AR/VR technology in education[10] pointed to the expansion and acceleration of what data are being collected about learners and how these data are being mobilised to compare learners and assess teachers. It identified "the immediate potential for data-related harms in the use of VR education tools in enterprise for hiring and promotion, and problematic claims about the predictive potential for VR data."

There is growing debate over the governance of AI amidst concerns that private AI developers are defining their own systems including tracking of users. AI applications in education require that users sign up to agree with such rules, which are often not transparent and it is not usually clear how user's data is being stored and for what purposes. UNESCO[11] considers that " (…) the rise of private governance undermines the public governance that is accountable to make AI a common good."

There appears to be a growing consensus over the need for regulation of AI, although less consensus of what form such regulation should take. But additionally, the ethical concerns reveal the need for education, in order that not only teachers and trainers, but the general public are able to understand both the potential but the issues that AI raises with society in general and education in particular.

Perhaps most important is that teachers and trainers are not only aware of the potentials and dangers of AI, but are involved at every level in the development and regulation of AI in education. This should include the development and testing of AI applications and well as the wider regulation of such technologies.

3.2. The future of work and VET

Occupational changes - Facing technological unemployment

The spread of AI in the world of work makes it urgent to enhance the digital skills of workers, as this will not only concern the new occupational profiles outlined in recent years, such as data scientists, digital officers, mobile developers. Instead it also concerns the current professional occupational profiles that will be redefined with hybrid curricula that will combine new skills with existing ones. There are at least three elements related to the spread of AI to be taken into consideration in planning employment policies[12]:

- The automation processes that make use of AI have now pervaded almost all production sectors, including services, as well as all of society in daily life. Therefore, the phenomenon should no longer be considered as characterizing only the industrial production sector.
- It is necessary to avoid a polarizing approach to the subject of AI. It is counterproductive to focus attention on the positive or negative aspects of the ongoing change, as, in both cases, this can lead to immobility. Rather, the continuous change invites us to continue the investigation and to seek and test new tools (also based on AI algorithms) that favour the retraining and relocation of workers. In this way, it will be possible to distribute the positive effects more equitably in society and limit the equally inevitable downsides.
- If on the one hand, it is essential to find tools to constantly monitor the new and changing labour market, to be able to provide workers with the necessary training to remain active and competitive, on the other hand, it is important to involve initial VET schools and institutions to promote a culture of continuous training. This can no longer be relegated to sporadic experiences promoted only by the most far-sighted companies, nor limited to the transmission of technical skills, but should include ongoing discussions between the company (the business world) and workers (society).

To maintain high levels of competitiveness and innovation continuous updating is required with the arrival of new technologies, including AI.

[10] Carter & Egliston (2021)

[11] https://en.unesco.org/sites/default/files/ai-in-education-forum-2021-cn-en.pdf

[12] Perini et al. (2021); Tommasi et al. (2021)

Implications for the skills needs of the future worker; the phenomenon of the "augmented operator"

AI-applications in technological work processes raise important issues concerning the increasing autonomy of technology related the structures of work activities and the implications of this change for the autonomy and responsibility of the operator, when part of competences and decision making are "absorbed" into machines[13]. When the application of AI in the production processes targets the increasing capacities of workers and operators it leads to the emergence of the new type of occupation and qualification - "augmented operator" or "universal worker". What are the implications of this change for the VET curriculum design and training practices?

Obviously, the qualification of "augmented operator" includes ICT knowledge and skills needed to handle the work processes with the help of AI. This knowledge and skills can be provided as an integral part of the existing VET curricula, or integrated in existing training modules. However, amending the current VET curricula with this knowledge and skills would not be sufficient to prepare the "augmented operator". One of the specific competencies of the "augmented operator" is the ability to handle the whole technological work process by assuming responsibility for their operation with company, customers and society at large (e.g., environmental implications). The application of AI potentially liberates the "augmented operator" from routine tasks (both psycho-motor and intellectual), but at the same time imposes the requirement to understand the technological work processes in a systemic and holistic way, by considering technological, organizational, ergonomic, economic, environmental and other aspects and implications. It implies two important requirements for the VET curriculum design: interdisciplinarity in design of the training modules and subjects and a focus on work-process related training oriented to the provision of the competencies needed for executing and managing of 'smart technological chains', handling the issues of process management, big data, ensuring networking and information security - all which is needed to assume responsibility for integrated work processes and the AI enhanced operation of production lines.

A universal and holistic orientation to the qualification and training of the "augmented operator", in turn, creates significant challenges for the traditional competence-based VET curricula, which can fail in providing such qualifications due to fragmentation in the provision of knowledge and skills[14]. We can presume that the training of "augmented" operators will require significant changes in the organization of VET by strengthening the provision of work-based learning and fostering the integration of "academic" knowledge in the VET curricula and intensifying cooperation between the VET and HE providers. Qualifications of augmented operators could also find their place on level 5 of the 8 level qualifications frameworks.

Bundling competences - Cooperation with companies, educational institutions, policy and more

VET is the interface between education and training and employment and economic policies. Through this interconnection, changes in one area also have a direct or indirect impact on the other. Vocational education practice has thus always been affected by constant change and shifting influences. However, increasingly rapid and far-reaching digital transformation further intensifies pressure to adapt vocational education and training and calls for innovative concepts for action in order to train skilled workers. The vocational training systems in the European Member States differ greatly in some cases and so do the national individual responsibilities for vocational training and apprenticeships. A wide range of stakeholders including VET providers, social partners, companies, chambers and many more are involved. Given the ever-faster changing working world and a high level of uncertainty about the future,

13 Tūtlys & Spöttl (2021)
14 Tūtlys & Spöttl (2021)

these stakeholders need to combine their competences to promote VET as an attractive pathway for jobs and life.
Even in Germany where the cooperation between companies and VET schools is the core element of the dual VET system, effective cooperation between these two learning venues is difficult. German VET teachers from the Taccle AI project stated that personal effort from the teachers is crucial for that task. One example[15] in which the bundling of competences worked is the smart factory project at a German VET school. VET teachers from the vocational school and trainers from the Volkswagen factory implemented smart factory models in the school to teach the latest technologies and prepare the students for the 'real' smart factory[16] .
Our survey among vocational school teachers in Germany[17] also showed that latest changes and innovations in companies only find their way into the school curriculum if there is a close personal contact with companies or manufacturers of these latest technologies.
Besides the cooperation between different learning venues, there is also a need for horizontal collaboration networks including the formation of communities of practice. Via those communities, teachers could provide mutual support and knowledge generation, as well as inspiring each other for new or collaborative projects.

3.3. AI and Teaching and Learning in VET

AI technologies to support training

AI technologies could support training both to support learning processes and manage organizational issues. AI can help in situations that require the processing of a large amount of data in order to obtain useful information for training. These technologies are still evolving and are not yet widespread. Nevertheless, AI can support VET teachers in the following ways: empowering the sharing and the provision of information about the labour market (jobs, occupations, qualification requirements, courses and work experience opportunities); facilitating the recruitment and engagement of students and workers; storing students records and progress; providing nudges to enhance students involvement; reducing time and cost in producing and delivering learning contents; speeding up evaluation activities, allowing teachers to increase formative assessment activities. Some examples of artificial intelligence technologies already available and which can be used in the modalities listed above are: chatbots, natural language processing, the use of the Experience API, intelligent tutoring systems and e-assessment tools. Their use has given rise to innovative teaching approaches, such as "smart classrooms", which are physical learning rooms equipped with different types of sensors (microphones, cameras, etc.). The data collected through the sensors is used by teachers or artificial intelligence systems to provide assistance, tools or learning strategies for student support[18].
It is important to stress that the increasingly widespread use of these technologies will not threaten the teachers' jobs. Teachers and trainers have a fundamental and irreplaceable role in supporting learning processes and these roles cannot be replaced by any technology. Rather, AI will reduce teachers administrative duties for example checking documents, preparing lessons, evaluating homework, allowing them to pay more time and attention to individual learners, coaching activities and focus on students most in need of help.

How to teach about AI to VET students

We are several years into a new age where machine learning (a functional subset of AI), big data and enabling technologies are transforming every sector. In every sector, there is a big data set behind

[15] More information on the Tacle AI homepage: http://taccleai.eu/2021/04/27/1675/
[16] https://www.foraus.de/de/themen/smart-factory-industry-4-0-in-vocational-education-and-training-135395.php
[17] http://taccleai.eu/2020/10/06/survey-results-perspective-of-german-vet-teachers-on-ai/
[18] Attwell at al. (2020)

every question. Every field is computational: healthcare, manufacturing, law, finance and accounting, retail, and real estate. We all work with smart machines—and they are getting smart fast.

Given these important and rapid shifts, it is a good time to consider what VET students (especially younger ones) need to know about AI and information technology. First, everyone needs to be able to **recognize AI** and its influence on people and systems, and be proactive as a user and citizen. Second, VET students should have the opportunity to **use AI** and big data to solve problems. And third, VET students interested in computer science as a career should have a pathway for **building AI**.
Recognizing AI is an initiative of leading computer scientists that have identified five big ideas that VET students should know about AI:

- **Computers perceive the world using sensors.** Examples include speech recognition and computer vision; emerging issues include the nature of intelligence and the limitations of human and computer perception.
- **Agents maintain representations of the world and use them for reasoning.** Examples include types of algorithms, the work they do and their limitations.
- **Computers can learn from data.** Examples include types of machine learning - yet there are concerns about issues such as bias in training data.
- **Intelligent agents require many types of knowledge to interact naturally with humans.** Examples include interacting with digital assistants, chatbots and robots. Emerging issues involve the nature of consciousness and limitations of AI interaction.
- **AI applications can impact society in both positive and negative ways.** Emerging issues include the use, fairness and transparency of algorithms and likely social impacts.

The MIT Media Lab developed a middle school AI+Ethics course that hits many of these learning objectives. This course can be adapted to VET settings. Harvard Professor Xiao-Li Meng suggests starting with cross-curricular conversations about data quality—including where does it come from, what bias might be incorporated, how could we gather more?

Using AI. Beyond recognizing the growing influence of AI, VET students can benefit from the periodic application of smart tools across the curriculum.

Building AI. For VET students interested in AI, data science and more broadly in computer science, a dedicated pathway or academy is a great option.

3.4. AI, the curriculum and the skills required for teachers and trainers

Implementation of the AI and VET curriculum change

When analysing the implications of AI for VET curriculum change, there two main groups can be distinguished: 1) related to competencies and learning outcomes; 2) related to the organization and structuring of the VET curricula.
Concerning the implications of the use of AI in the work processes for competence requirements, it is of crucial importance to analyse the AI enhanced, supported and assisted work processes by focusing on the changing functions, roles and responsibilities of the skilled workers and operators, for example, the phenomenon of the “augmented operator”[19]. The implications of AI for competence requirements concern not only the technical dimension of work processes (new skills needs for AI enhanced technologies), but also the communication and cooperation dimensions of work (the key skills and competencies needed for the interdisciplinary communication and cooperation in the work processes

[19] Becker, Spöttl & Windelband (2021); Tūtlys & Spöttl (2021)

with engineers, customers and other stakeholders). It leads to increasing demand for multidimensional competencies needed for the autonomous and responsible execution of AI enhanced and supported work processes[20]. Here it is also important to distinguish the depth of the implications of the AI for the competence needs: whether the application of the AI in the work process requires essentially new competencies (implying the design of the new training modules and curricula) or if it requires just adjustment and updating of the existing competencies. When the application of the AI increases the autonomy and widens the scope of activity and responsibility of skilled workers and operators ("augmented operators") it can lead to a shift of the vocational qualifications upwards on the qualifications framework due to increasing autonomy and responsibility. Here the relationships between the processing of information and autonomy of performers are of crucial importance[21] and can enhance the "academization" of vocational qualifications by increasing the role and scope of academic knowledge[22].

Regarding the organization and structuring of the VET curricula, the changing competence needs can lead to tensions in the curriculum design. On the one side, there is a pressure for increasing flexibility of the curricula in order to keep-up with the dynamic changes of skills needs. From the other side, the new demands of interdisciplinary, multidimensional competencies, the necessity for a holistic understanding of the technical work processes, is leading to trends for the academization of vocational qualifications. This implies revising t traditional approaches to the competence-based modularization of the VET curricula in searching for more holistic vocational modules (e.g. units of qualifications covering whole work processes), and by paying more attention to the provision of systemic underlying knowledge and skills.

Action-oriented learning approaches

In addition to changing professional competencies (knowledge of new technologies, AI etc.), social competence, personal and methodological skills are increasingly necessary: creative thinking, independent work, teamwork, self-directed learning, socio-ethical issues like personal data protection etc. This raises the question of how vocational training courses, projects and modules can respond to this requirement? On the one hand, topics such as AI and digital technologies for smart production can be dealt with in vocational school. In order to also promote social, methodological and personal skills, tasks in vocational school should be as action-oriented as possible. So-called Learning and Working Tasks (LWT) can be one way of making teaching more action-oriented, combining theory and practice and thus promoting the development of learners' skills. LWT are characterized by project-based, process and task oriented learning, which makes use of problem situations in occupational contexts[23]. Within the Taccle AI project we have found several examples of such approaches.

Example 1:
Deep Reinforcement Learning-Project

Click here to read more

Example 2:
Robot-Car-Project

Click here to read more

An important finding is that the interests of the learners should be considered in such projects. Only in this way is it possible to maintain motivation over longer project phases.

[20] Becker, Spöttl & Windelband (2021)
[21] Becker, Spöttl & Windelband (2021)
[22] Tūtlys & Spöttl (2021)
[23] Howe & Gessler (2018); Howe & Knutzen (2012)

Initial training and continuing professional development for teachers and trainers

Through the Taccle AI and Vocational Education and Training project, we found that most VET teachers and trainers were positive about the development of AI and keen to incorporate it within their professional practice, despite concerns around ethical issues.
However, they were not confident about their own knowledge and practice in incorporating AI in teaching and learning and expressed the need for professional development to support their continuing learning.
The use of AI in VET differs from AI in general education in that it has a dual focus. As in other sectors of education, AI can and increasingly is being used in VET for teaching and learning, for example using chatbots and for extended formative e-assessment and feedback as well as personalised learning. But AI is also a subject for VET, as it is increasingly adopted in different occupational competences and practices.

The Taccle AI and Vocational Education and Training project has identified additional competences for AI based on the European Commission DigCompEdu framework of competencies for educational practitioners[24].
However, it is one thing to identify the competencies needed, it is another to provide sufficient opportunities for professional development to ensure ALL VET teachers and trainers are supported in updating their competences. In this regard we recognise that traditional training courses for Professional Development may not be sufficient to meet the needs.
Therefore, we would urge an approach supporting more flexible and innovative opportunities for Professional Development including in particular blended and online learning programmes. At the same time, we also recognise that Continuing Professional Development programmes alone are not sufficient unless teachers and trainers are given the opportunities to practice what they have learnt. That implies close collaboration between curriculum bodies, social partners, employers and VET schools and training centres in designing and developing both initial and continuing professional development opportunities for VET teachers and trainers in the design and use of AI for teaching and learning.

These considerations have led us to develop the following recommendations.

- Incorporate competences for AI into all initial training programmes for VET teachers and trainers
- Encourage and support the development, searchability and sharing of Open Educational Resources for AI in VET
- Encourage and support the development of online programmes of Continuing Professional Development for AI in VET
- Support collaboration between industries, VET schools and training centres to develop new curricula and training in the use of AI in different occupations
- Support collaboration between industries, VET schools and training centres to allow VET teachers and trainers time with industry and c companies to update their own knowledge and competences in the use of AI in different occupations
- Update VET curricula to include AI

Let's shape the future of education.

[24] http://taccleai.eu/wp-content/uploads/2021/02/TaccleAI_FullReport_IO1_2021.pdf

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