ARTIFICIAL INTELLIGENCE & VOCATIONAL EDUCATION AND TRAINING

Perspective of VET teachers

Survey results

The Erasmus+ funded European project 'Improving the Skills and Competences of VET teachers and trainers in the age of Artificial Intelligence' (Tacle 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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1. Introduction

Artificial intelligence (AI) is not a new topic, instead it has been occupying computer science since the early 1950s. The term was first coined during the Dartmouth Workshop on artificial intelligence in 1956. The topic has been particularly high on the agenda in recent years, as recent technological advances push the limits of what machines can do (McKinsey, 2018). This is particularly due to the increasing use of the Internet, the availability of data and more powerful computing and algorithms. A uniform definition of what artificial intelligence is, however, does not yet exist, since AI combines a multitude of technologies. Artificial intelligence is therefore to be understood as a kind of 'umbrella term' (Southgate et al., 2019, p. 17). The challenge of defining AI lies in the fact that it cannot be conclusively determined what is considered »intelligent«. Nevertheless, there are some attempts at a definition, for example the following from the German online platform for AI, which serves as a basis for definition in this paper[1]:

> *"The term AI stands for systems that exhibit behaviour commonly assumed to be human intelligence. The goal of modern AI systems (learning systems) is to enable machines, robots and software systems to independently process and solve abstractly described tasks and problems without each step being programmed by humans. At the same time, the systems should also be able to adapt to changing conditions and their environment."*

The official strategy paper of the European Commission (European Commission, 2018) on AI starts by proclaiming that »AI is reality«. And indeed, many of us use AI-based technologies in our daily lives: voice assistants, image analysis software, search engines, speech and face recognition systems. Most people know rather less about AI processes and technology, what data are used and how the algorithms look like. However, such knowledge is necessary to understand possible dangers and ethical challenges in the context of digital transformation. Technological change is leading to a fundamental change in the world of work: occupational profiles change, occupations disappear and other occupations emerge (Brynjolfsson & McAffee, 2014). How is the educational landscape reacting to this trend, especially in vocational training? What skills will teachers need to have in the future to prepare young students for the working world of the future? The Erasmus+ project *Tacle AI - Improving Skills and Competences of VET Teachers and Trainers in the age of Artificial Intelligence*[2] deals with these and other questions. The following is a brief overview of the influence AI has on vocational training. This is followed by the results of an online survey among German vocational school teachers.

2. Background information on Artificial Intelligence and VET

Vocational schools face two challenges in the context of the digital transformation. First, they must prepare young people for a technology-based working world. Second,

[1] https://www.plattform-lernende-systeme.de/glossar.html

[2] Tacle AI is a two-year Erasmus+ project with partners from five European countries. It focuses on the question of which (new) competences teachers and trainers need in order to respond to the AI transformation of the professional and working world and to prepare young people for an AI-based working environment. Project homepage: http://taccleai.eu/

vocational schools, as educational institutions, must themselves undertake a digital transformation. Learning and teaching can be further digitalized through new technologies, and schools must discuss how to deal with this. In Germany the curricula for some apprenticeship programmes have already been adapted to changes in the world of work, e.g. the IT professions. Topics such as optimisation of digital processes and smart products, networking and automation as well as analysis of data and processes are to be taught there.
The German AI strategy[3] states that the understanding of AI for vocational education and training needs to be promoted among young people in a new kind of way. Concrete projects in this context are the establishment of learning factories at vocational schools. These could help to improve technical skills by topics related to AI. These Learning Factories provide a professional learning environment to allow project-based and work process-oriented learning which support social skills. However, have these ideas and the field of AI already reached vocational schools? These and other questions are dealt with in the following.

3. Study design for the survey of current and future role of Artificial Intelligence in vocational schools in Germany

In June 2020, vocational school teachers in Lower Saxony and Bremen were surveyed on the topic of "artificial intelligence in vocational education and training". The overall aim of the online survey was to get a first picture of the role artificial intelligence plays currently and for the future in vocational training in the region of Lower Saxony/ Bremen. It was of interest to find out what actually takes place at vocational schools in the context of AI as well as the individual opinions and assessments of vocational school teachers on the topic of AI in general and in vocational schools. 29 vocational schools were contacted with a request to forward the survey to the colleagues. The results presented here reflect an initial interim status and do not claim to be representative. The survey is explorative in nature, so that no generalisations can be made from the sample to the target population (vocational school teachers in Lower Saxony and Bremen). Nevertheless, the data show tendencies in how vocational school teachers perceive and evaluate AI.

Data collection through an online survey

An online survey was chosen for data collection as the survey could be distributed relatively easily and simultaneously. This enabled the vocational school teachers to process the questionnaire independently of time and space (Wagner & Hering, 2014). On the other hand, there is the advantage that no interviewers are used, as is the case with telephone surveys, for example. This eliminates interviewer effects and minimizes effects of social desirability. The result can be an increased sense of privacy, which can have a positive effect on data quality. At the beginning of the survey the participants were given a definition of AI to ensure that the respondents had a relatively similar understanding of the term. The socio-demographic data were then collected. In addition to age and gender, these include questions on work experience, subjects taught and occupations for which the respondent is trained. In terms of content, the questionnaire is divided into four thematic areas. First, the general attitude towards AI was asked. The second set of topics includes questions on

[3] https://www.bmbf.de/files/Nationale_KI-Strategie.pdf

the integration of AI at vocational schools as a) preparation for the AI-based working world, i.e. in the form of projects or lessons on AI and b) as an application for learning and teaching. The third section of topics covers questions about work and occupation-relevant developments in the context of AI transformation. The final thematic section deals on the one hand with which competencies are becoming increasingly important for vocational school teachers. The areas of competence covered are based on the European Framework for the Digital Competence of Educators (DigCompEdu). On the other hand, it is asked whether vocational school teachers consider training courses on AI to be relevant for themselves, whether they would participate and which topics would be of particular interest.

When creating the questionnaire, attention was paid to integrating both open and closed questions. The closed questions offer the advantage that quantified statements can be made about the participants and the answers are more comparable. However, closed questions require that the questionnaire creators are aware of the alternative answers. Furthermore, closed questions run the risk that the categories of answers will influence the participants' response (Franzen, 2014). Open questions, on the other hand, can be used to collect answers that do not indicate a mental direction and the respondents can express thoughts in their own words (Züll & Menold, 2014). However, evaluation is more time-consuming and comparability is reduced. The mix of open and closed questions is intended to combine the respective advantages of both in order to obtain a comprehensive picture.

Descriptive evaluation of the survey results

Sociodemographic characteristics of the sample

48 vocational school teachers aged between 30 and 63 years participated in the online survey. In the following, the percentage figures refer to this number of cases (N=48) if no further details are given. The average age of respondents is 50 years old. Eight of those interviewed were female, 38 male and two persons had an item non-response, i.e. the individual question was not answered. The majority of the persons (40%) have been working as vocational school teachers for eleven to 20 years. The interviewees were able to indicate which professions they mainly train for. The open answers were coded using the classification of occupations[4] (from 2010) and assigned to the ten occupational areas or main occupational groups. 60 percent of the respondents provide training for an occupation in raw material extraction, production, manufacturing. It can be seen that within this area, respondents provide training primarily for mechatronics, energy and electrical occupations as well as for mechanical and automotive engineering occupations.

General attitude of vocational school teachers towards AI

The general picture of the respondents about AI is generally positive, with almost 80 percent stating that they have a rather positive or positive image of AI. None of the individuals surveyed indicate that they have a negative image of AI. The positive image of AI is consistent across age groups, gender and work experience. For example, in each of the four age groups, the majority of respondents have a positive image of AI (Table 1). A breakdown by profession also reveals no differences in attitudes towards AI.

[4] https://statistik.arbeitsagentur.de/nn_10414/Statischer-Content/Grundlagen/Klassifikationen/Klassifikation-der-Berufe/KldB2010/Systematik-Verzeichnisse/Systematik-Verzeichnisse.html

Table 1: General attitude towards AI by age groups

	30 -39 years	40 – 49 years	50 – 59 years	60 years or older	total
(rather) negative picture	N=2	N=2	N=4	N=0	N=8
(rather) positive picture	N=7	N=4	N=21	N=5	N=37
total	N=9	N=6	N=25	N=5	N=45

Question: In the following we would like to know what your general attitude towards AI is. What is your overall image of AI?

This (rather) positive basic attitude is also reflected in the high level of agreement (62.5%) with the following statement: Artificial intelligence is good for society because it helps people to do their work or to perform their everyday tasks at home.
The statement that artificial intelligence is necessary because it can be used to do work that is too difficult or too dangerous for people is also supported by two-thirds of the respondents.

AI for teaching and learning in VET

The second set of topics asked whether the topic of AI is already being addressed, what effects AI has on the professions in the teachers' opinion, and whether curriculum adjustments would have to be made in response to these changes.
More than two-thirds of the respondents (69%) say that they themselves or their school does not have a project dealing with AI, or that they know nothing about it. One third say that an AI project exists at their school. Six of the respondents state that it is an internal school project. Nine of the respondents say that it is a project in cooperation with external partners (e.g. companies). The teachers who have not been involved in any AI project so far or who do not know of any at the school were asked whether they consider the development of AI projects to be useful in the future. 76 percent think it is useful.
The respondents were then asked to report more about the projects. It is noticeable that the spectrum of the projects is quite broad. The following topics were identified in the open answers: smart production facilities, autonomous driving, intelligent sensors in the industrial sector 4.0, deep reinforcement learning, collaborative robotics, programming of AI systems and data analysis.
The diversity of topics makes it clear how differently AI can be addressed in vocational school. While some deal with programming for character recognition, others deal with intelligent sensors in the area of Industry 4.0. Another project deals with the topic of "Deep Reinforcement Learning". Reinforcement Learning means intensified learning and describes a "process in which a learning system makes decisions on the basis of which it then acts. It uses an algorithm that learns to better assess the chances of success of the individual actions in different situations. It receives positive or negative feedback for the selected actions. The goal of the system is to receive as much positive feedback as possible. Deep Reinforcement Learning uses artificial neural networks as models that have been successfully used in games (e.g. Go, Poker, Atari)" (Lernende Systeme, 2020).
Another vocational school teacher reports on a cooperation project with a company for autonomous driving in Hamburg. This is aimed at prospective electric mobility technicians and is intended to clarify the requirements for autonomous driving and thus enable students to make their first contact with artificial intelligence. Another teacher reports on the school-internal and cross-professional "Smart Factory". Smart Factories are

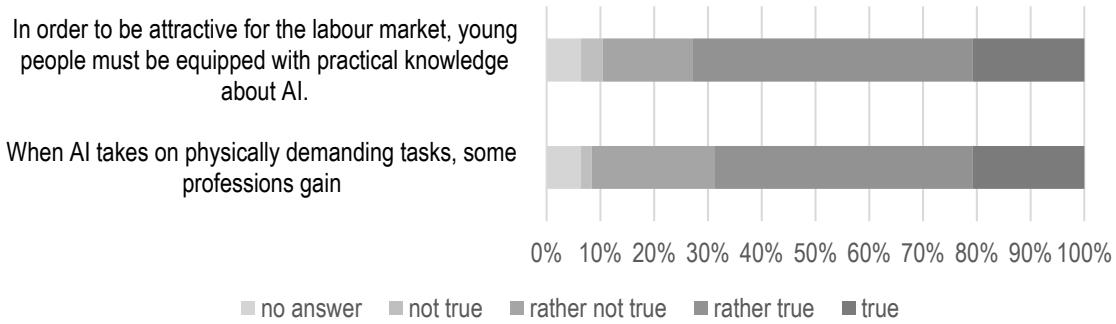
decentralized learning workshops that were established at six locations with a total of eleven vocational schools as part of the Lower Saxony project "BBS (VET school) fit for 4.0". They are intended to give trainees in industrial-technical and commercial professions the opportunity to further their education in modern 4.0 environments. At a VET school in Wolfsburg, apprentices for automation technology and dual students have built a smart bottling plant. The industrial facilities in the neighboring Volkswagen plant serve as a model. At the models of the Smart Factory, the students* can gain practical experience in dealing with the latest industry 4.0 technologies.

In the second set of topics, vocational school teachers were also asked about the use of AI applications for teaching and learning. One third of the respondents consider the use of AI technologies in teaching to be helpful in principle. A quarter even stated that they already use learning or teaching applications based on AI. However, 90 percent of the people who have not used AI applications for learning and/or teaching so far can in principle imagine doing so. The teachers were also asked how they assess the future importance of the following AI technologies as learning applications in vocational schools over the next three years: Learning Analytics, AI-based examination systems, machine learning tools and apps, adaptive learning, intelligent and speech-based assistants and humanoid robots. The question is taken from the mmb Trendmonitor (2020), in which 60 experts from Germany, Austria and Switzerland are interviewed online every year on the topic of digital learning. The experts of the mmb Trendmonitor expect Learning Analytics and Adaptive Learning to gain importance as learning applications in the next three years (mmb Institut, 2020, p. 12). Humanoid robots are considered to have the least potential. The assessments of vocational school teachers are basically in line with those of mmb trend monitor experts. They ascribe the highest importance to Adaptive Learning, Machine Learning Tools and Apps and Learning Analytics for the next three years.

The vocational school teachers were also asked to agree or disagree with a number of statements. Over 60 percent assume that teaching and learning will fundamentally change through the use of artificial intelligence. However, they do not think that the use of artificial intelligence will replace teachers, trainers or instructors. In the category "Other remarks", a teacher made the following statement on the topic of whether AI will replace teachers: "AI will not be able to replace teachers because of the empathy and social skills of teachers. It should only be seen as support. (...) otherwise humanity and social integrity will be lost".

Future effects of AI on the working and occupational world

In the third block of questions, the teachers were asked about their assessment of future AI-induced developments in relation to the labour market and education in general. 71 percent assume that there will be neither job cuts nor job gains, but that the number of



jobs will remain relatively constant. Instead, there will be changes to tasks within occupations, according to the teachers' assessment. The teachers were also asked to indicate the extent to which they agree with the following statements. They assume that the assumption of physically demanding tasks by AI can make some occupations more attractive. At the same time, the vocational school teachers also see that action knowledge about AI is necessary for young people in order to be attractive for the labour market.
Overall, the interviewees therefore see that AI changes the working and professional world and that it also has an impact on competences. The vocational school teachers were also asked whether they assume that the use of artificial intelligence influences the professions for which they themselves train. 75 percent of the respondents expect that AI will have an influence on the occupations for which they train.

Teachers digital competences in the age of AI

In the final section of questions, the teachers were asked whether they could imagine taking part in an online course entitled "Vocational school teachers fit for AI". The vast majority (77%) would participate in such a course. The main argument against participation is lack of resources (time). The top 3 training topics that would be of interest are AI tools for teaching, AI pilot projects from other vocational schools and practical examples from industry.
The DigCompEdu framework was used to find out which digital competences will become more important for teachers in the coming years in the context of AI and vocational training (Redecker, 2017). The DigCompEdu framework proposes 22 digital competences organised in 6 areas. The competences are divided into further levels of competence (A1, A2, B1, B2, C1, C2), so that teachers can determine their level of competence. In principle, the framework is aimed at teachers in all sectors of education and is intended to support them in the use of digital media in educational programmes. Area 1 focuses on the professional environment, i.e. the use of digital technologies by educators in professional interaction with colleagues, learners, parents and other interested parties, for their own individual professional development and for the continuous innovation of the institution and the teaching profession. Area 2 deals with the competences required to use and create digital learning resources effectively and responsibly. Area 3 is devoted to the management and orchestration of the use of digital technologies in teaching and learning. Area 4 is concerned with the collection and analysis of data relevant to learning and the provision of feedback. Area 5 focuses on the potential of digital technologies for learner-centred teaching and learning strategies. Area 6 deals with the specific pedagogical competences needed to promote digital literacy among pupils. Areas 2 to 5 represent the pedagogical-didactical core of the competence framework.
According to the teachers surveyed, all areas of competence will gain in importance when AI becomes part of everyday life at vocational school. It is noticeable that in area 4 "Use of digital technologies and strategies to improve the assessment of student internal performance" and area 5 "Use of digital technologies to improve social integration and personalization of learning tasks", more respondents assume that these competencies will remain the same or, in the opinion of some, even decline. This assessment is interesting, since it is precisely the evaluation of performance and the personalization of learning tasks that is seen as the decisive added value of AI for schools.

4. Summary and Outlook

In summary, there are isolated AI projects in schools, but these have not yet reached the wider community and should therefore be considered pilot projects. Of the projects identified, 60 percent are carried out in cooperation with external partners. The initiation of AI projects could therefore promote cooperation between learning locations.
It can also be concluded that vocational school teachers are quite open to the use of AI-based learning applications in vocational school. On the one hand, they can imagine themselves using AI-based applications. On the other hand, they expect that AI-based learning applications, such as Adaptive Learning, Machine Learning Tools and Apps and Learning Analytics will gain importance in vocational school as a whole and that teaching and learning will change fundamentally. At the end of the survey, the respondents were able to make further comments on the topic. There were a few critical statements, e.g.

> *"AI is important for the future and there will be no way around the use of AI if institutions want to remain competitive. But in vocational schools there are much more urgent problems that need to be solved. In the face of so many projects, action orientation and media mania, students today only in exceptional cases master basic cultural techniques such as meaningful reading, the simplest mathematical skills and concentrating on one thing for more than three minutes".*

The survey was conducted within the European project Taccle AI. In the future, it is planned to conduct similar surveys in the project partner countries to compare how the topic AI and VET is approached there. There will also be a survey of companies in the region of Lower Saxony and Bremen. After all, vocational schools are only one place of learning in the dual German vocational training system. It is therefore also of interest what the companies expect for changes in the labour market in the future and what effects this will have on the qualifications required of employees.

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