Guidelines on the implementation of digital training and virtual mobilities in automotive professions

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DAMAS VET

Digital Apprentices Mobility in the Automotive Sector

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Abstract

This document contains guidelines that support VET (Vocational Educational Training) teachers and trainers with the digitalisation of both the learning process of their students and the support of possible apprentices' mobility abroad. The main focus of this study is on the automotive sector, yet, its outcome will be transferable to other industries. The guidelines first introduce all five project partners and their automotive industry: Belgium, Catalonia/Spain, Germany, Italy and Sweden. The reader will find an analysis of successful digital examples within VET schools and companies in the partner countries, as well as a methodology about how to further digitalise VET. Chapter two focuses on the VET studies while chapter three gives inputs to blended or fully digital mobilities of the students. Chapter four introduces the reader to different online tools that proved efficient within the partner countries. In chapter five, all outcomes of this project are summarised comprehensively. Throughout these guidelines, the various approaches for introducing digital means in teaching VET and in supporting mobilities for VET students are introduced, but we also look at their concrete and transferable advantages.

Table of Contents

1. Framework and Specifications

I. Quick Description of the Project in the Current Pandemic Context and Short Presentation of all Project Partners

One of the most pressing problems facing Vocational Education and Training (VET) students and teachers, especially in the COVID-19 context, relates to apprenticeships and Work-based Learning (WBL). The issue is aggravated when it comes to international mobility. Will future mobility still be physical, virtual or rather blended? All partners involved in this proposal are convinced that new solutions have to be found for the future, all the more as during COVID times, there has been an even greater uncertainty surrounding travel abroad.

We will test virtual training and mobility in the automotive sector, which is a big challenge and one of the main innovations of the project. The sector was chosen as a pilot branch because automotive manufacturing is an important industry in most of the partner regions, especially in Baden-Württemberg and Catalonia.

The project results could be part of experiential education. There are applications in the industrial sector where technical skills are only taught by making use of virtual reality. In today's society, it is important for everyone to gain insight into the use of digital technology and the way technologies interact. In labour market-oriented programmes DAMAS also focuses on the sustainable use of computer programmes, apps and (new) technological applications. In this way, we develop future-oriented training programmes for young people.

This is of course highly specialised, and no national education system as yet has an overall solution. That is why it is essential to tackle this on a Europe-wide level. Our target groups are policymakers, teachers and ultimately pupils in VET, as well as the automotive industry – big or smaller companies. All of them are essential partners to accomplish a digital shift in teaching VET.

Since February 2020, the COVID-19 outbreak has had negative effects on ongoing or planned mobility activities for apprentices eager to go abroad for a short-term training period within their VET time.

The European Commission published three recommendations on 1st July 2020, which can also provide a 'support' and favourable context to overcome the devastating

consequences that the Covid-19 crisis infringed in the education, training and youth sectors:

- Council Recommendation on Vocational Education and Training (VET) for sustainable competitiveness, social fairness and resilience
- Youth Employment support package
- European Skills Agenda – Skills for jobs
- In addition, in late September 2020 the
- European Education Area initiative and
- the new Digital Education Action Plan

were adopted.

Key terms like "green and digital transition", "accessibility", and "a modern, attractive and flexible VET" are mentioned in the three documents and are central to our proposal. The Erasmus+ programme 2021-2027 proposal includes a clear focus on the green and digital transition and also addresses social inclusion.

The development of innovative digital methods and training tools can contribute to a stable supply of apprenticeships and WBL during critical economic situations like the ongoing pandemic. In addition to this, supporting educators in their professional development enhances their digital readiness. It should be noted that new learning environments, tools and pedagogy linked to digitalisation are necessary for increasing the digital readiness of VET institutions.

Furthermore, it is relevant to mention the two following initiatives:

- the Pact for Skills launched in November 2020
- the renewed European Alliance for Apprenticeships together with the above-mentioned Erasmus+ programme 2021-2027.

Presentation of the project partners

Borås vuxenutbildning Sweden:

Boråsregionens vuxenutbildning (BRvux) is the adult vocational education and training provider for the (Borås) region.

The region of Borås (Boråsregionen) is located in the southwest of Sweden, near Gothenburg. The region consists of eight municipalities, Bollebygd, Borås, Herrljunga Mark, Svenljunga, Tranemo, Ulricehamn and Vårgårda. The target group for

adult education is employed or unemployed people who need competence development or would like to change careers.

Borås records experiences in the field of digitalisation, as they provide blended learning in different adult education courses.

More information at: brvux.se

Training 2000 pcs:

TRAINING 2000 is an adult education centre, which operates activities of Adult Education and Training (VET), consulting and promotion of training activities in companies, and training of trainers and teachers in schools. Such training courses take place in the areas of social integration, entrepreneurship, ICT e.g. for migrants, integration of disadvantaged groups for employment, eco-tourism, sustainable environment, new methodologies in teaching and learning (distance learning), community development and healthy lifestyle.

Training 2000 is a "Certified centre for training" in the Marche region and cooperates in Regional and European networks of different actors: Employment Offices, Trade Unions, National association of SMEs (C.N.A), Associations of seniors and migrants, public libraries in the Province of Pesaro and Urbino, Municipality of Fano, Public offices, Universities of Urbino and Ancona.

Training 2000

- analyses the training needs within target groups and local communities,
- develops new occupational profiles and training curricula
- executes vocational training courses and apprenticeship programmes apt to requalification and re-skilling of youths and adults in the major economic sectors of the region.

TRAINING 2000 has been involved in various international projects, with partners from most European countries since 1994. At the moment, Training 2000 employs 5 full-time staff and cooperates with more than 30 external experts covering different knowledge domains.

More information at: www.training2000.it

EARLALL:

EARLA LL is a Brussels-based network of regions aiming to contribute to EU policy-making and takes part in projects in the field of lifelong learning. Based on the unique strengths of every region and local authority, EARLALL facilitates regional collaborations and partnerships, as well as an open and rapid exchange of knowledge in a context of trust and confidence. Today, EARLALL counts on 12 full member regions, as well as on a group of partners (universities, public institutions and sector-related entities).

Members and partners are actively involved in the life of the EARLALL organisation through their participation in meetings, technical working groups specialised in particular issues, thematic seminars and other events. The Secretariat in Brussels ensures day-to-day management: it provides information and briefings on EU policy, cooperates with stakeholders, releases reports, handbooks, project information and results, and helps members with the exchange of good practices, partner search and dissemination of projects and events.

More information at: http://www.earlall.eu

HET GEMEENSCHAPSONDERWIJS- GO! BELGIUM:

GO! organises official education in the Dutch-speaking part of Belgium. It is financed by the Flemish government but functions independently of the Flemish Minister of Education. GO! is one of the three main educational networks in Flanders. GO! schools are spread all over Flanders and the Brussels capital region.

GO! provides education from nursery school through compulsory school age to adult education. Also, it includes schools specialising in creative and performing arts and technical and professional education. GO! provides curriculum development and teacher training for its 773 schools, which means currently working for 28,000 members of staff, and serving 212,000 students and 110,000 adults. The main mission of GO!'s Council is to guarantee free choice of education in Flanders and the Brussels capital region. The members of the GO! Council makes the main strategic choices for the future of GO!

GO! provides all children, whatever their background or status, with equal opportunities in education, helping them discover and develop their unique talents.

In today’s world with all its various aspects, beliefs, opinions, religions, and ways of life, it is more than ever crucial to teach children how to live together.

GO! has a large network of secondary VET schools (135) offering a wide range of vocational and technical subjects such as catering schools, welding, automotive, and building but also horticulture, fishing and inland navigation.

GO! has been investing in using digital means for education but the period of emergency online teaching in the first half of 2020 made the current lack of knowledge clearer, especially as to effective ways of distance education for VET subjects.

DEPARTAMENT D'EDUCACIÓ- GENERALITAT DE CATALUNYA:

The Government of Catalonia is structured into different ministries responsible for the various areas of government. The Departament d'Educació (Regional Ministry of Education) is the administrative body of the Government of Catalonia responsible for education matters.

In close cooperation with local companies and professional associations, the DGFPIERE sets up training programmes for IVET students and supports training centres. It also deals with all the actions involving school-enterprise links. It has control over 45% of the pedagogical curricula for VET.

It also coordinates the compulsory work placement of all the vocational students in the country, who study in the 400 Vocational Training Centres of the region. Approximately 40,000 students are involved in work placements. More than 1300 of those work placements take place abroad.

The ongoing changes the world of labour evolves into are translated into vocational innovative policies designed by the educational experts working in the ministry. Several programmes have been developed in recent years to generate vocational excellence in the training centres the DGFPIERE (Direcció General de Formació Professional) manages. Those programmes led to the creation of eight working networks, through which the vocational training centres are informed and updated on the most recent vocational policies and initiatives.

More information at: http://xtec.gencat.cat/ca/projectes/mobinternacional/

BBQ Bildung und Berufliche Qualifizierung gGmbH, Germany:

The "Bildungswerk der Baden-Württembergischen Wirtschaft e. V. " is the education and training organisation of employers' confederations, gathering 26 regional or branch-related business associations, Chambers of Commerce and companies of Baden-Württemberg, south-west Germany. This region is number one in Europe as far as innovation is concerned.

One big key partner of the training organisation in the M+E industry (Metal + Electrical) is called SüdwestMetall. They started a strong initiative named "Southwest metal makes education" as a consistent commitment in every single phase of the educational biography, especially VET. Its final goal: to secure skilled workers in the metal and electrical industry.

Videos, Apps, M+E Truck, Programs and projects for 2000 apprentices in industrial metal-working professions are constantly being designed and conducted throughout the big region.

Together with its Academy for Personal and Organisational Development and two subsidiaries, Apontis GmbH and BBQ Bildung und Berufliche Qualifizierung gGmbH, over 600 employees in three training centres and 50 branch offices are active in all regions of Baden-Württemberg. Projects and services are being offered for different target groups all year round. Quick figures: 50.000 attendees per year and 4.000 companies involved in the various projects of the "Bildungswerk der Baden-Württembergischen Wirtschaft e. V."

Moreover, the training institution has been partnering with international networks since the 1990s, gathering solid project experience with companies and institutional partners on several continents. Particular focus is being made on the promotion of professional mobility, the development of vocational training structures and international exchange.

More information at: www.biwe-bbq.de

II. Virtual VET and Apprentices Mobility: Definition and Good Reasons for it

A relevant transnational problem that our DAMAS project is focusing on, is to which extent the experience with online learning and recognition of learning outcomes gained during virtual mobility, can be facilitated. Another key issue that shall be examined more closely is the relevance of various e-learning methodologies and techniques for VET teacher training.

Furthermore, the pandemic led to the positive development of new pedagogical tools and methods of teaching through digitalisation.

Virtual reality (VR) and extended reality (XR) can be used in teaching vocational education and training in automotive in several ways:

- VR simulations can be used to create interactive, immersive learning experiences that allow students to practise and learn automotive skills in a safe and controlled environment. For example, students can use VR headsets to practise tasks such as changing tires, diagnosing engine problems, or repairing brakes.
- XR technologies such as augmented reality (AR) can be used to overlay digital information and instructions onto real-world objects and environments. This can be particularly useful for providing students with step-by-step instructions or guidance while they are working on automotive tasks.
- VR and XR can also be used to create interactive, 3D models of automotive systems and components, allowing students to explore and learn about these systems in a more interactive and engaging way.
- VR and XR can be used to create virtual field trips or virtual visits to automotive facilities, allowing students to experience and learn about different automotive environments and technologies without having to physically travel.
- VR and XR can also be used to create virtual classrooms and training sessions, allowing students to participate in interactive, online training sessions from anywhere.

Overall, VR and XR technologies have the potential to revolutionise the way vocational education and training are delivered in the automotive industry, providing students with more interactive and immersive learning experiences that can help them better understand and retain important concepts and skills. But this potential is still on the brink of being rolled out.

A concrete example is the use of Microsoft Hololens in automotive VET in Belgium. The Microsoft HoloLens is a mixed-reality headset that can be used to augment a user's real-world view with digital information and interactive 3D models. In the automotive industry, the HoloLens can be used for a variety of training and educational purposes, such as:

- Visualising and interacting with 3D models of automotive systems and components: With the HoloLens, users can view and manipulate 3D models of various automotive systems and components, such as engines, transmission systems, and suspension systems. This can be a helpful tool for understanding how these systems work and how they fit together.
- Providing step-by-step instructions for complex tasks: The HoloLens can be used to provide detailed, step-by-step instructions for tasks such as diagnosing and repairing automotive systems. This can be especially useful for training technicians who are learning to work on new or complex systems.
- Simulating real-world scenarios for training purposes: The HoloLens can be used to create realistic simulations of various automotive scenarios, such as working on a vehicle in a garage or troubleshooting a problem on the road. This can be a valuable tool for preparing technicians for real-world situations they may encounter on the job.

Overall, the HoloLens can be a valuable tool for teaching and training in the automotive industry, providing an immersive and interactive way for students and technicians to learn and practise their skills

III. Quick Overview of the Automotive Sector in Belgium, Germany, Italy and Catalonia/Spain and Sweden

Belgium

For decades, the automotive industry has played an essential role in the economy of Flanders, Belgium's northern region. High-quality cars, trucks, buses and other vehicles are assembled in Flanders and exported over the world from a unique, central location in Europe that has all the logistics, production and innovative expertise.

Despite its relatively small size, Flanders buzzes with automotive activity, accounting for:

- 302 companies and 47,595 direct jobs
- EUR 16.4 billion in annual turnover
- an annual investment value of EUR 385 million
- EUR 3.3 billion in added value per year

(Agoria, 2020)

A broad range of automotive research and knowhow

Two car assembly plants are located at the core of Flanders' automotive industry: Volvo (Ghent) and Audi (Brussels). Moreover, the following bus and truck manufacturers play a big role: Van Hool (Lier), VDL Bus & Coach (Roeselare), DAF Trucks (Temse) and Volvo Trucks (Ghent). Together with Flanders' dense network of universities and market-driven research centres, they create the right climate for continuous innovation and even pioneering R&D in the automotive sector.

Automotive logistics facilitating this dynamic:

Flanders is situated right in the middle of Europe's main motor vehicle production sites, a central position from which each automotive business benefits greatly in terms of logistics, distribution and more. Flanders' ports in particular play a crucial part in automotive logistics in Europe and the world:

- The Port of Zeebrugge is the world's largest hub for handling finished vehicles based on deep-sea roll-on/roll-off (Ro-Ro) volumes. The port doesn't just grant access to a well-oiled and finely tuned network of RoRo terminals, vehicle processing centres, equipment processing centres, car deck storage, railway-

connected terminals and automotive transport firms. It also offers a broad range of value-added services such as pre-delivery inspection, carwash, (de)waxing, painting, repairs and more.

- The Port of Antwerp, Europe's second-largest seaport, has numerous multipurpose as well as dedicated RoRo terminals. In addition, its vehicle processing centres offer a wide variety of services, including remarketing, repairs, waxing, washing, etc. Interesting fact: the port is considered a market leader in the export of second-hand cars to West Africa.
- North Sea Port Ghent is home to an interconnected automotive cluster of car and truck assembly firms, car distributors, producers, suppliers and more – not to mention Volvo Cars' largest assembly plant, Volvo Trucks' biggest assembly factory and Honda's European distribution centre.

Education:

Belgium is characterised by a service economy. At the same time, there is a growing awareness that a strong industrial base is an indispensable foundation for a sustainable and healthy economy.

Without successful training of technically skilled workers, however, reindustrialisation remains an illusion. Industry and the dealer distribution network are facing an acute shortage of qualified employees. This shortage can be explained by a lack of inflow into technical and vocational training. There is additionally a growing gap between the educational programmes and system on the one hand, and the expectations of the industry, on the other hand. And although the economy should not be the only driver of education, the economic reality is a challenge for both the education and training systems. Technical and vocational training is the first victim of the "waterfall system" that the Belgian education system itself and therefore too many young people are concretely suffering from.

Too few students entering or completing this type of vocational training, too many young people getting tired of school, and training still generates little passion - these are some of the reasons why technical training suffers from an image problem and cannot offer a sufficient answer to the qualitative and quantitative demands of the industrial world, - among others, of course, the Automotive sector we are focusing on.

Specifically, for car mechanics, we observe that out of 100 young people who start such training, only 70 graduate and only 20 starts working in a car company after their apprenticeship. Moreover, 40% of those starting car mechanics leave the profession within five years.

Catalonia (Spain)

In Catalonia, the automotive sector is the second largest industrial sector - after the food sector - with a turnover of more than 19.4 billion euros (8.66% of GVA). It employs 38,800 people in 352 car manufacturing companies (specifically OEM and Tiers 1, 2 and 3) and produced more than 386,000 vehicles in 2020 (17 % of vehicles manufactured in Spain).

Adding manufacturing companies and car repair shops, the total number of companies in the sector exceeds 10,400 (1.7% of the number of companies in Catalonia).

Catalonia hosts companies from the entire automotive value chain as well as an industry support ecosystem made up of engineering and service companies, technology and R&D centres, clusters, trade fairs, universities and training centres.

When looking at exportation, the automotive sector represents about 12% of the total exports from Catalonia (Institut d'Estadística de Catalunya). Car production is the main subsector (74.2% between 2016 and 2020) followed by the production of components and other motor vehicle parts (24.2%) - Germany, France and the United Kingdom being the three main destinations for Catalan exports.

On the other hand, during the period 2016-2020, 27 foreign direct investment (FDI) projects were registered in Catalonia with a total capital investment of more than 1 billion euros, which created 2,558 jobs (representing 40.9% of the number of projects in Spain). This brings Catalonia to the third European destination for capital investment in the automotive sector.

Also noteworthy is the investment in start-ups: during 2016-2020, Barcelona attracted 144.2 million euros from emerging companies dedicated to transport and services related to electric mobility. This is the case with Paack, Wallbox, Cooltra, Silence or Yego.

(ACCIÓ - Generalitat de Catalunya)

Germany

The automotive industry is one of the most important industrial branches in Germany. Both the design/production of vehicles (e.g. Mercedes, BMW or VW), as well as the support industry (with Bosch or Continental supplies and spare parts), own big companies based in Germany. In 2020, the German automotive industry had a turnover of around 378.2 billion euros. Most of this revenue was generated overseas. The employment rate in the sector of combustion engine production started to shift to the sector of electric mobility in 2019, due to the increasing importance of the latter one. Still, according to Statista, the prognosis for the development of the employment rate stays very high. Especially in South Germany (Baden-Württemberg and Bavaria regions), the employment rate is incredibly high (Kords).

As we can see in Figure 1, about one-third of the German automotive companies are based in Baden-Württemberg. The best known may probably be Daimler AG and Porsche AG but several less-known companies are working from Baden-Württemberg as well: many system suppliers on a global scale and over 1000 small and mid-sized suppliers businesses (Clusterportal BW).

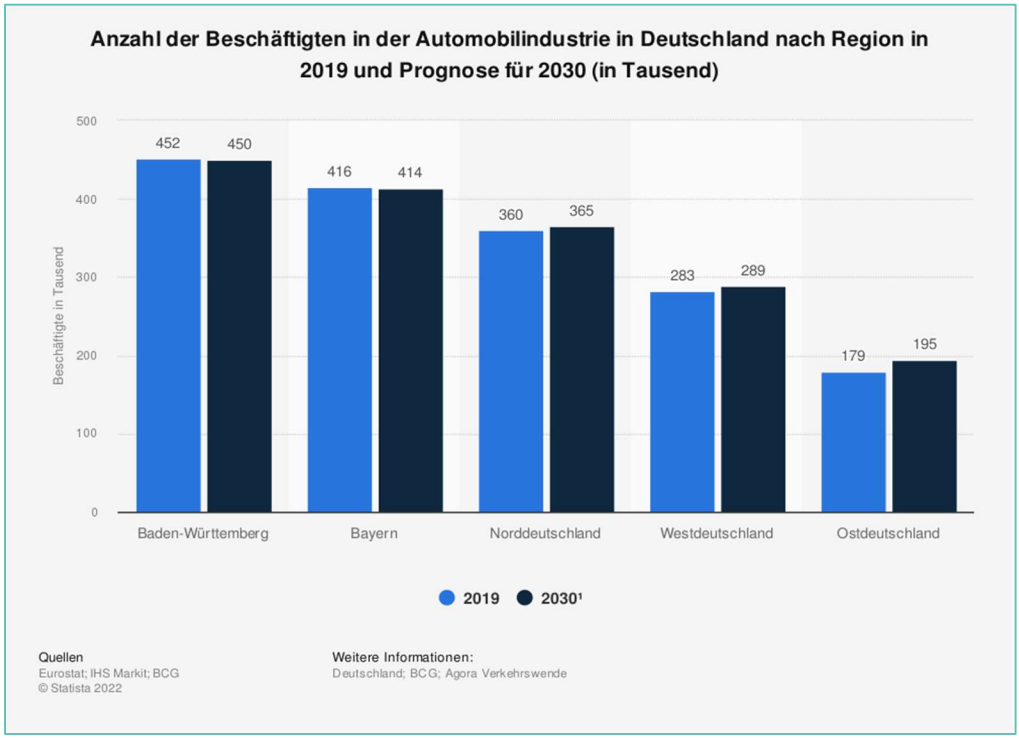

Figure 1 Number of employees in the automotive industry – 2019 - in Germany by region (Southern Germany with Baden-Württemberg and Bavaria, Northern Germany, Western Germany and Eastern Germany) and forecast for 2030 (in thousands).

Italy

The automotive industry has played and continues to play a very important role in Italy's economic development, especially given the big number of jobs covered here. This is true for the entire value chain, from the vehicle and component design to the manufacturing and marketing of finished goods, both inside the country and around the world. In 2019 the Italian automotive industry ranked 6th in Europe and 19th in the world. In terms of vehicle sales, the Italian market is the 4th largest in Europe and 9th in the world.

The sector can be split into the following main segments: personal and commercial vehicles, trucks and buses, and components.

In the automotive manufacturing sector overall, there are 2,467 active businesses in Italy. Their combined annual revenue came to around €107 billion in 2018 and the industry employs about 163,000 people. The vehicle segment accounts for 59% of the total Italian automotive sector, while the component segment is the second largest by revenue.

Key Figures:

2.467 **Companies**

163,202 **Employees**

107 billion **€**

Key Business Areas:

Vehicles: 59%

Commercial Vehicles 11 %

There are four main automotive regions in Italy:

- The industrial district in Piedmont, dominated by the FIAT-Chrysler group;
- "Motor Valley" in Emilia Romagna, where world-famous Italian luxury brands are produced;
- Lombardy, where there is a high concentration of component manufacturers, especially in the province of Brescia.
- The Abruzzo automotive industry district, that is active in new technological developments for motor vehicles and other machinery.

The production structure is characterised by substantial economies of scale, highly automated and relatively inflexible production lines, along with high capital intensity.

Education and training

Higher education

Automotive engineering is a branch of vehicle engineering, incorporating elements of mechanical, electrical, electronic, software and safety engineering as applied to the design, manufacture and operation of motorcycles, vehicles and trucks and their respective engineering subsystems. Several Master's Degrees in Automotive Engineering are available at different Universities in Italy. The professional profile of the Advanced Automotive engineer specialises in powertrain systems, the architecture of road vehicles, the architecture of racing vehicles, motor vehicles and in production.

1. Master Degree in Advanced Automotive Electronic Engineering is an Inter University International programme sponsored by MUNER - Motor Vehicle University of Emilia-Romagna, a project proposed by Regione Emilia-Romagna and that is the result of the collaboration among the Universities of Bologna, Ferrara, Modena and Reggio Emilia (administrative headquarters of the programme), Parma, and the world's most prestigious automotive companies based in the territory: Automobili Lamborghini, Dallara, Ducati, Ferrari, Haas F1 Team, HPE Coxa, Marelli Europe s.p.a., Maserati, Pagani, Alpha Tauri and, more recently, AVL, Bosch, CNH, Pirelli, ST Microelectronics.

2. Automotive Engineering at the Polytechnic of Torino,

3. Advanced Automotive Electronic Engineering-School of Engineering and Architecture Bologna

4. Transportation and Automobile Design POLI.design – Milan

5. Advanced Automotive Electronic Engineering University of Parma- Parma.

Vocational training courses

- The Automotive training courses for professionals in the Automotive sector cover aspects related to improving the management processes of vehicle and component manufacturers, with an increasing focus on sustainable and smart mobility. These training courses deepen knowledge of industry-specific regulations from IATF 16949:2016 to VDA standards.
- Courses on qualification of manufacturing processes and suppliers, testing of Automotive components, in-depth and hands-on functional safety and safety training courses complete the offering, targeting technicians working on hybrid vehicles and E-mobility. This is the case for various business functions such as

quality and quality assurance managers, auditors, production managers, product research and development managers, as well as engineering and logistics experts.

The most common topics addressed by the Vocational training courses in the Automotive field are as follows:

- EC Regulation 168/2013
- EMC Vehicles and Components
- Hybrid and Fuel Cell Vehicles
- Electric Vehicles
- Electric Architectures
- Automotive Quality management system

Sweden

Sweden is one of the countries in the world where the automotive industry has the greatest importance for the economy. In an international comparison, Sweden is unique: it counts only ten million inhabitants while hosting several vehicle manufacturers with both manufacturing and product development. The automotive industry is one of (West)Sweden's largest industries and it has a high international position. It consists of OEMs (Original Equipment Manufacturers, and producers, such as AB Volvo, Volvo Cars and Scania) as well as suppliers, which often are small and medium enterprises. In total, the automotive industry is estimated to employ approx. 140.000 people. Moreover, there is even a "multiplier effect" where each job in the automotive industry is estimated to generate two more. It is therefore in the national but also the regional interest to keep the automotive industry successful - otherwise it would lead to big negative consequences for the whole of society, with unemployment and reduced growth as a result.

The fast development of technology and new societal needs means that the automotive industry gets increasingly complex. This leads to rising needs in certain highly technical areas, but also the development of completely new business models and changes in organisations and approaches. The automotive industry in Sweden therefore needs, to be able to maintain its international position, to undergo a competence transition among its employees.

IV. Objectives of this Handbook / Expected Results / Action Plan

This handbook is designed as a practical tool for VET teachers, trainers at companies and VET students in vocational education, but also organisations, professionals planning and organising ERASMUS+ mobility schemes or policy-makers, staff of business and training associations, companies and other employers - particularly within the automobile sector that was the focus of this study.

- It can obviously be used by anyone e.g. working with virtual reality, willing to develop in this field, or interested to learn how other organisations and countries work in this new field.
- These guidelines can help organisations to enhance distance education for VET subjects and use digital means for apprenticeships, both nationally and internationally. This shall also happen through the establishment of coaching and dual education training for VET teachers at schools and trainers at companies. The ultimate goal is rising chances of employment for VET pupils.
- This handbook is also a tool to implement blended- and online training in the automotive sector taking into account universal inclusion principles.
- This handbook can motivate and support the development and use of digital applications for the VET teacher to manage autonomous and social learning processes in vocational education on an individual basis. It could also boost the digital facilitation of learning processes to ensure that learning becomes transparent, manageable, controllable and transferable and enable the users to make the best use of technology since pedagogy and technology have to go hand in hand.
- The guidelines will, on the one hand, respond to the needs of teachers and trainers in vocational education to acquire methodological and pedagogical skills on how to integrate digital elements and training tools in the framework of VET in general. On the other hand, the guidelines cover the management and workflow/processes of European mobilities and make visible how digital elements can be integrated into pre- and post-stay activities of mobilities (application, selection of candidates, pre-stay discussions, information and training, practical travel and accommodation arrangements as well as follow-up activities and permanent contacts after the stay) and during the training period abroad or online. This handbook also aims at sharing short best practice reports and illustrations based on pilot training and - mobilities carried out by other organisations abroad.
- It will be promoting blended and online VET apprentice mobilities through all hereby developed tools and contents. The guidelines will be relevant both for hybrid

mobilities combining online elements and physical stays abroad and for 100% virtual VET mobility.

- The COVID-19 outbreak has had negative effects on ongoing or planned mobility activities: By learning from what several other organisations and countries have done in the VR area within the automotive sector, brand-new tools and methods will be presented in these guidelines. Furthermore, the handbook could encourage people with special needs to perform fully digital mobility.

2. Successful Examples of Virtual VET Teaching

I. Successful Blended or Fully Virtual VET Teaching in Belgium

Diagnose Cars is a non-profit organisation that provides material, hard- and software, knowledge and inspiration to the Flemish automotive schools of both the public and catholic networks, in collaboration with the automotive industry.

In 2019, Diagnose Car developed EV'nAR. An AR application for the MS hololens.

This application makes it possible to get to know the components of an electrically driven vehicle. Also, students can learn how to de-energise the vehicle, according to the manufacturer's prescribed standards, with visual and auditory support. All pupil activities can be followed by their teacher via a central platform.

GO! Technisch Atheneum Keerbergen, a Flemish public (T)VET school, started several years ago with virtual reality in an attempt to keep track of innovations in the industry and close the gap between the classroom and the workplace.

i. Description of the Situation and Involved Parties / Regional Legal Frame / Tools List and Reasons for this Choice

DIAGNOSE CARS / COSMO Keerbergen

The school uses the Diagnose Cars application which was developed in cooperation with many actors. Two secondary schools were extensively involved, as well as various authorities for funding. The development itself was done by Enriched (Cronos group - recently merged into RMDY). Diagnose Car coordinated and led the whole project.

The school chose AR over VR because…

- Teachers also need to be able to teach with the hololens (pupils follow via live streaming)
- When a teacher is teaching, he/she stays in touch with the class because of the type of glasses. This is not possible with VR.

The hololens is expensive but has the right specs for this application.

Also, dynamic guides is an MS application for hololens that helps you to make 3D guided explanations and instructions, thus making it easy to use and create.

The application brings an electric vehicle into every school in Flanders. The hololens can be borrowed for free via Diagnose Car.

GO! TA Keerbergen (COSMO & Innovet)

The COSMO project is an abbreviation for cognitive support in manufacturing operations. Within a consortium of industrial, academic and educational partners, opportunities, possibilities and output were deeply investigated to use VR as cognitive support in manufacturing operations.

GO! TA Keerbergen secondary school was responsible for the VR test case, as there was also an AR case for protected factory environments, where special education schools were involved. More information can be found at https://www.imec-int.com/en/what-we-offer/research-portfolio/cosmo (project description/video/leaflet).

As this project's scope was very narrow (solely aimed at manufacturing), the school applied for a second project, Innovet (Innovation for VET) 'VR in the classroom', where they obtained grants to investigate VR on a broad scale for technical and vocational education. In that project application, the school tried to connect with industry partners and VR providers. The aim was to test existing VR applications for VET along with how this technology could be pedagogically most optimally applied in classroom environments. In this project, they experimented with VR-applications in automotive, carpeting, electricity, plumbing and many other environments.

Dissemination of the project results was to be delivered by some TTT-alike workshops over the Flemish provinces, but Covid19 interfered along the way.

For sustainability reasons in this project, the school offered a **plug-and-play flight case** with a professional VR-set to the Diagnose car project, so the investment could be reused after the project time frame by other schools in Flanders. Logistics are now maintained by Connectief vzw /Diagnose Car for the circulation of an automotive application that not only focuses on technical but even on soft skills and procedural competencies.

ii. Analysis of Success Criteria / Evaluation of Possible Threats, Model Weaknesses and Risks / Consideration of Ways to Potentially Limit or Minimise them / Global Satisfaction

DIAGNOSE CARS / COSMO Keerbergen

Building this application has been the first step. It still needs to be developed further. Getting the first grants was easy because of their innovative character. Unfortunately, it is now much more difficult because every further development is no longer as innovative

as the first one. For example, the school also wants to make the application usable for mobile phones and tablets, so that it can be used anywhere anytime.

Buying a hololens for a school is indeed a threshold, although we're sure that through Dynamic guides, a lot of options are open to making the hardware usable for every lesson.

It is also important to put technically strong people in the team alongside others.

The developers are not aware of the technicalities they need to incorporate into the application. By having a non-technical person write the scenario, you can be sure that the developers also understand what it is about.

Finally, although further work is needed on user comfort for certain small parts, schools are very satisfied with the application.

GO! TA Keerbergen (COSMO & Innovet)

Success criteria analysis:

VR is a very powerful tool for personalised learning when used in the right pedagogical circumstances. Its added value situates especially on procedural competencies and soft skilling in very dangerous or non-affordable contexts at the school level.

To illustrate the learning outcome of their projects, the school showcased a learning path at SETT 2022 Education Fair, where VR was used as part of a blended learning approach that squeezes the gap between classroom and workplace as part of a lifelong learning strategy. More information can be found here: text and videos in Dutch that should be understandable in English https://sites.google.com/technischatheneumkeerbergen.be/sett2022vrarblend/home

Possible Threats	Way to limit threats
▪ Only a limited offer of VR applications in (T)VET that aligns with the curriculum. This still is the biggest bottleneck for full scale-up of VR adoption in this and other schools. ▪ VR-application cost: developing VR-applications can be very expensive (the school tested a BMW application of about	▪ Using industry data standards that fit educational needs by supporting monitoring and evaluation data in personal learning. ▪ Building a main digital platform/portal that provides an overview of all existing VR

€80k), which makes the licensing model for educational organisations hardly affordable. ▪ As a result of the above issues, the industry's willingness to share their VR applications at an affordable cost for education is rather low, although there are good examples of big companies that have already a long-term vision of investing in youth and upskilling with innovations. ▪ Lack of easy-to-use evaluation possibilities in current virtual reality applications. Applying VR in education enhances the workload for teachers and instructors. ▪ Very fragmented and disruptive market in hardware setups and software applications. There is no clear overview and specific hardware only supports dedicated applications (or vice versa). For that reason, strategic investments to cover a wide range and maximum usability, are still very heavy.	applications, labelled on usability with a specific curriculum. ▪ Governmental funds/incentives to adjust industry VR applications on educational needs and make them available free of charge for educational use (optionally under NDA licence or similar solutions).

Global satisfaction is very high on the student level, especially under the condition of a VR application that fits the curriculum and enhances in that way the learning ability, gain and motivation. The satisfaction rate on the teachers' side is very dependent on the availability of VR applications that are in line with the curriculum or industry tendencies. There should be a real added value and pedagogical workload is a really strong side aspect to keep in mind (can learning data be easily extracted from the VR application? is monitoring and feedback possible? How is the personalised entry level on the applications? …).

iii. Contribution to a Green / Inclusive Economy

DIAGNOSE CARS / COSMO Keerbergen

Electric vehicles are still too little part of the curriculum in Belgium. This application helps schools to make this green shift present in schools and the living environment of young people. Moreover, it allows schools not to buy electric vehicles.

The application is available in Dutch, French and English and therefore easy to use for many people.

GO! TA Keerbergen (COSMO & Innovet)

Inclusive economy: 'personalised learning' that addresses inclusive economy can easily be obtained by implementing personalised entry levels (goal-oriented differentiation) depending on foreknowledge and competence level. This was the whole setup and aim of the COSMO project. Depending on the learning progress, specific VR modules were automatically generated to facilitate cognitive support on the competency level. Even physiologic parameters such as stress level were monitored to determine more difficult tasks in a manufacturing procedure.

On the other hand, the school obtained nice examples of collaborative learning in "buddy systems" with some specific and more complex VR applications.

The whole process enhances student agency towards a lifelong-learning mindset.

Green economy: obviously, this all supports the big switch from combustion engines to electric cars.

i. Analysis: Would this Model be Applicable to other EU Countries and under which conditions?

DIAGNOSE CARS / COSMO Keerbergen

This model is perfectly applicable to other countries. Funding is the most important element, though. A tiered approach to development (from least innovative to most innovative) to make the funding stream as efficient as possible, can also be recommended.

GO! TA Keerbergen (COSMO & Innovet)

The shared insights from a broad network are very interesting. There was already communication with EU/international partners (Netherlands, France) in the previous projects to tackle specific problems or investigate specific applications - but no structured platform has been installed so far. An international exchange platform could enhance the insights and progress made on this very promising educational technology.

II. Successful Blended or Fully Virtual VET Teaching in Spain

The partners involved in this fully virtual VET teaching experience developed in 2020 are:

Institute Andreu Nin is a public school that offers compulsory and post-compulsory studies, such as Middle-Grade Vocational Training and Upper-Grade Vocational Training. One of its specialities is automation and car electro-mechanics. The whole school team, consisting of specialised teachers, promotes continuing education through the "Qualify and Teach" in alternation and Dual programs, according to the agreement with the IDIADA automotive company.

Applus IDIADA is a global partner in the automotive industry with over 30 years of experience supporting its clients in product development activities by providing design, engineering, testing and homologation services. The company has 2.700 professionals and an international network in 22 countries.

i. Description of the Situation and Involved Parties / Regional Legal Frame / Tools List and Reasons for this Choice

Regional Frame:

Before the Covid-19 pandemic, the students of the Mechanical Manufacturing Design training cycle of the Institute Andreu Nin had been carrying out dual professional training in the IDIADA company designing 3D automobile parts. When the lockdown began, a new teaching system based on virtual platforms had to be organised to adapt VET apprentices' internships to the new reality.

In Catalonia, dual training practices of the students are regulated on a regional basis. In dual training, students should carry out approximately 1,000 hours during their internships in a company. They might combine internships with their current studies at the training centre.

This work experience is then fully recognised in their VET studies.

Tools List:

During this virtual VET training experience, participants used different digital tools:

- Google Classroom - https://classroom.google.com/
- Microsoft Teams - https://www.microsoft.com/es-es/microsoft-teams/log-in
- 3DExperience platform (Dassault Systems) - https://www.3ds.com/3dexperience

Google Classroom was used as a digital platform to show, manage and deliver documents and exercises. Participants had access to the platform through their corporate email.

Microsoft Teams was used to carry out video conferences in live virtual classes. During online sessions, teachers explained content, students clarified their doubts and worked in collaborative groups.

3DEXPERIENCE (3DX) platform is a collaborative environment that empowers organisations to innovate in entirely new ways. It provided our participants with a holistic, real-time view of business activity and ecosystem, connecting them, ideas, data and solutions together into a single environment. In this platform, 3D design tools such as CATIA (Computer-Aided Three-dimensional Interactive Application) were used.

Collaborators, i.e. teachers and students could manage and edit files according to their own roles and rights.

ii. Analysis of Success Criteria / Evaluation of Possible Threats, Model Weaknesses and Risks / Consideration of Ways to Potentially Limit or Minimise them / Global Satisfaction

Possible Threats	**Way to limit threats**
The highest risk would be the lack of attention and follow-up by the student. Indeed, in some age groups, face-to-face teaching is more recommended due to a lack of maturity. After the experience, though, Andreu Nin students proved mature enough and followed their teachings attentively.	The highest risk would be the lack of attention and follow-up by the student. Indeed, in some age groups, face-to-face teaching is more recommended due to a lack of maturity. After the experience, though, Andreu Nin students proved mature enough and followed their teachings attentively.

After developing their experience, participants' evaluation indicated a high level **of global satisfaction** with the use of blended VET teaching.

iii. Contribution to a Green / Inclusive Economy

Digital VET training benefits a green economy, as it reduces the number of travels and consequently diminishes atmospheric emissions and costs.

Online options may also allow students with difficulties regarding travelling or participating in mobility projects, to get involved in virtual or blended mobilities. Other participants with some difficulties physically attending courses at the training centre or a work placement could of course be included here. Digitalisation may also allow us to present contents and practices in an interactive, immersive, understandable language and safe environment, which would be helpful for students with cognitive disabilities or difficulties.

iv. Analysis: Would this Model be Applicable to other EU Countries and under which conditions?

Considering that access to these programs is completely online and the language used is English, it can be considered an applicable model in any country.

III. Successful Blended or Fully Virtual VET Teaching in Germany

This chapter focuses on a case of the German Automotive Industry, in which a successful digital VET teaching component has been included in the work schedule of German VET students. The company has provided detailed survey answers and a 1:1 interview about the topics at hand.

The interview took place with the business unit Electrical Drives of Robert Bosch GmbH. They are technological leaders in electric and mechatronic systems in motor vehicles. There, they offer different vocational educational pieces of training (IW Medien GmbH, Robert Bosch GmbH).

i. Description of the Situation and Involved Parties / Regional Legal Frame / Tools List and Reasons for this Choice

Bosch employs 125 students on-site in the professions of a mechanic, mechatronics engineer, electronic engineer and IT specialist.

Bosch offers a wide range of different training online and hybrid. Every student gets his or her own laptop that is connected to the Bosch network to attend online training and seminars but also to use at school. The training elaborates on topics that are directly related to the VET but also more general, company-related topics: safety and health at the workplace, data safety, web safety or cultural differences. There is no special language coaching, as English is part of the curriculum throughout the VET. For most of the above-mentioned training, any other Bosch employees are entitled to fill up the vacant slots, if any: this allows the students to network with them and gain more insights into work life at Bosch from other perspectives. The lecturers are either external or from other Bosch divisions.

Figure 2 Students learning at Bosch. Source: https://www.bosch-presse.de/pressportal/de/de/mitarbeiter-bei-der-musterproduktion-231894.html.

Other operating cycles that are conducted online include knowledge tests, evaluations of the quality of work progress, students' behaviour or personal engagement. Students may even use their cell phones for information research in the classroom. Bosch is constantly making progress to digitalise the VET and several general work processes that are not necessarily conducted at the workshops.

The following list contains the most important digital tools that Bosch uses for work and in particular for VET:

- Microsoft Teams: Bosch insists on conducting online training and classes for VET students in an interactive manner, with the camera turned on, so that they remain active and motivated.
- Vocanto: a platform that gets regularly fed by the various VET actors and holds all the digital learning material
- Web-based Training (WBT): distance learning training from a platform dedicated to the VET students
- Kahoot: different types of use, e.g. gamification of learning processes for higher motivation, evaluation of opinions, monitoring of learning progress. Anonymity is a primary advantage here (Domröse, 2022).

ii. Analysis of Success Criteria / Evaluation of Possible Threats, Model Weaknesses and Risks / Consideration of Ways to Potentially Limit or Minimise them / Global Satisfaction

Success Criteria:

The person responsible for VET at Bosch named some important factors for the success of virtual VET:

- Flexibility as to the application, the timeframe and the place where VET online teaching and learning take place
- Using new technologies such as interactive presentations keeps curiosity and motivation higher
- Individual learning processes however remain individual: if they are addressed methodically and didactically in an online context too, this should guarantee a higher success
- Interaction between teacher and students, as well as between students is essential.

Possible Threats
▪ Getting tired of constantly sitting in front of a laptop and bored with the monotonous daily routine – this applies to students but also teachers, potentially. Here comes the danger of zoning out or at least getting distracted easily ▪ Difficulty for the teachers to check on the real individual work process and the working times precisely ▪ Time-consuming hurdles until everyone gets the necessary IT equipment (laptop, internet connection, application features) ▪ Still, too few lecturers have the necessary knowledge to provide appropriate lessons online ▪ Data privacy monitoring gets essential in an online environment (Domröse,2022).

Example 2: VET Schools

At German VET schools, digital learning tools were not that usual till 2020. Due to Covid19, though, many organisations were forced to switch to online learning as much and as quickly as possible. Even if the now frequently used tools do not work for teaching real practical topics, the schools still intend to keep using them to go with digitalisation.

But digitalisation is not the only reason for them to continue working towards more digital school surroundings:

- Communication with the students and even their parents (not necessarily important for VET but for other classes) is easier when using an online communication system.
- Working with online material and using an online diary is better for the environment than using tons of paper.
- In case of sickness, the teacher can still make sure the students know what they have to do and post some additional homework.
- Pedagogical methodologies can easily be followed through in a digital environment (e.g. when it makes more sense to only show part of the solutions or to only show the solutions for a limited amount of time to the students).

At one school, the teacher let a student with a mental illness present his findings of a project online from home with a video, instead of having him present them in front of the whole class, which would not have been possible for him - this was a great success: Due to less pressure, the student managed to give an excellent presentation and received a top grade.

During Covid19, students and teachers alike, were working remotely. Now that the classes are back in the classrooms, digital tools get integrated into school life. Whiteboards are a good option, they work similarly to an interactive laptop and can easily be seen by all students in the classroom.

As long as the students all work under the same technical conditions (laptops, headphones, Wi-Fi etc.), digital tools are indeed really attractive for schools.

- Schools as well as companies use the platform autoFACHMANN. It is an official platform that provides material and information for VET students in the automotive industry. The content is in sync with the official German VET training regulations.
- In Esslingen, Germany, a facility called Zukunftswerkstatt 4.0 opened in November 2021. It is a workshop of the Future and a test lab for the automotive market. The concept is split into four parts:
- Education: schools with a technical background may use the workshop opportunities.
- Further training for companies that work in the automotive sector and its related fields

- P.R. opportunities and events: start-ups as well as established companies can test and introduce their new technologies. It is also a location for advanced training and sector-related events.

(Gantner, 2022; Koch, 2022; Müller, 2022)

iii. Contribution to a Green / Inclusive Economy

Minimising pollution and protecting human, financial, and environmental resources are the main reason for working in a digital environment for Bosch Germany.

Bosch also gathered a lot of experience in working with disabled people over time. However, there does not seem to be any special digital program for VET students with special needs. The main reason for this is that most of them do not want to be treated differently than their peers. They do however have special rights which are defined through a legal frame, e.g., more vacation, employment protection, social consultations etc. (Domröse, 2022).

iv. Analysis: Would this Model be Applicable to other EU Countries and under which conditions?

There seem to be good basic approaches here, hybrid VET teaching models are well established.

Also, the possibility of writing and searching for reports on mobile devices appears attractive to the students.

But to adapt such models to other countries, the dual VET system itself would first need more stability in Germany. Would this be feasible within a digital surrounding at all?

An additional hurdle remains capacity in all fields: implementing and fine-tuning a new concept needs workforce increase, training and in our case, strong digital adjustments, for which there is simply not enough time within the current structures (Domröse, 2022).

IV. Conclusion: Analysis of Common Denominators to all Success Stories / Practical Recommendations / Policy-Makers

The experiences with digital tools in VET schools and companies in the different countries are rather different from each other. While the Belgian focused on the application of AR technology as an addition to the normal curriculum, the German and Catalonian examples mentioned the application of new practicable tools to digitalise the current curriculum. Especially the pandemic-related necessity to digitalise education was often mentioned. Tools such as Google Classroom, Microsoft Teams, and Kahoot were used, along with training platforms that are web-based or apply 3D illustrations.

The advantages of digital tools range from better safety while learning to operate dangerous machines in the workshops, to the possibility to personalise the learning process. Another big advantage is the curiosity of the students regarding those digital tools, which possibly leads to their more attentive engagement with the lessons.

The threats and disadvantages, on the other hand, are outstanding: tools like AR and VR are high-priced and imply constant development, which first stands in no relation to the costs of those oftentimes minimal changes. The use of digital tools in the classrooms comes with a massive amount of extra work for the teachers, due to the lack of easily accessible, pre-developed material and oftentimes to the lack of necessary technical knowledge. Moreover, data security becomes more challenging when transferring big parts of the teaching into a digital environment. And for the students, digital teaching means being forced to almost completely act on their own responsibility. This often leads to higher distraction potential and less focus. Solutions to those problems include public funding to allow professional execution, as well as a combination of digital solutions with face-to-face learning. Concerning inclusive learning, digital tools can indeed prove helpful as they are more accessible from home. According to the VET schools and companies that have been interviewed, digital tools also contribute to a greener environment thanks to fewer business trips, less daily commuting and therefore fewer CO2 emissions. All interviewees from the various partner countries take for granted that a transfer of these statements to other EU countries should be feasible - an easily accessible international platform was even suggested.

3. Successful Examples of Blended or Fully Virtual Mobilities

Our study aimed to identify virtual mobilities, learn from them and extrapolate our learnings to future proposals.

However, only a few examples have been identified, so our results currently lack statistical relevance. These experiences are however meaningful and exposed in the sections below. Thus, we have analysed them on a qualitative basis and extracted a few conclusions.

In order to complete these conclusions, we have performed a theoretical analysis of how virtual and blended methodologies can be used in the context of virtual mobilities and made some proposals.

We realise that our recommendations are only a starting point for testing our approach and determining its feasibility.

I. Successful Examples of Blended or Fully Virtual VET Mobilities in **Italy**

This chapter focuses on two best practices of Italian virtual learning cases.

In both cases, a component of successful blended VET Mobility was included in the training for Italian VET students. Both companies have provided detailed survey answers and face-to-face interviews about the topics.

The first interview took place face-to-face with one of the representatives of DIGITAL SMART SRL, a company located in Fano, Pesaro and Urbino (Italy), that is part of the Scientific Research and Development Services Industry. The second interview was held online and involved the representative of Apro Formazione, a vocational training organisation in the Piedmont region, focusing on vocational education and training for youth and adults, and on corporate training. Both organisations offer different vocational educational training that involves virtual and blending learning applied to different sectors.

i. Description of the Situation and Involved Parties / Regional Legal Frame / Tools List and Reasons for this Choice

Example 1: Digital Smart

Digital Smart is a successful product of the fourth industrial revolution: it embraces ICT skills and technologies needed in INDUSTRY 4.0 processes for the development of Smart Manufacturing and is considered the fundamental path for the revival of Italian industry. Techniques that allow us to make resources work in a smarter and "connected" way, bringing speed, streamlining and flexibility - elements that manufacturing companies need to recover for higher competitiveness.

Digital Smart is involved in 4 main areas of activities:

1. **Corporate Academy** - helps companies to manage the training of internal human resources through a careful analysis of internal training needs, by combining it with the best funding channel
2. **Training of new professional figures** - through the funding of the European Social Fund provided by the Marche Region
3. **Research & Development activities** in the technological field
4. **Low-Interest Financing-** identification of the most appropriate facilities to innovate and increase competitiveness in the market

Digital Smart aims to ensure the acquisition of digital skills as a tool to digitalise all sectors and apply digitalisation to all processes including that of production (in Industry 4.0). Digital Smart provides many VET opportunities for adult people:

- A course in 3D Design planning
- A course in Mechanical Drafter
- A course for specialists in processes organisation of shipping of the goods.
- Robotics

Digital Smart trains technical experts in robotics, capable of designing and programming systems such as robotic arms, material handling and production process automation systems with traditional or collaborative technologies (Cobot: Collaborative Robot).

Around 150 students per year participate in the training - however, due to a close collaboration with additional organisations (university and training association), the number of trainees usually reaches 500 participants /per year.

Virtual training has been provided and implemented for many years at Digital Smart and has been increasing because the COVID-19 pandemic that boosted both virtual training and distance learning.

The Digital Smart blended training/learning in synchronous and asynchronous mode is based on the virtual lab industry 4.0 that utilises specific software and platforms:

Digital Smart uses the main platforms for synchronous training (mainly Google Meet, Microsoft Teams, and Zoom) while for asynchronous training the organisation has chosen Thinkific, a multifunctional platform for online courses. The production of Learning Objects is carried out in-house: Digital Smart has set up a laboratory for shooting videos and editing images with audio, where the staff integrates these productions with virtual images generated by the Digital Twin system in the laboratory. In this case, the software used is “Articulate”.

This Laboratory is based on “the digital twin” system: the strength and the success key of the "digital twin" is that it can provide a near-real-time comprehensive linkage between the physical and digital worlds. This system helps optimise business performance and guarantees all successful production processes monitoring the entire life cycle of the product or plant: every piece of data received becomes an "engineering item", an "object" that can be explored, compared, traced and used to make decisions. Any information in real space can be contained and mirrored in virtual space. Once the

"door" of communication and connection of information between the two spaces is found, each product (or process) is formed by two interacting systems, the physical and the digital. Two systems intertwined throughout the product life cycle, where the virtual one helps the physical one to explore "virtual subspaces", i.e. the different scenario possibilities, in all phases of creation, production, operation and disposal.

Specifically, within Digital Smart, the system is used to reproduce mobile phones. The laboratory simulates the industrial production chain of a mobile phone; the production process is a simplified, but fully functional replica equal to the real physical model, capable of reproducing all kinds of production problems in a 100% industry 4.0 compliant environment.

The lab replicates every type of production procedure so that in both real and virtual environments, training sessions to acquire Industry 4.0 competences (following the EU Dig Comp) are guaranteed:

- **Solutions for Advanced Manufacturing:** today, the fields of robotics research and development are facing exponential growth; the already high levels of automation of the 2000s are being overcome by the introduction of collaborative, interconnected and intelligence-enabled robotics.
- **Additive manufacturing:** Thanks to innovations that are constantly being developed, additive manufacturing is capable of renewing existing processes. Here is an example: 3D printing technology was born in recent years and is progressing very quickly, thus offering totally new ways of designing, prototyping and pre-series production, up to producing new and very different logic from those of previous manufacturing.
- **Augmented and virtual reality:** Providing any information that can be useful to improve and ensure safety in performing a job is now possible in a user-friendly and time-saving manner. Virtual reality, on the other hand, is used to recreate immersive environments useful for an increasing number of purposes; one of the most important ones being the health sector, where augmented reality and artificial intelligence are bringing numerous benefits.
- **Simulation:** using data from interconnected machines allows processes to be optimised by simulating various scenarios and being able to appreciate and compare the results without having to change the real processes.
- Vertical and horizontal integration: all available data get integrated into the model in order to replicate thoroughly the value chain.

- **Industrial Internet of Thing (IIoT):** making 'objects' communicate with each other with 'industrial grade' technologies; they are reliable technologies as is mandatory for a production process that cannot run the risk of discontinuity
- **Cloud Computing:** the management of very large and highly variable amounts of data and data processing through platforms is insured with virtually infinite capacity, but also no investment barriers as only paying for actual consumption is required.
- Cybersecurity: protecting and securing operations are carried out over the whole network in order to avoid any kind of intrusion, data recruitment rape and criminal acts of all kinds.
- **Big data & Analytics:** Analysing large quantities of data, even in real-time, for several purposes is useful for improving processes and increasing the quality of products and services. (A concrete example is the recent use of Big Data in health care, in order to support research for rare diseases)

Additional services

Some companies called Digital Smart for the development of company virtual tours (for example the most important company in the automotive sector-TESLA). Digital Smart has the adequate technologies to further develop these aspects and has a long partnership with two companies in the automotive sector which have been involved in virtual mobility implementation for many years.

By the way, such virtual tours can definitely be useful also within virtual mobility programs.

Example 2: APRO FORMAZIONE, Italy

Apro Formazione is a vocational training organisation in the Piedmont region focusing on vocational education and training for youth and adults, and on corporate training. Every year Apro Formazione offers new courses in order to allow the participants to increase their professional competencies and chances of finding a job. The courses meet the training needs identified through in-depth analysis, resulting from meetings held with businesses and operators.

Since 2009, Apro Formazione works at an international level: Apro International has distinguished itself as a driving force at the local level within the European mobility of students and trainees interested in training experiences abroad. Apro International is

both coordinator and partner of various Regional and European projects (ESF, Erasmus+ KA1- KA2 – Capacity Building). Currently, Apro is actively working on international projects in the field of technology, green transition and Hospitality.

The main training sectors are the following:

- APRO DIGITAL & TECHNOLOGY (industrial automation and mechanic)
- APRO HEALTHCARE
- APRO TECH (ROBOTICS MECHANICS & INDUSTRIAL AUTOMATION)
- BEAUTY & WELLNESS

Apro has two locations in the Piedmont Region, Alba and Canelli, and APRO Formazione specialised in the management of education and training mobility projects for students, apprentices, youth, adults, teachers, trainers and educational for a total of 600 students in the age of compulsory education and 4000 adults trained during the year. It includes 90 employees, among whom 40 are teachers.

During the pandemic, there has been an effective increase in virtual support and this resulted in the implementation of new and innovative digital pathways. The APRO staff (teachers and trainers) had already an effective knowledge and current understanding of virtual training and virtual mobility before Covid-19 broke out. An e-learning platform (on Moodle) has been available for training already before the period of Covid-19. All the training paths included an online training part that included individual study, group activities, exercises, etc.

The type of virtual learning/mobility experiences allowed in the organisation however depends on the local guidelines of the Piedmont Region. Unfortunately, a rather low percentage of online training hours is currently recognised by the regional directive, i.e. about 20-30% of the total amount of hours: VET pathways have a higher percentage of online training than that recognised for students in compulsory education.

ii. Analysis of Success Criteria / Evaluation of Possible Threats, Model Weaknesses and Risks / Consideration of Ways to Potentially Limit or Minimise them / Global Satisfaction

Example 1: Digital Smart SRL

Success Criteria:

This type of laboratory (Cyber Physical Factory) has a high cost and is able to host a limited number of operators per single training session. On the contrary, blended training allows a virtually unlimited number of participants, who will be in direct contact with the equipment - but at a distance, thanks to Digital Twin System.

DT also allows for insights and operations that would not be possible in the classroom, so it is not a matter of providing a lower level of training; if the training is well designed, the virtual training approach (or blended) even improves the overall quality of the educational and training offer.

The virtual lab represents a training tool as well as a virtual space of learning because it allows a reproduction of the whole production process virtually. People can do it remotely and this ensures the participation and involvement of many more people. Supply chain machinery (Festo) is used virtually in remote mode on both real and remote series.

Technology has become ubiquitous in educational organisations seeking to respond effectively to the demand for improvement, optimisation, and personalisation of large-scale, technology-supported education. Automatically tracking the progress of learners becomes possible, at least for assessing attendance, and acquisition of knowledge or skills. Information sources are increasingly heterogeneous and complex in learning environments. With continuous innovations in the way Digital Smart teaches and learns, there is a need to rethink and transform the model of integrating technology into teaching, in order to achieve intelligent collaboration and coordination between technology and people for learning.

Digital Smart experienced many opportunities in the emergence of Covid-19 when the technology was already mature. Since that time, investments have increased, quality has become higher and at the same time, users have improved their knowledge. Regardless of what has happened, virtual learning has enormous potential but the cost of equipment is often very high and, as is the case of our cyber physics factory, it is also complex to involve a large number of learners in the activities. Furthermore, virtual

activities, implemented through augmented reality, increase the educational potential of the laboratories: simulation allows faster and more complete learning and the easier access to additional information available allows for insights that are often decisive in the learning phase and the acquisition of a complex skill. Therefore, the final balance of this type of learning is always positive, in qualitative/quantitative terms. Last but not least, this technology also reduces the risk of accidents at work and allows safety issues to be approached with new paradigms.

Digital Smart has implemented blended training (through the guidelines of Festo company) to train teachers. Applying virtual technologies to the VET is their strength; this represents a very powerful asset and advantage over their competitors: the competitors are not yet aware of the potential for significant progress linked to the use of digital technologies and virtual reality within the production system. Thus, Digital Smart shall further develop the opportunities for virtual training within Festo.

Opportunities
Digital democracy allows a wider level of equity in the resources available to learners that puts everyone under the same conditions. This is not just a matter of democracy (being in itself very important) but also an extraordinary advantage in terms of the quality of teaching. The trainer is able to work more efficiently if all learners are in the best learning conditions, the role of technicians and tutors is simplified and these experts can make themselves available to solve problems that they would otherwise not even consider. A virtual machine server (VM server) enables training multiple people in virtual mode. It hosts or operates virtual machines that run various systems and act as full computing platforms on their own through emulation and virtualisation. A single physical server allows 150 people to be connected at the same moment and to work independently through it. This ensures equity among all the participants and the same system quality, both inside and outside the organisation. Server virtualisation software divides physical servers into multiple virtual segments that can be managed independently. Server virtualisation products are used by organisations to partition dedicated servers into scalable virtual instances called virtual private servers (VPS). Virtual private servers created with server virtualisation software can each host a unique operating system and be managed independently through an integrated hosting control panel. Organisations use server virtualisation

software to allocate server resources among virtual machines for workload optimisation. Virtual machines created with server virtualisation software are often more flexible and reliable to manage, in comparison with unpartitioned servers.

These technological and digital advances have also favoured the adoption of several pedagogical approaches (online training, blended learning, etc.) aimed at improving the teaching process. These ongoing innovations in the way Digital Smart staff teaches and learns, require us to rethink and transform the model of integrating technologies into teaching. The aim of it is then to achieve intelligent collaboration and coordination of physical and/or virtual actors at the service of education: the virtual lab is a step forward with this objective.

Evaluation of possible threats, weaknesses in the model and risks

The difficulties are linked to the fact that for each type of training, there is a need for good quality digital content, resulting in a higher cost and a longer time for implementation.

There are nowadays production standards and companies are moving to the digitalisation of all processes (e.g. CADENAS DE), thus bringing this methodology a step forward to global standardisation and a very high level of dissemination too. The continuous training of workers requires it and finances it too, so the VET world shall also benefit from such investments.

The main course where Digital Smart staff implemented blended learning was the Higher Technical Institute (an Italian tertiary educational institution) in a two-year higher education course for industry 4.0. Students performed some hours in presence and many more in remote modus. The most critical problem was thus pedagogical: the choice of content to be taught in the presence and at distance, the choice of methodologies, etc. The whole thing definitely needs to be redesigned.

The barriers and obstacles to virtual and/or blended training
Everything has to be organised and 'engineered' very well, a short training phase on the use of technologies is needed, support and availability of services must always be efficient in terms of connectivity and broadband availability – obviously, issues or even the lack of such resources challenges everything. Administrative barriers have been overcome because of the urgency caused by COVID-19: the pandemic boosted the necessity to implement new digital training methods that are supported by ICTs and virtual systems. In recent years, the public system has started monitoring virtual systems and trusts them more. Pedagogical challenges have been won due to the covid-19 pandemic that forced teachers to use these technologies. Teachers are digitally friendly but need to be well-trained. The challenge is great and the goal is very ambitious; as described above, if well provided, virtual/blended training (through the use of these technologies) greatly improves the VET training quality.

Example 2: Apro Formation

APRO Formation piloted a project in the food processing sector concerning Digital Pedagogy (focused on food) that represents a success for virtual VET. The project aims at developing a common virtual module of 4 hours with the partnership of 4 different schools. The project will consist of :

- 10-hour distance preparatory activities
- 20-hour digital training programme for all 4 schools (each lesson dedicated to one single food recipe)
- 10-hour follow-up to finalise a project work (the creation of a common menu realised through the Google Meet platform with the participation of students from different schools).

This activity has been implemented totally virtually.

Next school year Apro Formation will plan the activity in different sectors.

- The project IMPACT (https://impactalbacannes.eu/index.php/it/), funded by Interreg V-A France-Italy (ALCOTRA) and promoted by Apro Formazione of Alba and the Faculté des Métiers & École Hôtelière of Cannes, develops a binational educational path in the hospitality & tourism sector: they are using innovative and digital training

methods, mobility schemes for students and teachers, and close collaboration with companies in the territories of Alba, Italy and Cannes, France. Through an e-learning platform, streaming lessons, internships abroad, digital learning materials and the strengthening of partnerships with local companies, students, teachers and companies themselves have the opportunity to improve their skills in an international and 2.0 perspective. They can introduce innovative elements in favour of and collaboration with the territory. The project promotes the integration of training and production systems, the digitalisation and the internationalisation of education.

- Module it! Digital Teaching for VET (https://moduleit.eu/) is a European project coordinated by the Apro Formazione (Italy), together with Noorderpoort (The Netherlands), SEDU (Finland) and Faculté des Métiers - École Hôtelière de Cannes (France). Module it! Digital Teaching for VET project aims at improving the digital skills of teachers and trainers in the vocational sector and, in particular, to increase the following abilities:

    1. To create attractive and interesting digital lessons
    2. To motivate, support and engage students in digital learning
    3. To increase their ability to use pedagogical digital technologies.

As a virtual VET, the project consisted of providing an online course catalogue for teachers and trainers and setting up a 40-hour digital training module. The online course catalogue collects a selection of already existing courses about digital teaching that are selected, tested, evaluated and validated by the partnership experts. The 40-hour training module is meant to offer a methodology that can be applied digitally to any vocational sector, to implement digital lessons even in vocational subjects. The structure of the training module is the following:

- 10-hour distance preparatory activities
- 20-hour digital training programme (shared streaming lessons/courses)
- 7-hour project work
- 3-hour final assessment.

Another successful example is the applied hybrid mobilities in the field of Green Entrepreneurship within the "SdE - Sustainability-driven Entrepreneurship" project (https://sdeproject.eu/). The planning of a system to recycle plastic bottles automatically has been developed at a distance while the presentation and the description of this model of recycling are planned to happen in-person. The same hybrid mobility is implemented in the field of industrial automation and technology.

Opportunities
In the post-Covid19 times, the awareness of the necessity to use technology has increased among students, however, they still have to face logistical and economic factors. With regards to the trainers or teachers, some difficulties arose because of their inability to use digital tools as innovative training and teaching methods. To support them, some monitoring and training activities were implemented through the Moodle Platform. In the beginning, this kind of remote and online training with digital tools and the use of the internet addressed teachers and trainers and was merely linked to the emergency situation of the pandemic. However, afterwards, an in-house training program on the use of digital or IT devices and innovative methodologies was designed and it is still carried out among the Apro teachers and operators.
The barriers and obstacles to virtual and/or blended training
In the pre- COVID-19 situation, the main barrier was the difficult access to technologies among the participants. Many of the beneficiaries are young people and not all families own personal computers or have a sufficient internet connection to attend the online training sessions.

iii. Contribution to a Green / Inclusive Economy

Example 1: Digital Smart SRL

The green transition is revolutionising the way of thinking among companies and this is also reflected in the great sensitivity to the E.S.G. (Environmental, social, and corporate governance) issues which have now become a favourite topic for advanced companies or those wishing to maintain their levels of competitiveness, to be able to face global challenges.

Schools still have a long way to go to increase their engagement with digitalisation. In Italian schools, there is rather a very low interest – on the contrary, ITS foundations and universities are positively receiving virtual and digital training innovations - even if not yet in a systematic and integrated manner nor with a programme truly focused on the green transition.

The involvement in the green transition and the commitment of Digital Smart in this evolution is shown e.g. by the company's support for broadband accessibility.

Digital Smart is pursuing the idea of supporting the development of prototypes in the automotive components sector. In fact, the staff trains students of partner organisations that are involved in sustainable mobility for the leisure boat industry. Digital Smart supports the green transition through a partnership with an innovative start-up involved in the production of green hydrogen and aims at constantly improving virtual training among all these sectors.

Example 2: Apro Formation

The virtual training experiences that APRO Formation provided contribute to the green economy and the creation of a new awareness among young people regarding the need for a change in terms of new environment-friendly habits. Students attended lessons concerning these issues in the pre-departure training and they learnt what sustainability is, and what sustainable mobility means.

The only disadvantage of virtual mobility can however be the lack of a real physical experience. Apro Formation contributes to the Inclusion of people with disabilities. Digital skills and virtual training are a way to ensure that everyone can participate in, contribute to, and benefit from the digital world. Building young people's digital skills allows them to better and easier access the digital sphere in their studies, smoother transition to work, and participate democratically in society.

This is especially important to overcome the isolation experienced during the pandemic and to ensure that young people are connected and engaged in the world around them.

iv. Analysis: Would this Model be Applicable to other EU Countries and under which conditions?

According to the information gathered, the program and training approach implemented by Digital Smart and Apro Formation both support the digitalisation of learning training and virtual learning more than the Italian average of other vocational training and adult education organisations – the latter is lacking in many aspects from the virtual and digital perspective.

The two representatives of Digital Smart and Apro Formation pointed out that the Italian VET system is still unprepared to correctly answer to the challenge of the digital transition: the institutions and the organisations responsible for the learning and training scheme are not well-equipped and are not even enough aware of the need to be able to apply digital and virtual learning process

II. Successful Examples of Blended or Fully Virtual VET Mobilities in Sweden

In Sweden, experiences with virtual mobilities within automobiles in vocational education have been hard to find, also it's hard to find anything related to virtual or even blended mobility within vocational education in the automobile sector. However, other examples where virtual mobility has been used have been found, although it is in other areas than vocational training, this can possibly be useful in this manual.

There are mainly two successful virtual VET mobilities in Sweden that will be mentioned in this chapter.

One example of blended virtual mobility in Sweden is NTI Gymnasiet. They have been working with virtual and blended mobility since 2021. The success is that they pick out the parts that can be done digitally, during and after the mobility and make this virtually, so-called, blended mobility. Most virtual mobilities take place within the IT program, but the school can see an opportunity to integrate this into most of the education (Öhberg).

The NTI gymnasium and their EU-project coordinator Pernilla Öhberg wanted to keep working with high quality and international exchange from other countries even though there was a pandemic. They started with their IT students who already had experience working digitally. They have collaborated with a company in several different countries, such as South Africa, Ireland and Germany. Pernilla believes that there is an opportunity to apply this way of working to more vocational training

NTG gymnasium seems to be the only vocational education found in Sweden that worked with total virtual mobility.

We interviewed Oskar Emt, who is working on a pilot project that develops technical equipment, and electrification at Scania for their training in the automotive industry. He is working on virtual training for their workers with car batteries, to be able to train remotely. They have over 1500 employees in Sweden who need this training. It is about being able to work with car batteries with high voltage which can be dangerous to test physically and with more virtual elements it will also be safer in the future.

In an interview with Norberg, he describes that he also has experience in vocational education as he was the school leader for the vehicle program at the upper secondary school for a few years in the 90s.

i. Description of the Situation and Involved Parties / Regional Legal Frame / Tools List and Reasons for this Choice

Emt is not aware of any legal framework, except for the usual requirements around the battery and the ordinary legal aspect around education.

The tools they will be using are VR -glasses and computers. The choice of digital environment they use, they are going to develop with start-ups, including many game manufacturers, who can provide the right form for environmental technology. In this pilot project, they send out a request to many small start-ups and will, after several meetings and contacts, choose the one that can deliver the best solution to continue working with.

Common tools for other ordinary vocational education centres are Microsoft Teams Google etc.

ii. Analysis of Success Criteria / Evaluation of Possible Threats, Model Weaknesses and Risks / Consideration of Ways to Potentially Limit or Minimise them / Global Satisfaction

Emt, who works for the company Scania (trucks and buses), believes that the benefits of working with virtual education are mainly two things. It saves time, both for trainers and technicians. The second is the cost savings this entails. Other benefits that it generates, he describes would be the environment, because they don't have to fly in experts from all over the world. It is also safer because the participants do not work directly with batteries in high voltage.

Emt sees no risk in using digital environments, only benefits. It is even possible to make it more social by having a coffee break in the digital space.

Norberg believes it can be a mistake to only look at the differences online - offline, classroom - learning platform, analogue-digital, physical - virtual, technical - traditional, etc. He thinks it is necessary to adapt to the individuals who are going to learn and sometimes mix virtual with other elements or physical meetings to follow up with the student. Otherwise, it can be too boring and lonely for the student. Norberg gives an example that only 5% of those who enthusiastically start an international MOOC course

finish. **The conclusion of this is that more support and structures in the learning process are needed.** While it's easy to put out a bunch of web pages and hope course participants learn, it can be a waste.

They switch in the teaching/learning process between simultaneity (synchronous) – the situations in a process where the participants are together in a real-time, classroom lesson, a video meeting, or chat – there are several examples – and asynchronous studies – when the individual or small groups do flexibly work when they have time and opportunity, between the synchronous meetings. The secret of a good course design is often the construction of the transitions between the synchronous and the asynchronous. Another risk is that it becomes "a course and a half". It is very easy for the teacher to upload lots of material and tasks in the asynchronous domain (ie on a learning platform etc) and thus feel good and efficient. Research into this is called "cognitive load". (A. Norberg)

iii. Contribution to a Green / Inclusive Economy

By working with VR elements in the training, parts of the mobility can be replaced virtually and thus reduce travel, says Emt.

Universitets- och högskolerådet, UHR, is the national agency for Erasmus programmes in Sweden. Their report on broadening recruitment to international mobility is certainly based on higher education institutions, but similarities probably also exist among vocational education centres. The report highlights that more people dare to take the step toward international mobility by combining the internship with virtual elements. The virtual elements could be preparation, meeting virtually with the tutor or practical steps. This can contribute to people who otherwise wouldn’t go abroad feeling safer and more confident. This makes the Erasmus program more accessible to more people, especially those with fewer opportunities. The teachers seem to have an important role in inspiring and motivating students to international mobility, and also the virtual part of it.

iv. Analysis: Would this Model be Applicable to other EU Countries and under which conditions?

Most of the interviews show that it can be applied in other countries, but also other organisations and companies (Emt). The thing is to find the right solution for your particular work and to increase the knowledge of those who will work with it, such as the teachers. (UHR)

III. Successful Examples of Blended or Fully Virtual VET Mobilities Conclusion: Why and How?

i. Why Integrate Digital Elements in Mobilities for VET Apprentices?

In 2018 the German Parliament (Bundestag) initiated a commission of inquiry. Its purpose: to discuss the future vocational training in a digitalised workplace. Within 543 pages, the commission formulated recommendations for action in order to digitalise and internationalise VET as much as possible.

Among these proposals, we find a better certification of qualifications that have been acquired abroad and an extension of resources for schools and businesses for the organisation of stays abroad (Enquete Commission, 39).

According to the commission, vocational training must include research of technologies to synchronise the mediation of competencies and learning content with the process of innovation (Enquete Commission, 68).

Furthermore, technological change in the workplace has to be seriously considered. Not only it is important to use digital tools while learning, but also schools have to implement new and innovative ways of teaching and learning. The commission sees the acute need for training to show teachers a pedagogically meaningful way to use digital media and learning concepts (Enquete Commission, 69).

The German Commission wants to utilise digital intuition - which most of the younger people actually show in their free time - and transfer it into the learning process. This way, they want to professionalise the youths' intuition, so that they can later on use it in the working environment (Enquete Commission, 88).

To give the learners a better occupational outlook and help them develop their personality, the commission sees international qualifications as necessary. Such qualifications include knowledge of foreign languages, intercultural competencies and foreign professional knowledge also of innovative methods. Especially in times of globalisation, better networking is also crucial for host companies (Enquete Commission, 204).

Furthermore, "virtual work placements provide the students with remote working skills and competencies for the global employment market" (Ralfpartnership.com).

Examples from Germany

This chapter deals with different aspects of successful mobilities in different European countries. As said, not that many mobilities took place that can be used as fully successful examples. The following example deals with a digital tool that tries to partly replace on site-work in the automotive sector, as a form of digital work experience and learning system.

ASCOT develops digital measuring instruments for different vocational and occupational fields. ASCOT also applies them in classrooms and even during VET exams. Among the different instruments, there is one called DigiDIn-KFZ. It is designed to help students in the automotive sector learn how to digitally diagnose errors and intervene.

The tool wants to promote the student's ability to generate, interpret and use information. According to the individual learning and competence level, the tool uses different instruments to support each student. DigiDIn-KFZ also allows working with other students and can be used within the context of an exam. It tells the students to what extent the learned skills are comparable to the work with a real-life car (DigiDIn-KFZ).

According to two different surveys, this tool helps improve the student's knowledge and skills regarding working with a real-life car. Apparently, working with videos of other mechatronic engineers and analysing their actions and mistakes has a similar effect to being present in a garage (Videovignetten-Test).

ii. How to Integrate Digital Elements in Mobilities for VET Apprentices

The mobility process can be split into three timespans:

1. Pre-mobility
2. During Mobility
3. Post-mobility

During those phases, there are many possibilities to work digitally.

The following chapter will give recommendations about the usefulness of digital tools for each. It is however important to note that every actor (external organisation, VET student, school, company…) handles mobility differently and also has different requirements. The mentioned ideas may serve as a source of inspiration for improvement and have been collected from two thorough interviews with experienced providers of (virtual) mobilities from Sweden and Germany.

Step 1: Pre-mobility

The process of writing a CV and a letter of application is crucial in any form of mobility. The job descriptions vary throughout different cultures, which makes it even more important for the candidate to give detailed information about his skills and managed exercises.

An important part of mobility indeed takes place before real work begins.

Especially in a digital environment, different skills are required to be successful. The students should therefore get the chance to attend seminars regarding those skills. Seminars can cover topics like working life abroad, etiquette, digital/communicative/working skills, the writing process of a CV or even the ergonomics of working digitally. Those seminars can easily take place on digital meeting platforms.

Once a student is placed within a company, a "meet and greet" with the company can take place - just like the seminars - digitally. This way, the company and the student can get to know each other.

Also, the regulations of mobility have to be discussed. It is important to find a project for the student that helps him or her grow, but at the same time does not intimidate him or her. The digital environment gives the student a lot of freedom to try out different approaches. But it also goes with a limited amount of assistance, compared to an office or a workshop with several helpful colleagues in one single place.

Checklist:

- ✓ Online selection of candidates: check for appropriate characteristics corresponding to the placement description, assess work ethic, and consult the teachers of the candidates and their VET tutors within the company.
- ✓ Pre-stay discussions: make sure the candidates are ready and set up with all the knowledge necessary for the virtual mobility experience
- ✓ Meet and Greet: virtual meetings between the candidates and the companies can ensure that the expectations and tasks are discussed.

Step 2: During Mobility

- During the mobility, it can be helpful to organise a proper workroom at school, where VET students can come every day and then work for themselves but be physically surrounded by other people. This way, a normal work routine can be established and

if guidance is necessary, their teachers can quickly help. Such aspects as fixed individual workspaces, a coffee machine, a separate room for lunch and co-workers around help keep the spirits and motivation high.

- Digital safety of the company: Letting external people in the IT system of a company can prove risky. This is the reason why many companies only correspond with students via email. But a mobility that only works via email is not ideal. It does not represent reality. Therefore, it can be useful to create a platform that is safe and takes several aspects of virtual mobility into account: e.g. important files can be transferred to that platform, which becomes the same time a means of communication for the student with his virtual company, and at the same time, a workplace.
- At any point of mobility, the students need to know their contact persons for different issues. If a real collective workspace is installed at school, it makes sense to have a contact person for technical issues and communication problems at the same school too. Within the company, a person responsible for the student's needs is to be determined. He or she will help with any questions concerning the foreign company, the project and everyday life abroad.
- Regular online meetings with the responsible partner at the foreign company can help the VET student to feel more integrated. Team meetings are an important part of work life for most jobs. Those meetings can serve as a check-up on the progress of the project, but can also encourage and deepen the students' cultural involvement.
- The preselected project which the student will work on needs to be digital. It should be simple enough for the student to be able to cope with it alone, but at the same time, it should not be too easy, to keep the interest and learning effect high. Such a project should be independent of other projects and it should be manageable within the timespan of the mobility. At the same time, the project should be realistic and have relevance for the company.
- For some tasks, a virtual exchange in advance can be useful to further deepen the cultural and language skills required in the modern labour market, to gain and strengthen contacts on a global scale and to exchange knowledge. "Virtual exchange (VE) […] refers to sustained, technology-enabled, people-to-people education activities in which constructive communication and interaction take place between geographically dispersed groups or groups from different cultural backgrounds, with the support of educators. VE combines the deep impact of intercultural dialogue with the broad reach of digital technology." (Reiffenrath).

Checklist:

- ✓ Work environment: to make the virtual mobility experience really special, a workplace can be nice-to-have
- ✓ Supervision and support all technical, communication, planning, work life, personal, and cultural questions
- ✓ Meet-ups: a chance for the student to talk about everything concerning mobility (work-related, life-related, problem related)
- ✓ Safety: the physical safety of the VET students may be less important in a digital setting. Still, their psychological well-being is all the more important. Also, the digital safety of the company has to be ensured while restricting the students as little as possible.

Step 3: Post-Mobility

After the virtual mobility, an assessment should take place. The VET student needs to reflect upon mobility and the company can help him with this.

Any problems that came up during the mobility should now be examined further to solve them and also eliminate them for future mobilities.

Checklist:

- ✓ Reflection: look at the work done but also at the work ethic of the student, let the VET student write about his or her virtual mobility experiences (if not already required by the individual mobility program)
- ✓ Clear, eliminate problems and prepare for future mobilities

(Öhberg)

4. Deep Dive into the tools identified in the companies and vocational schools survey

In this section, we classify and briefly describe the different tools stated in the surveys answered by Companies and Vocational Schools. Our approach has been to divide them from general to specific purposes for vocational studies.

We have tried to include all the tools mentioned in the surveys according to the specifications and possibilities of each category. For categories where only a very small number of tools have been identified from the surveys, some additional research has been done to provide some other similar tools thus allowing comparison with other similar available products in the market.

As there exist a high number of current tools and applications, this section is not and does not try to be an exhaustive list of all the available tools. Instead, it has to be seen as a list of examples of tools, mostly from the cases identified in the surveys.

I. Generic Tools – Benefits and Weaknesses

i. Presentation Design Tools

Description and uses

Presentation design tools are software platforms that are used to create visual presentations, such as slide decks, infographics, and other visual content. These tools often include a range of templates, design elements, and other features that can be used to create professional-looking presentations. Usually collaboratively enabling work.

Examples

Prezi	Genially	Google slides
https://prezi.com	https://genial.ly	https://www.google.com/slides

Microsoft PowerPoint	Mentimeter	Canva
https://office.live.com/start/powerpoint.aspx	https://www.mentimeter.com	https://www.canva.com

ii. Digital Interactive Boards

Description and uses

Tools that simulate a digital, live shared board on the screen, allowing collaborative writing, drawing and embedding some kinds of digital materials. It is very useful for developing concepts, problem-solving and brainstorming sessions.

Examples

Jamboard	Mural	Miro
https://jamboard.google.com	https://www.mural.co	https://miro.com

iii. Video Conferencing

Description and use

Tools that simulate face-to-face and face-to-audience events. They usually include options for sharing screens, recording sessions, textual chatting and controlling who can speak or use their camera. Additional features are digital rooms, video effects, attendance control, etc.

Other tools like digital calendars or virtual workspaces are often integrated.

Examples

Zoom	Webex	Microsoft Teams
https://zoom.us/	https://www.webex.com	https://www.microsoft.com/en-us/microsoft-teams/meetings-apps
Meet	**Adobe Connect**	**Jitsi**
https://apps.google.com/meet	https://www.adobe.com/products/adobeconnect/meetings.html	https://meet.jit.si/

iv. Live Feedback and Gamification

Description and use

Tools to design questions, polls, quizzes, slides, images, gifs, flashcards and more… in a live, interactive way.

Some of them help to monitor and evaluate student learning.

Examples

Kahoot	Mentimeter	Socrative
https://kahoot.com	https://www.mentimeter.com/μ	https://www.socrative.com/

Quizizz	Quizlet	Gimkit
https://quizizz.com/	https://quizlet.com/	https://www.gimkit.com/

Heading 1.1.1

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Quizizz	Quizlet	Gimkit
https://quizizz.com/	https://quizlet.com/	https://www.gimkit.com/

v. Video Capture, Edition and Delivery

Description and use

Such tools are designed for capturing, editing and delivering videos (broadcasting and/or online video repositories). In blended and online training, these are mostly used to create video tutorials, demonstrations and small learning material.

Examples

Screen capture and recording		
ShareX	**Loom**	**Camtasia**
https://getsharex.com/	https://www.loom.com/	https://www.techsmith.es/editor-video.html

Video editors		
Filmora	**Openshot**	**OBS Studio**
https://filmora.wondershare.es/	https://www.openshot.org/	https://obsproject.com/

Hosting and sharing videos		
Youtube	**Vimeo**	**TED**
https://www.youtube.com/	https://vimeo.com/	https://www.ted.com/#/

vi. Digital Workspaces

Description and uses

Digital workspaces are online platforms (cloud-based) that are designed to support collaborative work and communication among teams and organisations. These platforms often include tools for tasks such as file sharing, project management, and communication, and may be used in place of or in addition to traditional in-person

meetings and office spaces.

It usually allows setting permissions to different users or groups of users as well as automatic version control, to ensure the security and integrity of data. Common tools are word processors, spreadsheets, presentations, forms, mail, calendar, videoconference, drawing and diagramming tools, websites and a cloud file system, among others.

Digital workspaces can be used by businesses, organisations, and teams of all sizes to improve communication and collaboration among team members, regardless of their location. They can be particularly useful for remote teams or for organisations that have employees working in different locations.

Examples

Google Workspace	Microsoft 365	Zoho
https://workspace.google.com/	https://www.microsoft.com/en-us/microsoft-365	https://www.zoho.com/

vii. Intranet – Social Networking Software

Description and use

This is a digital platform with a set of tools that allow you to locate, communicate and collaborate with people efficiently with instant access to information, experts and approvals.

Examples

Jive	Saba Cloud	Happeo
https://www.jivesoftware.com/	https://play.google.com/store/apps/details?id=com.saba.spc	https://www.happeo.com/

Sharepoint	3dexperience	Jostle
https://www.microsoft.com/en-us/microsoft-365/sharepoint/collaboration	https://www.3ds.com/3dexperience	https://jostle.me/

viii. 3D Modelling and Animation

Description and use

The applications are mostly for computer-aided design (CAD), drafting, animation, creating 3D interaction experiences, etc.

Examples of these kinds of tools and their application in the automotive sector

Tool	Logo and website	Examples in the automotive sector
Autodesk solutions (AutoCAD, Maya3D, etc.)	https://www.autodesk.eu/products	https://www.autodesk.com/solutions/product-design/automotive https://www.autodesk.com/solutions/automotive/manufacturing
Blender	https://www.blender.org	https://www.blender.org/user-stories/mathilde-ampe-automotive-design-with-blender/with-blender/ng
Unity	https://unity.com	https://unity.com/solutions/automotive-transportation-manufacturing
Unreal Engine	https://www.unrealengine.com	https://www.unrealengine.com/en-US/solutions/automotive-transportation

ix. Virtual and Augmented Reality Tools

Glasses and headset solutions

Description and use

These are headset-based solutions for 3D virtual and/or augmented reality displaying and interaction.

It usually includes a set of environmental sensors and hand controllers for detecting the position and gestures of the user.

Examples of these kinds of tools and their application in the automotive sector

Tool	Website	Examples in the automotive sector
Hololens	HoloLens 2 https://www.microsoft.com/en-gb/hololens	https://customers.microsoft.com/en-us/story/1470455484645794351-renault-group-automotive-hololens-dynamics-365-fr-france https://news.microsoft.com/transform/vroom-with-a-view-hololens-2-powers-faster-fixes-mercedes-benz-usa/ https://customers.microsoft.com/en-CA/search?sq=%22HoloLens%22&ff=story_industry_friendlyname%26%3EAutomotive&p=0&so=story_publish_date%20desc
Oculus	oculus https://www.oculus.com/rift/	https://www.oculus.com/experiences/rift/1371947092898229/
HTC Vive	htc https://www.vive.com/eu	https://business.vive.com/us/stories/virtual-reality-delivers-immersive-remote-collaboration-automotive-design-teams/ https://business.vive.com/us/stories/lucid-reimagines-luxury-car-buying-experience-zerolight-and-vive/

Optical hand tracking and haptics recognition solutions

Description and use

This tool captures the movements of your hands with a great accuracy and near-zero latency. It allows the developer of the virtual solution to offer the user a more realistic

virtual user interface, to which the user can in turn, interact directly through its "virtual hand and fingers".

Examples of these kinds of tools and their application in the automotive sector

Tool	Website	Examples in the automotive sector
Ultraleap	https://www.ultraleap.com/tracking/	https://www.ultraleap.com/enterprise/automotive/
Sensoryx	https://www.sensoryx.com/	https://www.youtube.com/channel/UCb2pq_D8ufJlTNIYEE9dsDA/videos

Other resources

Tool	Website	Description
Virtual Reality in the Automotive Industry: Market, Adoption, Use Cases	https://www.scnsoft.com/virtual-reality/automotive	An interesting website describing how to use virtual reality in the automotive industry
Car Mechanic Simulator VR	 https://store.steampowered.com/app/1088770/Car_Mechanic_Simulator_VR/	Game-like application to build, repair, paint, tune, and drive cars in a 3D world.

x. Generic Learning Management Systems

Description and use

A generic learning management system (LMS) is a software platform that is designed to support the delivery and management of online or in-person learning programs. These systems can be used by educational institutions, businesses, and other organisations to provide training to their employees or students. These LMS platforms typically include features such as course creation and management tools, assessment and evaluation tools, and learner tracking and reporting capabilities. They can be used to deliver a wide range of technical training programs, including IT, engineering, and other technical disciplines.

These digital platforms allow the administration, documentation, tracking, reporting, automation, and delivery of educational courses, training programs or learning and development programs.

Examples

Moodle	**Google Classroom**	**SITOS**
https://moodle.org/	https://classroom.google.com/	https://www.sitos.at/
Sakai	**LMS solutions for Mircrosoft TEAMS**	**Edmodo**
https://www.sakailms.org/	https://education.microsoft.com/en-us/resource/038e7ec0	https://www.powerschool.com/classroom/schoology-learning/

xi. Generic Online Course Catalogues

Description and use

Generic online course catalogues are platforms that offer a wide range of online courses in a variety of subjects and disciplines. These catalogues may be offered by educational institutions, private companies, or other organisations and may include courses that are self-paced or have a fixed schedule. These platforms typically offer self-paced courses, allowing learners to complete them at their own pace. Some may also offer courses that have a fixed schedule, with live lectures or other interactive elements. Many of these platforms offer certification or credit for completing courses, depending on the institution or organisation offering the course.

These specific e-learning platforms do not only offer a complete LMS tool, but also a repository to host, deliver and commercialise (if desired) the courses created.

Examples

Tool	URL	Description
Coursera	https://www.coursera.org/	Online courses repository, some contents are free. Courses related to the automotive sector: https://www.coursera.org/search?query=automotive
Linkedin Learning	https://www.linkedin.com/learning/	Course repository embedded in the LinkedIn platform. Courses related to the automotive sector: https://www.linkedin.com/learning/search?entityType=COURSE&keywords=automotive
Canvas	https://www.canvas.net/	Online courses repository, some contents are free.

xii. Independent Authoring Tools

Description and use

Authoring tools allow the user to create interactive content and activities in a very easy way, usually using a WYSIWYG (What You See Is What You Get) approach - i.e. the content shown in the editor resembles its final appearance.

Every LMS includes its own authoring tools embedded in the platform (for example to create quizzes, wikis, and other content).

However, independent authoring tools also exist to create content that can be compatible with different LMS (notice that each LMS may be compatible with different authoring tools, so *not every tool is compatible with every LMS*). With the term *independent authoring tools,* we are referring to these tools not embedded or specific to a particular LMS.

There have been some attempts to standardise the learning packages obtained from authoring tools, such as SCORM or IMS standards, but none of them has yet become the most generic one.

Examples

Tool / Resource	URL	Examples of use/tools
iSpring Suite	iSpring Suite https://www.ispringsolutions.com/ispring-suite	This set of authoring tools can be used to generate a wide variety of content and interactive activities in a very visual and easy way. An Erasmus+ KA2 project called *E-tool for assessing the professional competencies of Car Mechanics in the context of EU experience*, probably useful for the DAMAS project was implemented using this authoring suite: https://erasmus-plus.ec.europa.eu/projects/search/details/2018-1-LT01-KA202-047069
H5P	H5P https://h5p.org/	This tool is very easy to use and offers both a very visually attractive design and a wide range of content and activity types. Its website offers a lot of examples:

		https://h5p.org/content-types-and-applications
SCORM compliant authoring tools	https://adlnet.gov/projects/scorm/	A very exhaustive list of authoring tools generating SCORM compliant content can be obtained from the documentation of the moodle LMS: https://docs.moodle.org/400/en/Creating_SCORM_Content

II. Specific Tools – Benefits and Weaknesses

i. Tutoring, Monitoring and Assessment Tools

Description and use

Online monitoring, tutoring and assessment tools for the internships/apprenticeships. They may provide some extra functionalities such as tracking, project-planning and hiring tools.

Examples

Tool	Website	Description of the tool
Integrated databank (BID)	BID BANC INTEGRAT DE DADES https://www.empresaiformacio.org/sBid/	This is the official digital online platform developed by the General Council of the Catalan Chambers of Commerce to manage, monitor and evaluate traineeships and apprenticeships of the Catalan initial and occupational VET system.
Toggl track	toggl https://toggl.com/track/	It is a time-tracking software that allows you to define tasks and track the time spent on them. It can be integrated with other software, such as calendars, digital workspaces, etc.

ii. Specialised Learning Management Systems and Course Catalogues

Description and use

Specialised learning management systems (LMS) are software platforms that are designed specifically to support the delivery and management of technical training programs. These systems can be used by educational institutions, businesses, and other organisations to provide online or in-person training to their employees or students.

These are specialised LMS for technical professions or, more specifically, for the automotive sector.

They usually include tools for diagramming, 3D modelling and animation, simulator, etc. They may provide the courses or allow you to create your own.

Examples

Tool	Website	Description of the tool
Vocanto	https://vocanto.com/en_GB/	E-learning platform for commercial and industrial-technical training. It allows you to create, deliver and share online courses using a wide range of integrated software tools. Some courses are offered for free and others by paying a fee. Vocanto course catalogue: https://vocanto.com/en_GB/library/
Electude	https://www.electude.com/	E-learning platform for industrial-technical training. It uses interactive resources, animations and simulations, to create a discovery-based environment. It contains courses and programs in light vehicles, heavy vehicles and systems technologies.
Auto Fachmann	https://www.autofachmann.de/	Specialised publisher in the automotive sector. It offers e-books and a related e-learning system.

iii. Blended Training Solutions

Description and use

These are educational solutions which contain both digital and physical-related experiences.

Example

Tool	Website	Description of the tool

Lucas Nuelle	https://www.lucas-nuelle.us/	This company provides content, software and hardware needed to deliver the training, with the help of an LMS. Specialised products for the automotive sector can be found in the Hybrid & EV section: https://www.lucas-nuelle.us/2765/apg/367/Products/Automotive-%7C-Hybrid-EV.htm

iv. Custom Tools

Description and use

These are tools developed specifically for a concrete purpose in the **automotive sector**.

Example

Tool	URL	Description
EV'nAR	https://www.diagnosecar.be/ https://youtu.be/LzWToENA-24	Developed by Connectief, it is an AR tool for hololens 2 to teach about components of electric vehicles and to switch off the high volt battery. It has been tested with both learners and with teachers. Related to the EU project https://www.enneproject.eu/augmented-reality-in-car-mechanics/

5. Conclusions

In this last chapter, we will find out the common denominators to all DAMAS partner countries, as far as virtual apprenticeships within the automobile sector are concerned. The aim of this conclusion is both to highlight similar best practices with virtual mobility and to underline the common needs for improvement in this field.
All in all, what would our VET/HVET teachers need in order to continue working with virtual learning and to integrate it further into apprenticeships?
Across all five countries, the relevance of the following parameters was highlighted:

- **Technical challenges:** Finding the adequate VR tool at the right price, according to the teachers' needs and school curriculum specifications, requires time, knowledge and commitment.
- **Financial aspects:** This concerns the new VR equipment, but also the possible need to hire an IT colleague or get someone trained specifically. Several partners told us that they collaborated with the business community and thus kept their consulting-related expenditures to a minimum. The budgets varied a lot, ranging from expensive to self-made tools or even to free versions like Microsoft Teams.
- **VR risks:** VET/HVET teachers and lecturers pointed out that students who are not self-organised - or still rather immature - may not take the virtual learnings seriously and they may not always attend the lessons, and fail their exams at the end. On the other hand, this virtual teaching is also seen as an opportunity for increased flexibility, control of their own time and increased motivation for students who can handle this new self-responsibility.
- **Technical Safety**: Most of the partners mentioned for the purpose of this handbook that in the automobile sector, the safety aspects become essential when increasing the use of VR at hazardous stages such as construction under high voltage.
- **Networking:** Several partners stated that a common platform to share different materials and recommended tools and methodologies with other schools/teachers would have been useful to them at their early stage of VR development.
- **Time savings:** The DAMAS Partners also mentioned that the use of VR makes education more cost-effective because commuting or business trips are reduced or even spared.
- **Green economy:** The partners mentioned that an increased use of VR can reduce travel and thus reduce carbon dioxide emissions.

I. Feasible Technological Approaches and Transferability to Other non-Automotive Sectors

In order to implement virtual mobility in an apprenticeship context, we should consider the following tasks, whereby many of them would require specific tools:

- Teaching, training and work-based learning processes
- Providing training content to the apprentice from abroad
- Assigning tasks and activities to apprentices from abroad
- Performing the tasks, activities and work-based activities assigned
- Delivering tasks and activities to VET providers and companies abroad
- Tutoring, monitoring, evaluating and assessing apprentices from abroad
- Communication and coordination between stakeholders
- Planning virtual mobility and its related agreements
- Scheduling, performing and documenting regular meetings
- Transferring and disseminating the results obtained.
- Sending surveys and making analyses.

We consider that Learning Management Systems (LMS) are the most appropriate tools as they allow us to integrate most of the mentioned aspects into the same tool. These are very versatile and customisable: both static and interactive contents, activities, communication systems, monitoring and assessment can be part of it.

Considering that, analysing the different LMS options in the market and choosing the one that best fits our needs may be a critical success factor for the virtual mobility project. Crucial aspects to be taken into account are the usability, the design, the previous knowledge of the tool by the stakeholders of the project, the price and licensing of the tool among others (open source OER or not, data protection aspects, exit strategy, etc),.

On the other hand, there are specific LMS that include ready-to-use courses or materials (Coursera, LinkedIn Learning, Canvas, vocanto, electude, auto-fachmann). These resources may be used in two different ways: to set a link to them in the LMS of the project or to use the LMS of the repository to provide these contents, if it is allowed.

To implement the educational activities, it is necessary to create and present interactive content and practices in order to enhance the participation of students in their own learning process within an immersive context, an understandable language and a safe

environment. Usually, LMS are compatible with a wide variety of interactive formats and design tools, including interactive quizzes, gamification, collaborative workspaces and tools, etc. As a consequence, the ability and skills to create digital and interactive contents are clearly keys to success.

Moreover, LMS gives the possibility to adapt content and activities to student learning requirements. All of them could be displayed depending on their progress and could also go with support materials or extensive activities enrichment. Additionally, all this would be helpful to promote inclusive education.

Digital twins, interaction: Such tools provide immersive educational learning using a virtual representation of an object or system in real-time (digital twins). Simulation is used to emulate real processes using some device solutions such as glasses and headsets.

To plan and manage the project itself, intranet and project management tools could be required. A vast majority of these tools allow one to plan, assign tasks, monitor the progress of the project as it develops, be it under synchronous or asynchronous communication. They also offer efficient meeting scheduling and performing, people locating and contacting.

Catalonia, as a last example, has even developed a specific tool, called BID, to manage in-company work-based learning, particularly focused on traineeships and apprenticeships. This tool covers planning the in-company experience, creating the corresponding agreements, and monitoring and evaluating the work-based experience. It also allows you to schedule and document meetings, and to perform final surveys in order to assess the degree of satisfaction of each participant.

II. Expected Results and Impacts of this Project

In the submitted proposal for the DAMAS Project, several goals have been set. Under the overall aim of innovation, the whole project wants to address the uncertainty of travel with regard to apprentice mobilities as well as work-based learning in general, by finding new ways to digitalise the VET experiences. Therefore, DAMAS aims at equipping teachers and trainers with the skills and online tools that enable them to develop blended or even fully digital VET courses and mobilities. This form of new accessibility proved not only helpful in times of Covid19 but also supports students that are restricted in some

ways and can therefore not be part of a traditional learning experience to experience a more customised learning process.

Furthermore, DAMAS not only enables better accessibility but also teaches digital skills that are much needed in the future of almost every workplace. All this has the positive side effect of blended and digital programs being essentially more flexible for students and teachers, the learning process "becomes transparent, manageable, controllable and transferable" (DAMAS proposal) as well as autonomous. Next to accessibility, another focus of this project is a greener economy. With online mobilities and, on a smaller scale, online VET lessons, CO2 emissions and pollution due to travelling can be reduced.

In order to achieve those goals, "pedagogy and technology have to go hand in hand" (DAMAS proposal, p.3), which is the goal of the DAMAS project.

III. Follow-up to the DAMAS Project

The following steps of the DAMAS project consist of the creation of a modularised platform and training programme to promote the use of digital technology during VET Teaching and VET mobility activities.

Open Education resources (OER) will be created based on the principles of openness and accessibility for VET trainers and organisations willing to initiate or continue virtual mobility experiences at the workplace.

These OERs developed will be used as part of a training course for VET trainers and will be developed on Moodle (Learning management system), thus allowing for high adaptability and transferability to other target groups, sectors and countries.

The online learning material is produced for VET trainers with a special focus on the automotive/mechanical/manufacturing sector.

Various modules on work-based virtual mobilities will be developed for VET teachers and company trainers and piloted in a continuous professional development path.

The DAMAS training curriculum will be tested and evaluated by VET trainers in the context of a Learning Teaching Training Activity (LTTA) with international participants.

All material developed within the DAMAS project can be adapted and used by VET trainers in Europe to carry out virtual teaching and virtual/blended mobilities with their VET students and apprentices in the future.

So keep on following the #DAMASproject for further developments!

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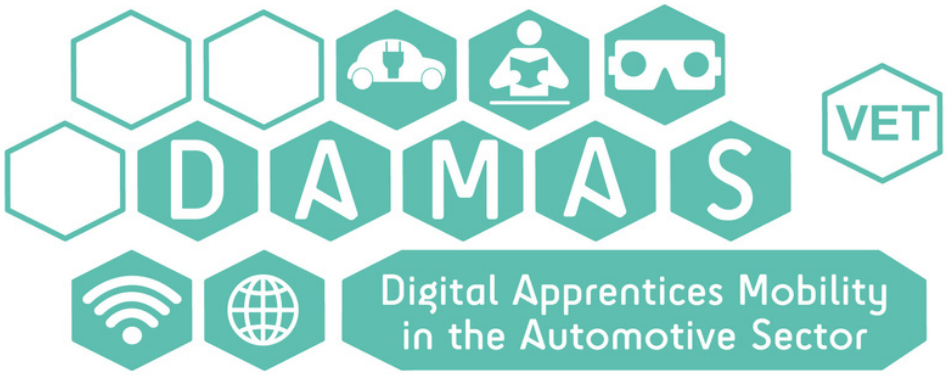

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