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Apprenticeships and the digital transition

Modernising apprenticeships to meet digital skill needs

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Foreword

On 15 and 16 June 2023, the third Cedefop-OECD symposium took place, focusing on apprenticeships and the digital transition. The symposium was organised at the start of the European Year of Skills, which highlights the importance of skills development for long-term sustainable growth and competitiveness. The symposium coincided with a time when technological advancements, particularly in AI, were creating a lot of new opportunities for labour markets and education systems, while also raising questions about effective and ethical use of such technologies, equal access to it and the distribution of its benefits across different workers.

The symposium and the set of research papers presented in this publication provide a timely contribution to the discussion on skills for the digital transition. Digital technologies are increasingly being adopted in a wide range of occupations and sectors, suggesting a growing need to equip most workers with a solid set of relevant skills. All workers will require basic digital skills – not only for work but also to navigate effectively more digital day-to-day life – while many will also require specific digital skills to work with specialised technologies. Others will require highly advanced digital skills to develop and maintain related tools and technologies. Ensuring that young people have opportunities to develop the right digital skills is crucial to avoiding skills shortages and fostering productivity. At the same time, adults who are already part of the workforce need to be able to engage in upskilling and reskilling programmes to develop and update their digital skills. Vocational education and training (VET) plays a key role in equipping young people and adults with the right skills for the labour market, including digital skills. Because of its close connection to the world of work, VET is well placed to anticipate and adapt to changing skill needs arising from the digital transition.

Apprenticeship is essential in this respect as it brings VET providers, employers and learners together in a structured way that allows for skills development in diverse learning settings. Apprenticeship generally provides a well-rounded learning experience that allows learners to acquire the skills that employers are looking for, as well as the skills needed to navigate changing and more digital labour markets.

While apprenticeship can be an effective tool to foster the digital transition by contributing to developing relevant skills, it can itself also benefit from digitalisation through the introduction of digital tools in the delivery of apprenticeship. Digital technologies have been making their way into the education sector, with a great impetus delivered by school closures during the COVID-19 pandemic. Technologies such as online courses, simulators, virtual reality and artificial intelligence have the potential to make apprenticeships more accessible, diverse, flexible, safe, and adapted to the needs of learners and employers. Such more digitalised learning opportunities complement excellently the learning elements that apprenticeship offers through the combination of school-based and in-company training components.

The research papers in this collection explore how skill needs are changing due to the digital transition, how this impacts apprenticeship systems, how apprenticeships can support and promote the transition, and how they can benefit from effective technology adoption and use in their delivery of the school-based and workplace components. The practices and insights presented in the papers by scholars from different countries and disciplines, contributes to ensuring that the digital transition will be a just transition that contributes to higher quality jobs and lives.

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CHAPTER 1.

Introduction

1.1. Digitalisation is changing labour markets

Digitalisation has been transforming labour markets around the world in recent years. Workplaces are increasingly adopting digital technologies, and this has implications for the skills that workers need. The European Survey of Jobs and Skills highlights that 44% of workers in the European Union (EU) ([1]) report that new digital technologies, like new computer systems, devices and/or programmes, were adopted in their company in 2020-21. Consequently, 35% of adult employees in EU countries say they had to learn to use new digital technologies to do their main job in that period; 45% now believe that they need or will need new knowledge and skills because of the new digital technologies in their workplace.

Cedefop analysis of online job advertisements (Going digital means skilling for digital) shows that the growth in demand for digital skills remains evident in both information and communications technology (ICT) and non-ICT related occupations. In the second quarter of 2023 there were more than 600 000 open job advertisements for information technology (IT) workers in the EU. Despite a slow-down (since 2022), in the longer-term the demand for IT workers will continue to expand: remote work will remain a practice in many organisations in the post- COVID-19 world, increasing the need to support new modes of working, providing services and protecting organisations against data breaches and other cyber security threats. The demand for digital skills in non-IT jobs is also growing. Sectors like electricity, gas, steam, and air conditioning supply, construction, and professional, scientific, and technical activities rely much more on them, with almost half of online ads for non-IT jobs posted in the first two quarters of 2023 requiring such skills.

It is expected that digitalisation will continue to have an impact on jobs. Automation, robotisation and other forms of digitalisation transform skill needs in all types of occupations and at all qualification levels. Digital transformation will shift upwards the level of digital skills employers ask for; even in low-skilled occupations, where no special training was needed in the past (such as agriculture), the demand for medium- and high-level digital skills (e.g. using sensors-based technology) will grow (see Skills in transition: the way to 2035).

According to updated estimates by the OECD (see OECD employment outlook 2023), the occupations at highest risk of automation account for about 28% of employment on average across OECD countries. Due to recent advancements in Artificial Intelligence (AI), high-skilled occupations are now more exposed to automation than before. Low-skill jobs remain most susceptible to automation, although several of these also include hard-to-automate tasks and skills, particular concerning social interaction.

While AI has the potential to transform many jobs, its impact in terms of number of jobs has been limited so far. A recent OECD survey on AI use in manufacturing and finance shows that – up to 2022 – job reorganisation was more prevalent than job displacement when AI is adopted. And new jobs are being created, particularly for high-skilled workers who have the right competences to work with AI. For example, the 2023 OECD Skills Outlook shows that the share of online vacancies requiring AI skills increased by 33% between 2019 and 2022, although it remained small at 0.4% in 2022 ([2]). Within the EU, AI adoption is still limited, and it will require more employers to adopt it before any AI replacement effect materialises (see Going digital means skilling for digital). We are, however, at a very early stage of adoption of a technology that is evolving rapidly and could affect every sector and in much deeper way. Monitoring the distribution of job loss and creation will be important with an eye on inclusiveness.

([1]) Refers to all the countries covered in the survey, i.e. EU-27 countries and Norway and Iceland.
([2]) In 14 OECD countries with available data

1.2. Digitalisation: opportunities and challenges for education systems

The speed and scale of labour market shifts, driven by accelerating technological advancements in automation, AI, and digital platforms, is unprecedented. This forces education systems and vocational training programmes to build far greater agility and responsiveness to ensure learners have relevant future-proof skills. Specifically, they need the capacity to redesign curriculums, programmes, and learning pathways at faster rates while still maintaining quality.

Embracing change and emerging technologies is essential for education systems and vocational education and training (VET) to keep pace. Digital platforms and solutions can help them become more scalable, flexible and data-driven to diagnose skill mismatches. Virtual reality (VR) or augmented reality (AR) can enable more immersive, accessible simulations for technical skill-building. AI-powered personalised learning analytics can allow customised support. Just as critically, teacher training frameworks must be transformed, with reskilling modules, to prepare teaching professionals to implement modern digitally enhanced pedagogies.

While technology has been making its way into the education sector, and this has implications for the role of teachers and trainers, digital technology is not replacing them. Rather, technology can support teachers in reinventing themselves as mentors, coaches, tutors, peers and designers of learning experiences. Collaborative tools and data-enriched technologies such as classroom analytics, robots, AI-powered assessments, blockchain-based credentialing, and early warning systems for at-risk students can help teachers to teach more effectively, and education systems to run more efficiently and equitably (see OECD digital education outlook 2021). In Europe, school and policy initiatives on digital skills and remote and blended teaching and learning have substantially increased over recent years, especially in response to the COVID-19 pandemic. Improvement of digital skills is among the priorities of national policy responses, when it comes to VET teacher and trainer initiatives (see Teachers and trainers in a changing world). To reap the potential benefits of digitalisation in the education sector, teachers and trainers need to be given the opportunity to learn how to use digital technologies effectively and to stay up to date with field-specific knowledge and skills. However, many teachers report a need for training in ICT skills, and a substantial share of teachers – especially older ones – do not feel comfortable using digital technologies in their teaching activities ([3]). For example, less than 60% of vocational education teachers older than 50 in OECD countries feel confident using digital technologies for class teaching or to provide feedback and support students ([4]).

Policy-makers need to prioritise reforms and investments in bringing both learners and teachers on board with technology-powered learning platforms to drive this workforce transformation agenda.

1.3. What does this mean for apprenticeship?

When well-designed and seamlessly integrating education and the labour market, apprenticeship can be a particularly effective tool to deliver the skills that individuals need in increasingly digital economies and societies. At the same time, apprenticeship – as with other parts of the education system – can benefit from the use of technology in delivery.

Future-ready skills systems that help people navigate the digital transition are crucial, and a fast responsive VET system is a critically important part of such skills systems. Having at its core to prepare individuals, young and adults, for employment, career advancement, and successful participation in the labour market, a strong VET system is solidly anchored in the labour markets; it is in pole position to

([3]) OECD (2021). *Teachers and Leaders in Vocational Education and Training*. OECD Publishing. https://doi.org/10.1787/59d4fbb1-en .
([4]) OECD (2021). *Teachers and Leaders in Vocational Education and Training*. OECD Publishing. https://doi.org/10.1787/59d4fbb1-en based on data from the European Commission's SELFIE tool.

adapt swiftly to emerging industry needs, technological advancements, and evolving job roles, ensuring that individuals remain competitive and agile in the ever-changing landscape of the modern workforce.

Apprenticeships play an essential role in this respect, as they are designed to bring the education system and world of work together, making them particularly suited to be responsive to rapidly changing skill needs. As the workplace is an integral part of apprenticeships, they can readily be adjusted to meet the demands of increasingly digitised workplaces and industries. The greater the exposure apprentices have to digital skills, the more adept they become at developing a spectrum of competences, spanning from basic to advanced levels.

As apprenticeships are inherently demand-driven, they are primed for the development of new programmes tailored to emerging digital occupations or sectors, such as cybersecurity.

Apprenticeship can not only serve young learners who are looking to enter the labour market, but also provide an effective upskilling and reskilling pathway for adults. According to Cedefop's European Skills and Job survey, 52% of workers need to acquire basic and medium digital skills yet only 26% of EU workers participated in digital skills training; those who arguably need it the most participate least. Because of their strong work-based learning focus, apprenticeship can be an attractive tool for adults to upgrade and update their skills – including their digital skills – to get a relevant qualification, progress in their careers or remain in employment.

The use of digital technologies has the potential to make apprenticeship even more attractive, relevant and effective. Digital technologies can remove barriers to access, enable more personalised approaches, facilitate communication between apprentices, employers and training providers, make training safer and greener, and increase the motivation of learners. These technologies have the potential to complement and improve the school- and work-based learning components of apprenticeship, provided that the right enabling conditions are in place. Nonetheless, it is crucial to ensure that technology integration does not dilute the distinctive feature of apprenticeships: the immersive hands-on experience within authentic work settings.

1.4. Insights from the research papers

The research papers included in this publication shed light on the role of apprenticeship in developing skills for the digital transition, as well as the potential of technology use in apprenticeship delivery, both at the school-based and the workplace component. They present research evidence and insights from practice from around the world.

Digitalisation shaping apprenticeship content

In various countries apprenticeship is still concentrated in traditional sectors or occupations, but there is potential to expand it to other parts of the labour market, including digitally intensive sectors or occupations. The papers of this publication present several current initiatives in such expansion (Matthews et al., Chapter 4; Pigeaud, Chapter 6; Forshaw et al., Chapter 13) in sectors such as software development, data science, user experience design, and cybersecurity. It seems that labour market actors (either individual companies or whole sectors) are increasingly turning to apprenticeships to cover acute skill gaps, sometimes through an open market approach that challenges how apprenticeships work. Learners are also attracted by digital sectors as they offer more promising career pathways and may be willing to enrol in apprenticeship schemes in such sectors (Bajka, Chapter 3). Papers show that apprenticeship offers a suitable platform for this expansion, revealing that actors often intend to back up the new provision with fitting frameworks and pedagogies (Matthews et al., Chapter 4; Wang, Chapter 5; Forshaw et al., Chapter 13). Those frameworks often point to the need for close cooperation between

VET schools and companies offering apprenticeships (Bajka, Chapter 3; Maniadaki et al., Chapter 7). The papers illustrate that the same strong linkages between employers and training providers that have made apprenticeship a success story in more traditional sectors and occupations offer great potential also to the digital sectors and occupations that need to respond to fast-changing skill needs.

In addition to developing specialised digital skills for digital industries, apprenticeship also plays a significant role in equipping a wide range of young people and adults across the board with solid technical digital skills at lower/medium level. The papers offer rich evidence on how (non-digital) sectors that are traditionally trained through apprenticeships are being transformed in light of the digital transition, to meet the evolving needs of changing jobs, skills and tasks. Apprenticeships, along with other forms of education and training (ET), VET included, need to offer basic skills across occupations, as expressed in European Frameworks of digital competences (Maniadaki et al, Chapter 7). A look at traditional apprenticeship sectors (i.e. non-digital ones) shows the variety of digital skills required in different occupations, from automation and use of digital machinery, to simple digital communication (Brown et al., Chapter 2). Digitalisation of apprenticeships in traditional apprenticeship sectors can demonstrate how modern, and therefore appealing, they are to candidate apprentices (Bajka, Chapter 3).

Good understanding of what these basic and lower-level technical digital skills are, and how they can be different in different sectors or occupations, is required. Insights from data and stakeholders are needed, to understand what happens within a sector, and what type of skills are most in demand (Brown et al, Chapter 2; Matthews et al., Chapter 4). Such information is essential to ensure that apprentices and their teachers and trainers are equipped with the right skills.

1.4.1. **Digitalisation supporting apprenticeship provision**

The papers clearly demonstrate that digital technologies have great potential for the delivery of education and training, including in apprenticeship. They present numerous cases of how digital technologies have already been introduced in VET and apprenticeships. Technologies such as AR/VR and simulators (or software for simulated environments) give learners the opportunity to experience settings that they may otherwise not be exposed to during their training either at school or at the workplace, in a safe way that allows for trials and errors. As such, they complement the rich work-based learning opportunities that are at the heart of apprenticeship. They often successfully reproduce work environments and allow apprentices to perform tasks that are close to authentic ones (Gentner at al., Chapter 8; Gaušas & Čop, Chapter 10; Stępnikowski, Chapter 11), also with a potential to overcoming physical limitation (e.g. number of companies already having a certain technology) and therefore make a learning experience accessible to more apprentices. Digital solutions that include simulations or gamification often help both customise the training process and increase apprentice engagement (Pigeaud, Chapter 6; Stępnikowski, Chapter 11). Teaching teachers and trainers in using enterprise resource planning (ERP) software produced positive effects in terms of developing new skills, closing digital skills gaps, developing the ability to train and assess their own apprentices (Mayer and Seifried, Chapter 11).

Digital technologies offer apprenticeships new platforms to increase training provision through online modes (Wang, Chapter 5; Pigeaud, Chapter 6; Forshaw et al., Chapter 13). Digitalisation of the actual provision can be seen as an opportunity to offer more programmes to an increased audience, including in new specialties or new learner groups. But it can also represent a challenge for apprenticeship, especially when the format is excessively modular and the link to full formal qualifications becomes less straightforward.

At the same time, papers also make clear that there are limitations to what digital technology can add to traditional ways of apprenticeship teaching. First, papers point to factors linked to the nature of the digital technologies used, most prominent of which is the time to be exposed to virtual, extended or augmented reality tools (Gaušas & Čop, Chapter 10; Stępnikowski, Chapter 11). Then, in several cases, the start-up costs to get a digital solution available across all VET/apprenticeship schools can be high (Pigeaud, Chapter 6; Stępnikowski, Chapter 11). Some technologies or pedagogical approaches are

initially developed for any ET/VET programme and are simply applied to apprenticeships as well, without further configuration that would reflect the particularities of this specific form of training (Pigeaud, Chapter 6; Gaušas & Čop, Chapter 10; Stępnikowski, Chapter 11). The need to customise and fine tune their content to the real training needs of apprenticeship specialties constrains the extent to which such solutions can become generally available.

Limitations may also rise from the readiness and motivation of actors involved in using digital technologies in apprenticeships. Digital transformation of apprenticeship training (in content and training process) may present challenges for schools and companies. Some employers may be more willing to restrict the use of software like ERPs purely to productive work rather than for training their apprentices (Mayer and Seifried, Chapter 11), whereas in-company trainer motivation towards digital training of apprentices may be limited by the lack of similar examples or their own personal predisposition (Ofstad, Chapter 12). Investing in teacher and trainer training is generally crucial for the successful adoption of digital tools. Both school teachers and in-company trainers need sufficient time to be acquainted to digital tools and develop their own skills before they teach apprentices with the help of such tools (Pigeaud, Chapter 6; Maniadaki et al., Chapter 7; Gentner et al., Chapter 8; Stępnikowski, Chapter 11; Ofstad, Chapter 12). Digital tools can have a strong complementary role to other forms of teaching and training, but the latter cannot be fully replaced or moved to the online domain (Gaušas & Čop, Chapter 10; Stępnikowski, Chapter 11). The role of teachers and trainers in guiding apprentices remains irreplaceable (Stępnikowski, Chapter 11), while several people can have this role of 'significant others' supporting apprentices in the workplace (Forshaw et al, Chapter 13).

1.5. Digitalisation is an opportunity for apprenticeships

This publication offers insights into both the benefits and challenges or limitations associated with the adaptation of apprenticeships to the digital transition. Although various challenges are worth the attention of apprenticeship stakeholders, the great opportunities that digitalisation presents to apprenticeships are overall more prominent.

Digitalisation gives apprenticeships the opportunity to show their labour market relevance and agility

The evidence presented in this publication shows the great potential for apprenticeships when it comes to the content of training: digitalisation calls for apprenticeships to develop new sets of skills in existing or new occupations. By expanding to new or emerging sectors, apprenticeships offer a much-needed contribution to skill development meeting digital transition needs. If a traditional apprenticeship occupation requires digital skills and includes tasks carried out digitally, apprenticeships will naturally need to adjust to that and prepare learners accordingly by adapting the content of training to include more digital skills. In both cases, agile apprenticeship that respond to digital skill needs can remain relevant and attractive for employers.

Digitalisation helps apprenticeships to attract learners

Younger learner cohorts are familiar with digital technologies in their everyday life. Several may aspire a career in digital occupations: apprenticeships opening up to such occupations can become an attractive option for those learners who can pursue their interest while benefitting from all other features of this particular education and training option (e.g. remuneration, social protection, immersion to a

professional community). Papers also show that the expansion of apprenticeships in digital sectors is a suitable option for older learners as well, which allows them to pursue a career change or upskill to remain employable in rapidly changing labour markets.

Even within traditional sectors, digitalisation of apprenticeship training makes the option more attractive to young learners: digital tools increase engagement, interest and customisation of training. Papers in this publication also show that, despite occasional high start-up costs in certain technologies, digitalisation in general has the potential to offer new and more equal possibilities for accessing learning and can provide learning experiences that cannot be made available in every workplace, through simulations of modern production processes.

1.6. The way forward

In this context, the discussion is not about whether apprenticeships should respond to needs stemming from the digital transition, but how they can adapt more efficiently, and how they can most benefit from the opportunities that the digital transition brings.

The digital transition calls for a well-designed and supported re-engineering of aspects of apprenticeship: to integrate basic digital skill development, to expand to sectors that are not familiar with apprenticeship training, to integrate technology-supported learning in school- and work-based learning settings, and to facilitate the participation of adults looking to upskill or reskill.

What could be the key enablers for the way forward?

Involve apprenticeship stakeholders in designing the content of apprenticeships to meet the needs of the digital transition

Apprenticeship can offer solutions to skill development in occupations that are either already trained predominantly through apprenticeships or are less traditional and now turn to this education and training type. In both cases, there is a need for clear understanding of the requirements of digitalisation, in terms of skills, qualifications, apprenticeship programmes and training content. There is also a need to reflect on the benefits of work-based learning when considering extending apprenticeship provision to new digital sectors or occupations: its advantages over school-based learning are not the same in all sectors/occupations, so when to opt for apprenticeships as a response to digital skill needs should be carefully considered.

Getting all the relevant players around the table is essential in understanding these changing skill needs and to jointly deciding what to train in the form of apprenticeships. Structured multi-stakeholder collaboration at this level will allow the exchange of insights from data and stakeholders to understand what happens within a sector, and what type of skills are most in demand. Participatory approaches in skills anticipation, apprenticeship governance and decision-making will support a targeted, effective and quality adaptation of apprenticeships to digitalisation. Only by getting everyone on board can apprenticeships be truly relevant and serve learners in a more digital society.

Share responsibilities to engage and support apprenticeship actors

Limitations on effective adaptation of apprenticeships to digitalisation may be related to the costs of expanding the use of digital technologies, especially in the case of introduction of advanced tools that require high development or customisation costs and expertise. Other limitations may be linked to the (lack of) digital skills of teachers and trainer, (lack of) time for professional development, and miscon-

ceptions or predisposition of teachers and trainers towards digitalisation of apprenticeship training.

Overcoming such limitations requires relevant actors to join forces and assume their share of costs and responsibilities. For example, the costs of the development and customisation of augmented/extended reality solutions can be shared among State authorities and the corresponding sector. Teachers can be trained in modern digital infrastructure and software at the premises of companies. State and social partners can jointly provide incentives for in-company trainers to take up courses in using new tools and adopting new digital pedagogies.

For the workplace component of apprenticeship training, investment in terms of organisational culture and pedagogical transformation is needed for digital technologies to be effectively put in use: this requires clear support from leadership to adopt digital technologies to train their apprentices (as well as their regular staff), new roles for training staff, time for in-company trainers to develop their own digital competences, including by learning from peers, and successful examples within the company.

Preserve the relationship of apprentices with teachers and trainers in digital contexts

Despite the many potential benefits of digitalisation, several papers also point out that apprenticeships come with a set of features that cannot be fully reproduced by digital technologies. Even during COVID-19 lockdowns, which gave a boost to fully remote options, these were used only temporarily and exceptionally. Time spent at the workplace and/or a VET provider remains the norm, even in the most 'advanced' examples of digital forms of apprenticeships.

In this context, teachers and trainers will remain essential actors in apprenticeship systems. Although AI solutions may become increasingly effective in supporting learners (chatbots), the relationship between apprentices and their trainers and teachers will remain central to the development of the wide set of skills that apprenticeships can help develop. For example, the teaching and communication skills of instructors remain important even when apprentices can use simulation software or AR/VR tools. What may change is the context of the role of teachers and trainers: they need to be prepared to work increasingly as coaches and facilitators of learning, rather than the sources of all knowledge, as learners in many cases are familiar with several digital technologies.

Balance agility of adaptation to digitalisation with a clear apprenticeship identity

In a context of rapidly changing technologies and acute skill shortages, there is often an urgency among stakeholders in adjusting apprenticeships to provide quick solutions. Especially in the case of upskilling or reskilling adults, the workplace component of apprenticeships is seen as a promising option for skills development, including in new digital sectors. In many cases, this is pursued through digital modules and microcredentials that are relatively new in the apprenticeship landscape.

Merely making use of digital opportunities to respond to emerging skill needs does not guarantee that a (new) programme will operate as apprenticeships should, and that it would help tap the potential that apprenticeship offers as a training option. The introduction of digital/online delivery options can help apprenticeships to adapt to digitalisation in an agile way, but excessive use of digital solutions of short duration could lead to provision of programmes that are not easily recognised as apprenticeships by traditional stakeholders, especially the education and State actors.

Digitalisation of apprenticeship provision should not result in abusing the apprenticeship concept, using its brand as a fake one: in the medium to longer term, this will only add confusion among learners, employers, education actors, which in turn may reduce trust and acknowledgement and may eventually be counterproductive in relation to the intended policy objectives. Various papers in this publication, and the discussions of their findings at the symposium on 15 and 16 June 2023, underline the importance of

ensuring that the core concept of apprenticeship remains intact, as this is what maximises its benefits for all actors involved: apprentices, employers, societies.

Use frameworks to ensure quality in the digitalisation adjustment

Papers in this publication made evident that expansion of apprenticeships in new digital sectors, or use of digital platforms to accelerate skill development (especially in modular formats), need to respect the core features of apprenticeship programmes. While adapting its content and provision to digitalisation, apprenticeship should continue to provide a strong vocational foundation through a combination of school-based and work-based training underpinned by solid quality assurance mechanisms and social partner engagement that provides learners with well-rounded training that prepares them for the labour market.

To this end, adaptation of apprenticeships to the digital transition can benefit from clear(er) links with frameworks of quality apprenticeships (such as the European framework for quality and effective apprenticeships or the ILO quality apprenticeships recommendation) or qualification frameworks. Such frameworks may provide great service to apprenticeship stakeholders (traditional or new) who look for ways to introduce apprenticeship in new sectors, to offer apprenticeships through digital tools and to update the content of apprenticeship programmes.

By respecting the requirements of such frameworks while adapting to digitalisation, apprenticeships can offer comparable learning experiences, which are valued by the labour market and education actors, and can help learners not only reactively (re)train themselves but acquire solid theoretical basis and first-hand practical knowledge that will allow them to be active in the labour market now and in the future.

CHAPTER 2.

How is the digital transformation changing demand for skills in apprenticeship-typical occupations?

By Duncan Brown, Elena Magrini and Mauro Pelucchi ([5])

2.1. Introduction

Digital and technological advancements are rapidly changing the world of work (Berger et al., 2016). Digitalisation, the rise of the robots and artificial intelligence (AI) are reshaping the labour market by affecting the way people work, the type of work they carry out as well as the type of skills required to succeed in the labour market (Nania et al., 2022; Magrini et al., 2019).

These trends have the potential to create many new opportunities for workers across the world. New technologies can help move away from manual, physical work. Automation and digitalisation can create efficiencies in the labour market, speeding up production, improving service provision and ultimately having a positive impact on productivity (Samek et al., 2021). On top of that, digitalisation can promote a more inclusive and sustainable economy, broadening opportunities for individuals from all backgrounds (European Commission, 2022b).

To realise these opportunities, people need to be equipped with the right skills. As the economy evolves to adapt to new technologies, employer needs will shift, and education provision will need rapidly to shift accordingly. This is the case for all types of education provision, and especially so for apprenticeships: their applied nature and close links to the labour market mean that apprenticeship provision needs to adapt even more quickly to new, emerging skill demands.

By leveraging the power of big data, this paper aims to shed light on the most recent trends on digital skills. It does so by using insights from job postings to analyse how digitalisation is affecting recruitment activity and skill demand over time in selected European countries: France, Germany, Italy, Spain and the United Kingdom. The research provides an overview of digital trends in the labour market as a whole and then dives deep into selected apprenticeship-relevant occupations in three sectors: construction, manufacturing and healthcare. For each of these sectors, the paper provides insights into the diffusion of digital skills, how this has changed over time, as well as the specific digital skills currently most in demand, with related implications for policy-makers.

The findings presented in this report provide unique insights for policy-makers interested in understanding more about the impact of digitalisation on apprenticeship provision. They offer direct, almost real-time information on what employers need in terms of skills requirements, especially for roles where apprenticeships are a typical route to employment, and how this is changing over time. These insights have practical applications policy-makers can then use by working together with education providers to adapt and shape apprenticeship offers to ensure they meet employer needs. This, in turn, will help widen opportunities for individuals, maximising their chances of securing employment.

The paper is organised as follows. The next section focuses on the methodology used in the report: it looks at job postings data, how digital skills are defined, as well as providing an explanation of the countries, sectors, and occupations selected for analysis. The section after presents findings from the

([5]) Lightcast, labour market analytics.

research, first at an overview level and then diving deep into each specific sector and its apprenticeship-reliant occupations. The report then closes with concluding remarks and implications for policy-makers.

2.2. Methodology

2.2.1. Job postings data

The analysis presented in this paper is based on Lightcast (formerly Emsi Burning Glass) proprietary data on online job postings.

The Lightcast job postings library comprises billions of job postings which are scraped on a daily basis from thousands of job boards, newspapers and employer sites. These job ads are then cleaned and deduplicated to ensure only one posting is counted for each opening, regardless of how many places it is advertised in. The job postings are then classified by location, industry, occupation, skills required and any other type of relevant information that can be extracted from the ad, using a combination of official and proprietary taxonomies.

The advantage of using this resource is that, unlike official statistics, it presents a unique opportunity to get insights from a large amount of almost-real time data on employers' needs. This helps quickly capture emerging trends, even before they appear in official statistics, and the granularity of the data helps understand the nuances in the labour market.

The downside of using job postings insights is that the quality of the data is dependent on employers posting their job ads online. This is normally more popular among employers looking to recruit for profession-based jobs, such as software developers and programmers, and less popular in other lower-skilled occupations, such as waiters and farmers.

2.2.2. Defining digital skills

To capture demand for digital skills in online job postings, this paper uses a definition of digital skills built from Lightcast Open Skills Taxonomy (Lightcast, 2023).

This taxonomy includes over 32 000 different skills terms, organised hierarchically in 32 categories and 400 subcategories, capturing all the skills employers mention in job postings.

From this taxonomy, approximately 12 000 skills were identified as digital. These skills encompass a wide range of skill clusters, from basic office digital technological tools, such as Microsoft Excel and Zoom, to more advanced digital tools such as programming languages and other IT-specific skills like Amazon Web Services. This definition also includes the skills and abilities necessary to use these tools – such as computer literacy – as well as the competences that, to be carried out, rely heavily on digital tools – such as automation, forecasting modelling and data analysis.

Table 1. **Examples of digital skills by category of the Lightcast Open Skills Taxonomy**

Category	Skill
Information Technology	NET Development Algorithm Design Code Analysis
Basic office technology	Microsoft Office Microsoft Outlook Zoom
Competences requiring knowledge of digital tools to be carried out	Analysis of Covariance Forecasting modelling Business Analytics Tableau (Business Intelligence Software)

Source: Lightcast Open Skills Taxonomy.

The report also applied the international European e-Competence Framework (e-CF) skills standard to assess the type of digital skills required in different parts of the labour market. The European e-Competence Framework (e-CF) provides a common language and reference system for identifying, assessing and developing digital competences. The e-CF skills were compared to Lightcast skills identified from the language used in the web postings, and were used to organise them across five dimensions:

(a) build: this level relates to the development of applications, software and systems;
(b) enable: this level is concerned with the configuration and deployment of systems and infrastructure. It includes skills such as installation, configuration and maintenance;
(c) plan: this level involves the planning and design of digital systems and services. It includes skills such as project management and business analysis;
(d) run: this level is focused on the operation and support of systems and services;
(e) manage: this level involves the strategic management of digital systems within an organisation.

Table 2. **Examples of digital skills linked with e-CF**

Category	Skill
Build	Network Infrastructure Industrial Software Ethernet Hub Brocade Switches
Enable	Control Systems Servomechanism Manufacturing Automation Computer Numerical Control (CNC)
Plan	Building Information Modelling Machine Learning Root Cause Analysis Analytics
Run	Spreadsheets Office Management Software Personal Digital Assistant Online Communication
Manage	Agile Management Social Media Marketing Digital Transformation Technology Assessment

Source: Lightcast Open Skills Taxonomy and e-CF framework, elaborated by the authors.

2.2.3. Selecting countries in scope

The analysis presented in this paper focuses on five European countries: France, Germany, Italy, Spain and the United Kingdom.

These countries were selected for three reasons, the first being data availability. The first step in selecting countries for the analysis was to assess data quality in job postings to ensure good coverage and representativeness of the sample.

Countries were then assessed in terms of variations in their apprenticeship systems. The idea behind this assessment was to ensure that different types of systems were represented in the analysis, making the findings of this paper applicable to different contexts. For example, Germany was selected for the long-standing reputation of its apprenticeship model. Its highly regulated dual apprenticeship system is taken as a model by many other countries as an effective way to improve employment opportunities for young people and meet employers' needs (Hoeckel et al, 2010). Italy's apprenticeship system also offers the opportunity to combine work with training for young people interested in gaining a particular

qualification, but along with a different type of apprenticeship contract, the *apprendistato professionalizzante*, which is purely workplace-based ([6]). In a similar fashion, France, Spain and the United Kingdom have different types of apprenticeship systems, which are at different levels of maturity and development.

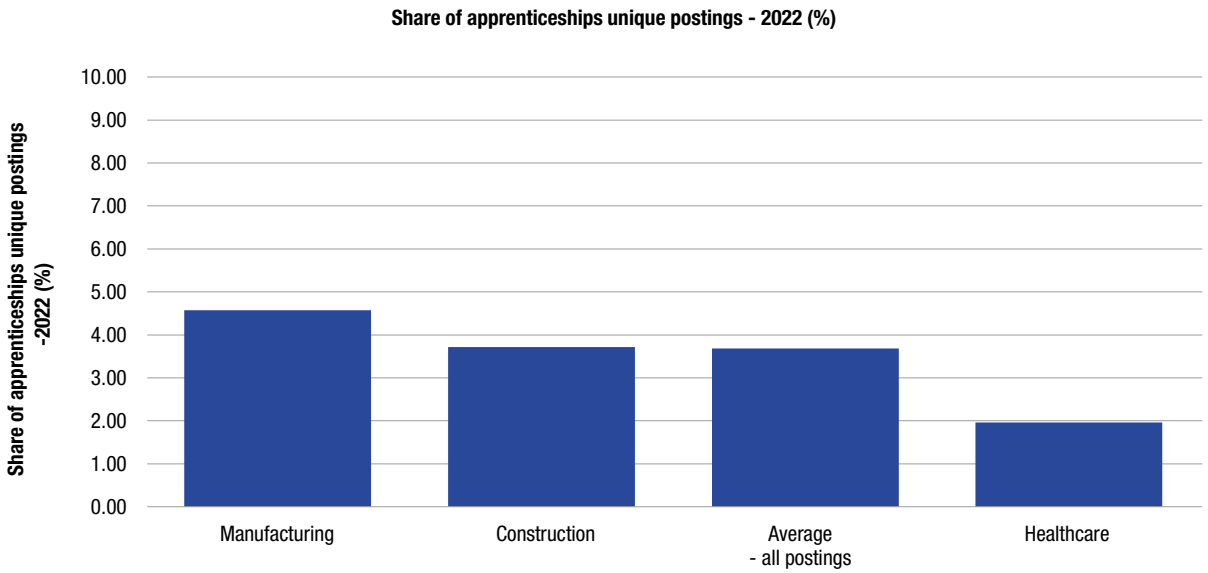
Geographic coverage and country size were considered, to ensure good spread across Europe. Using this criterion means that the five countries selected for analysis account for almost 45% of the population of Europe ([7]).

2.2.4. Selecting apprenticeship-relevant occupations

After providing an overview of how digitalisation is affecting the labour market in the selected countries, the paper dives deeper into three sectors, identifying several apprenticeship-reliant occupations.

These sectors are construction, healthcare and manufacturing. They were chosen for two reasons: the role that apprenticeships play in provision and labour market breadth. For all three sectors, apprenticeships and other vocational training are a popular entry route in the countries analysed. For manufacturing and construction this is also visible in job postings data: with 4.6% of all job postings related to manufacturing as apprenticeships, and 3.7% for construction, both sectors have a high prevalence of apprenticeships compared to the labour market average (Figure 1). Because of its public sector nature, recruitment activity for the healthcare sector tends to be different from that of manufacturing and construction and this may help explain why the sector appears to have a lower share of apprenticeships job postings. Nevertheless, the sector is heavily reliant on apprenticeships as illustrated by the number of enrolments and programmes available in the sector in different countries ([8]).

Figure 1. **Apprenticeship job postings in selected sectors compared to average job postings offering apprenticeships, 2022 (%)**



Source: Lightcast, Job postings data.

These sectors also offer insights into different parts of the labour market, meaning the findings presented in this paper speak to different parts of the market. These two factors combined mean that the analysis presented in this paper has broad applicability both across countries and sectors as well as being highly relevant to apprenticeship positions.

([6]) As this scheme does not lead to a formal qualification in the education and training system, it is not usually covered in Cedefop's work on apprenticeships.
([7]) World Bank. Population data.
([8]) UK government apprenticeship statistics

To further refine this choice, several apprenticeship-reliant occupations were selected for each sector. These were selected based on sample size – prioritising occupations with a larger number of online job postings – and on the basis that apprenticeships and other forms of vocational training are a typical route to employment ([9]). The full list of occupations selected, using the International standard classification of occupations (ISCO) 4-digit taxonomy, is presented in Table 3.

Table 3. **Apprenticeships-reliant ISCO occupations selected for analysis**

Sector	Selected occupations
Construction	Building and related electricians Structural metal preparers and erectors Bricklayers and related workers Roofers Plumbers and pipefitters Carpenters and joiners Glaziers House builders Plasterers
Healthcare	Healthcare assistants Dental assistants and therapists Home-based personal care workers
Manufacturing	Mechanical engineering technicians Metal working machine tool setters and operators Agricultural and industrial machinery mechanics and repairers

Source: Lightcast job postings data, authors' calculations.

2.3. Findings and discussion

Using the methodology set out above, this section first looks at the impact of digitalisation in the labour market overall, and then turns its attention to the apprenticeships-reliant occupations within the construction, healthcare and manufacturing sectors.

2.3.1. The impact of digitalisation on recruitment activity

This section presents two metrics looking at demand for digital skills in online job postings and how these have changed over time: frequency and degree.

Both metrics show that the increased importance of digitalisation in the economy is having an impact on the labour market, with digital skills (as defined in Section 2.2.2) being high in demand among recruiting employers.

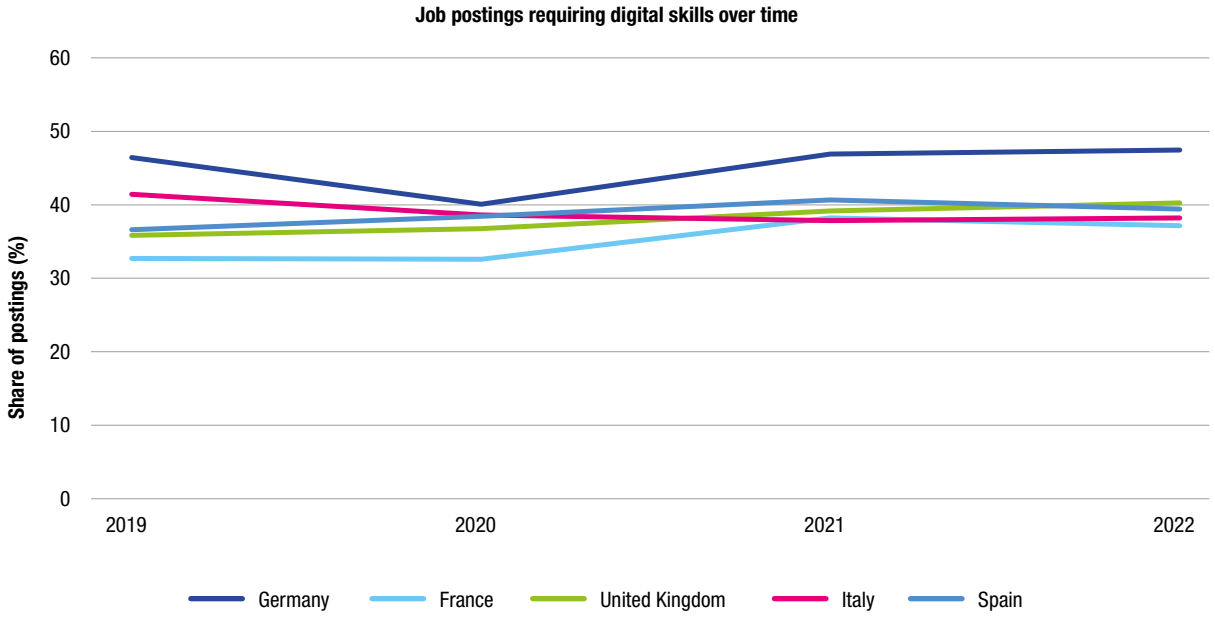
Figure 2 looks at frequency and shows the share of job postings requiring at least one digital skill in each country between 2019 and 2022. The figure shows high demand for digital skills: in 2022, digital skills were cited in 4 out of 10 job postings in France, Italy, Spain and the United Kingdom (UK) and in almost half of job postings in the German labour market. Except for Italy, the frequency with which digital skills appear in job postings has increased over time, from 2% in Germany to 14% in France. While the exact frequency and trajectory of travel over time vary from one country to another, demand for digital skills remains high, suggesting employers value these skills when recruiting.

Perhaps counter-intuitively, COVID-19 did not result in a substantial increase in job postings requiring digital skills. This observation might be attributed to the fact that online job postings are more popular among professional occupations, which were already requiring digital skills even before the pandemic. It is also important to remember that employers may not feel the need to quote specific skills when

([9]) Cedefop European database on apprenticeship schemes and Regulated Professions Database

recruiting. Some skills, like AutoCad for designers or Excel for data entry roles, might be implicitly assumed. As some digital skills become more inherent to specific occupations, they are more likely not to be mentioned by employers in job postings.

Figure 2. **Demand for digital skills over time: job postings requiring at least one digital skill 2019-22 (%)**

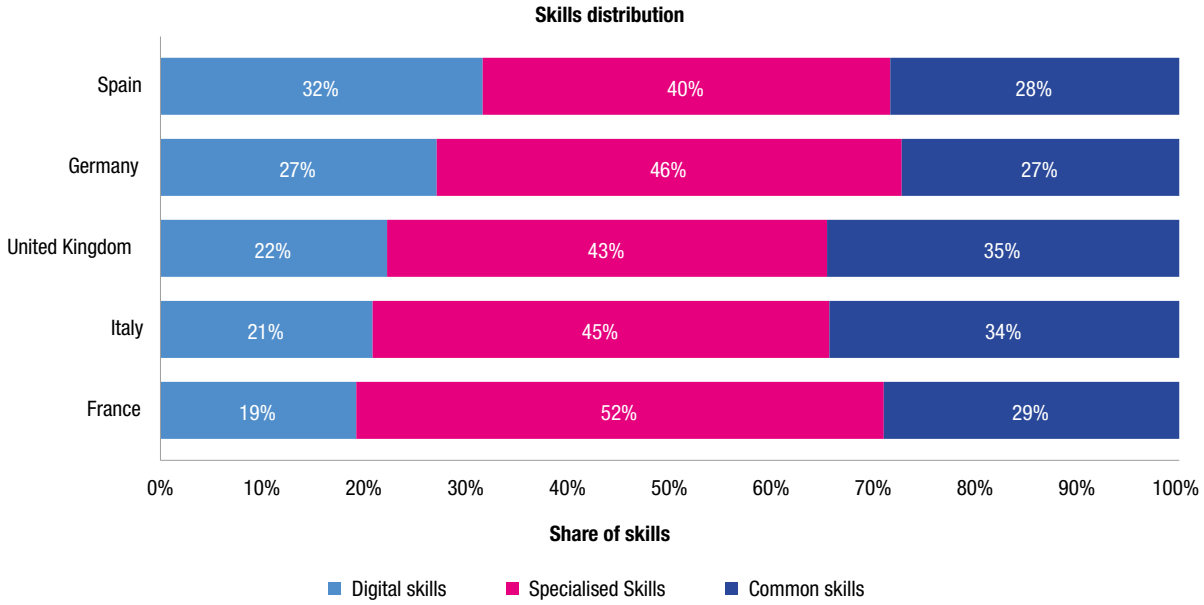


Source: Lightcast, Job postings data.

Looking at this from a skills degree perspective shows a similar picture. The skill degree is the frequency of occurrence of skills of a certain category (common, specialised or digital) in a given subset of postings (Colombo et al., 2019). Where an occupation has a specialised skill degree of 28%, among all job postings that relate to that particular occupation, 28% of the required skills fall within the specialised category.

Figure 3 looks at the overall number of skills present in job postings in each country and splits them into three categories: digital skills, specialised skills – i.e. other technical skills that are not digital skills – and common skills; the last are the most typically transferable skills, sometimes also referred to as soft skills. Using this metric, digital skills account for a fifth to a third of all skills mentioned in job postings, with actual values varying from one country to another. The criticality of digital skills in the contemporary labour market is further underscored by this observation, as organisations increasingly prioritise these competences to remain competitive and meet the evolving demands of customers and stakeholders.

Figure 3. **Skills degree in job postings, 2022 (%)**



Source: Lightcast, Job postings data.

2.3.2. Digital skills and how they are changing over time

To understand fully the impact digital skills are having on the labour market it is also important to identify which digital skills are most in demand and how this is changing over time. This is particularly important from a policy-making point of view. As illustrated in the methodology section, the definition of digital skills includes a wide range of skills clusters; identifying which ones are most in demand and which are rapidly growing gives important insights for policy-makers and education providers interested in ensuring training provision matches labour market demand.

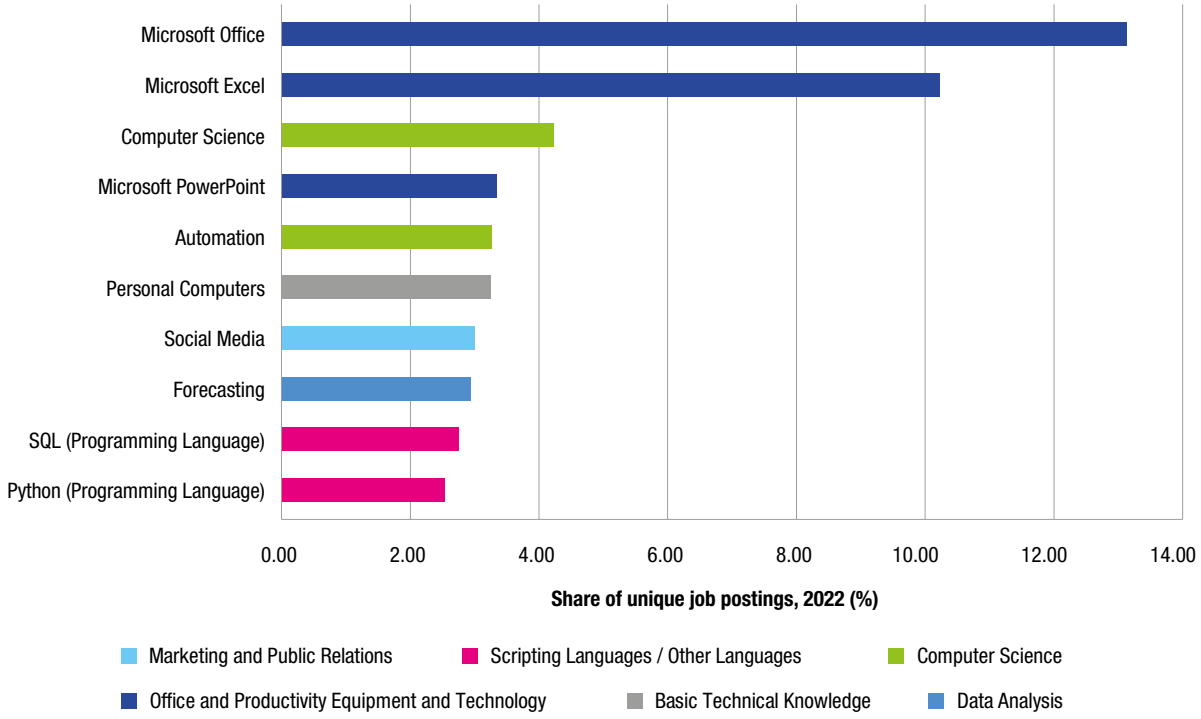
By combining insights from the five different countries selected for the analysis, Figure 4 shows the top 10 digital skills currently most in demand among recruiting employers in these countries.

The key to interpreting this figure is to look at the ranking rather than the specific shares of job postings requiring each individual skill. This is because not all skills are present in all occupations, so looking at the labour market overall waters down the frequency with which individual skills seem to appear. This is a general feature of job postings data and applies to all technical skills which are closely linked to specific occupations, not just to the digital skills analysed in this paper.

With this caveat in mind, Figure 4 shows that, on average, there are two broad types of digital skills that are in particularly high demand. The first group is clustered around the knowledge of office and productivity technology and equipment, particularly Microsoft Office, Excel and PowerPoint. While the level of knowledge required for these tools may vary from one occupation to another, their diffusion in job postings suggest that at least some basic knowledge and ability to use a computer and its core software packages is important across many roles.

In addition, the top 10 digital skills most in demand also include more advanced digital skills, especially around computer science and related disciplines, like automation, forecasting and programming languages. Demand for these skills is typically concentrated in IT-related roles. Their high demand is reflective of the very fast-growing demand for IT roles such as programmers and software developers seen in recent years, as well as increased efforts by the EU to reach 20 million ICT specialists by 2030 (European Commission, 2022a).

Figure 4. **Digital skills most in demand in job postings, 2022: France, Germany, Italy, Spain and United Kingdom (%)**



Source: Lightcast, Job postings data.

Alongside the digital skills currently most in demand, Figure 5 provides insights into the fastest growing and declining digital skills across the five countries under analysis. To remove small sample biases, the skills included in the analysis appear in at least 1% of all job postings in 2022.

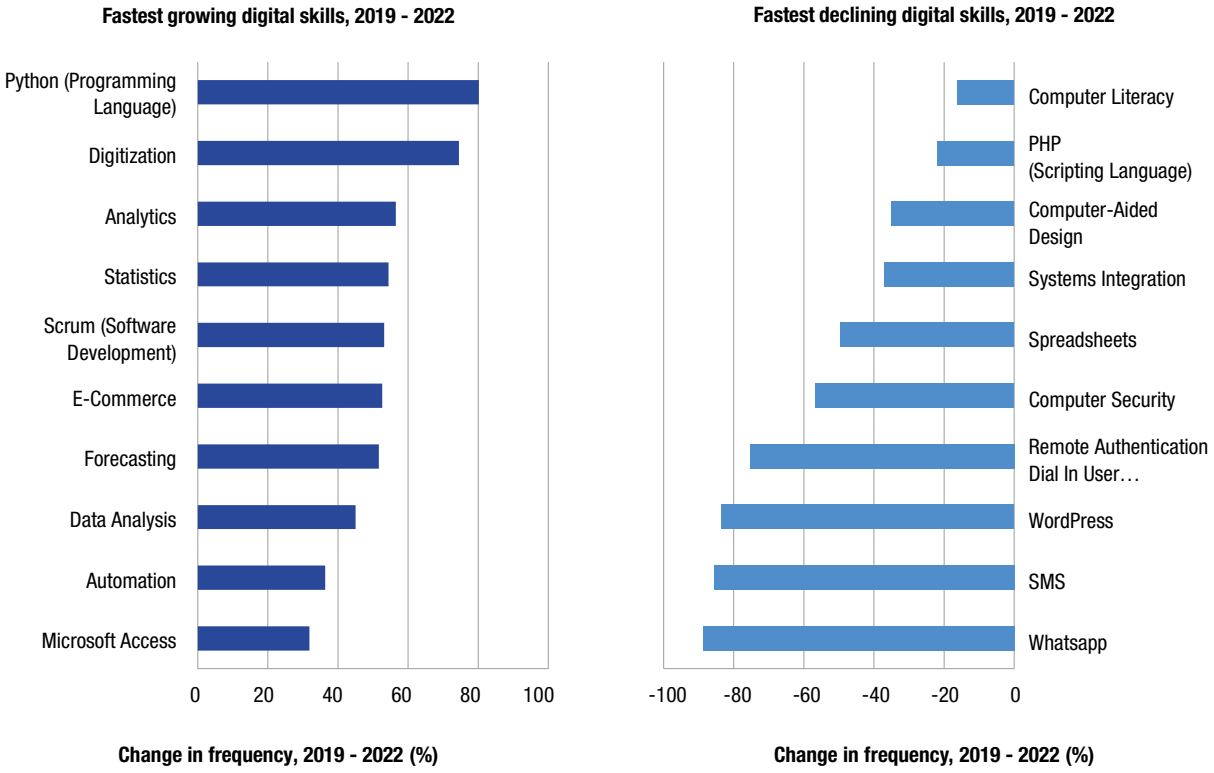
Many of the fastest growing digital skills belong to the field of computer science and programming languages. While Structured Query Language (SQL) is currently among the top 10 digital skills most in demand, Python is the fastest growing among digital skills (+80%), far outpacing the growth in SQL (+9% over the same time period). This may indicate that programming languages will continue to play an important role in the labour market, but the exact languages may change over time, suggesting churn related to the specific digital tool in demand.

Other fast growing digital skills include some of the those currently most in demand – such as automation and forecasting – as well as data analysis and analytics skills.

In terms of the fastest declining digital skills, many of these tend to be associated with basic knowledge of digital tools, such as the ability to use a mobile phone and general computer literacy. Rather than being indicative of a decline in importance of these skills, this insight may suggest that these skills are becoming so widespread in the labour market that employers may no longer feel the need to cite them in job postings and take them for granted.

Alongside these more generic digital skills, some of the fastest declining are related to specific software, programmes or languages, such as in the case of the scripting language Hypertext Preprocessor (PHP). This may also be indicative of churn related to specific technologies rather than a decline in importance.

Figure 5. **Fastest growing and fastest declining digital skills: France, Germany, Italy, Spain and United Kingdom, 2019-22 (%)**



Source: Lightcast, Job postings data.

These findings together suggest that, while demand for digital skills remains high, the types of digital skills most in demand are changing. This has two implications for policy-makers. First, when it comes to the type of digital skills that need to be taught, the analysis presented so far appears to suggest a shift is needed from basic digital skills to more advanced ones. Second, the analysis appears to suggest that there is high churn from one particular tool or software to another within specific skills clusters, meaning knowledge of the exact tools most in demand in the labour market today may be less relevant than skills aimed at helping people have a broad understanding of different tools as well as the agility to adapt and learn in a quickly changing labour market.

2.3.3. Digitalisation in apprenticeship-reliant occupations

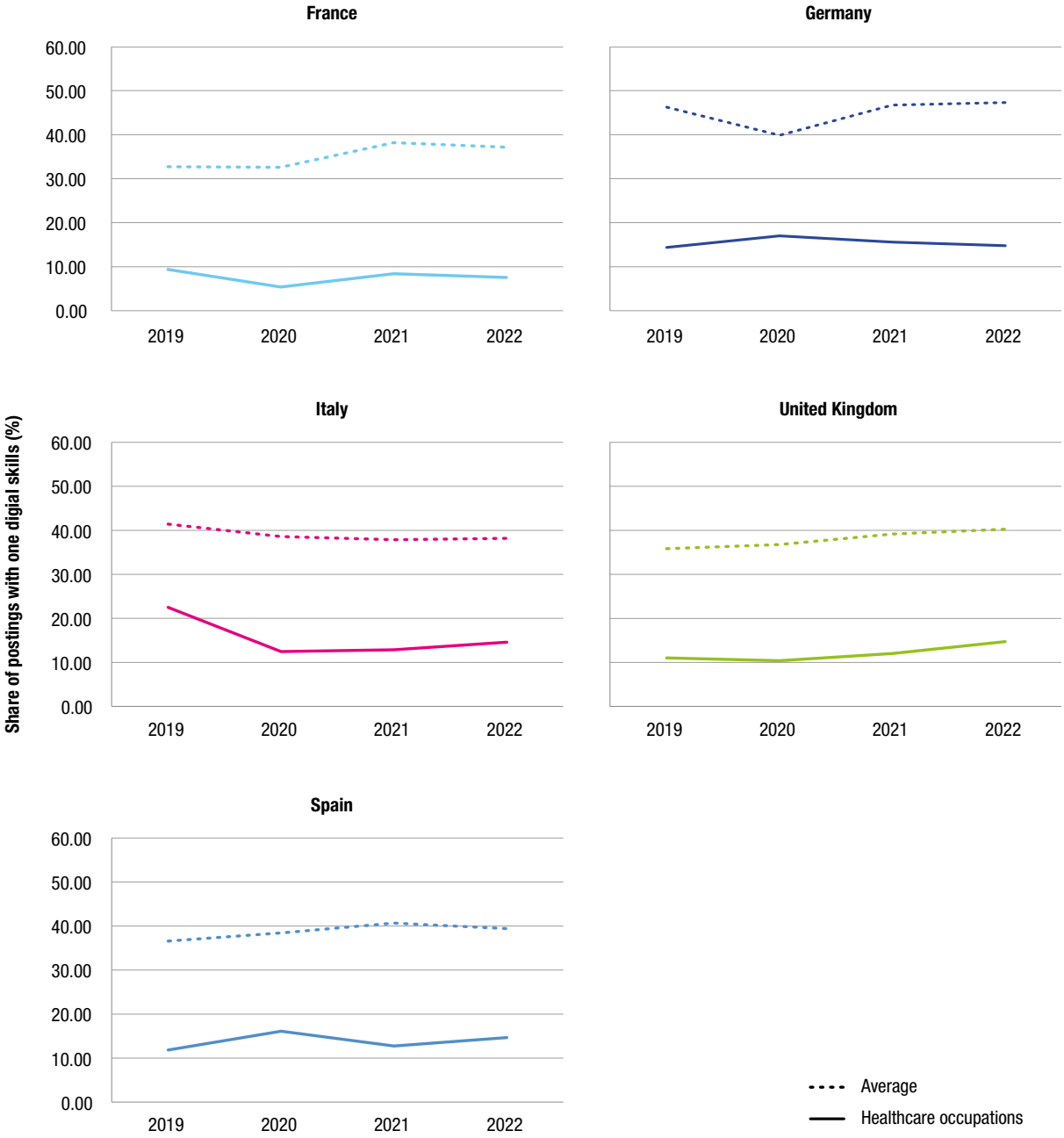
While the analysis presented so far looks at labour markets as a whole, different occupations have very different skill needs and this is also true in terms of digital skills. This section aims to analyse the impact of digitalisation on specific groups of apprenticeship-reliant occupations in three very different sectors: construction, healthcare and manufacturing.

2.3.3.1. *Healthcare*

The selected occupations in the healthcare sector display the lowest demand for digital skills of the three sectors examined. Compared to the average for all occupations across labour markets, the apprenticeship-reliant occupations of the sector, i.e. healthcare assistants, dental assistants and home-based personal care workers, generally have a much lower share of job postings requiring at least one digital skill in all five countries under analysis. The share of job postings requiring digital skills in these occupations ranges from 7% to 15% depending on the country, and it is between 23 and 32 percentage points lower than the average for all occupations in the labour market in each country (Figure 6).

While these occupations require fewer digital skills than others, the actual demand for digital skills in these occupations is increasing over time in most countries, especially since 2020. Compared to 2020, demand for digital skills in apprenticeship-reliant healthcare-occupations has increased by 17% in Italy, by 40% in France and by more than 42% in the UK. This suggests that digital skills are becoming ever more important, even in sectors that are traditionally people focused.

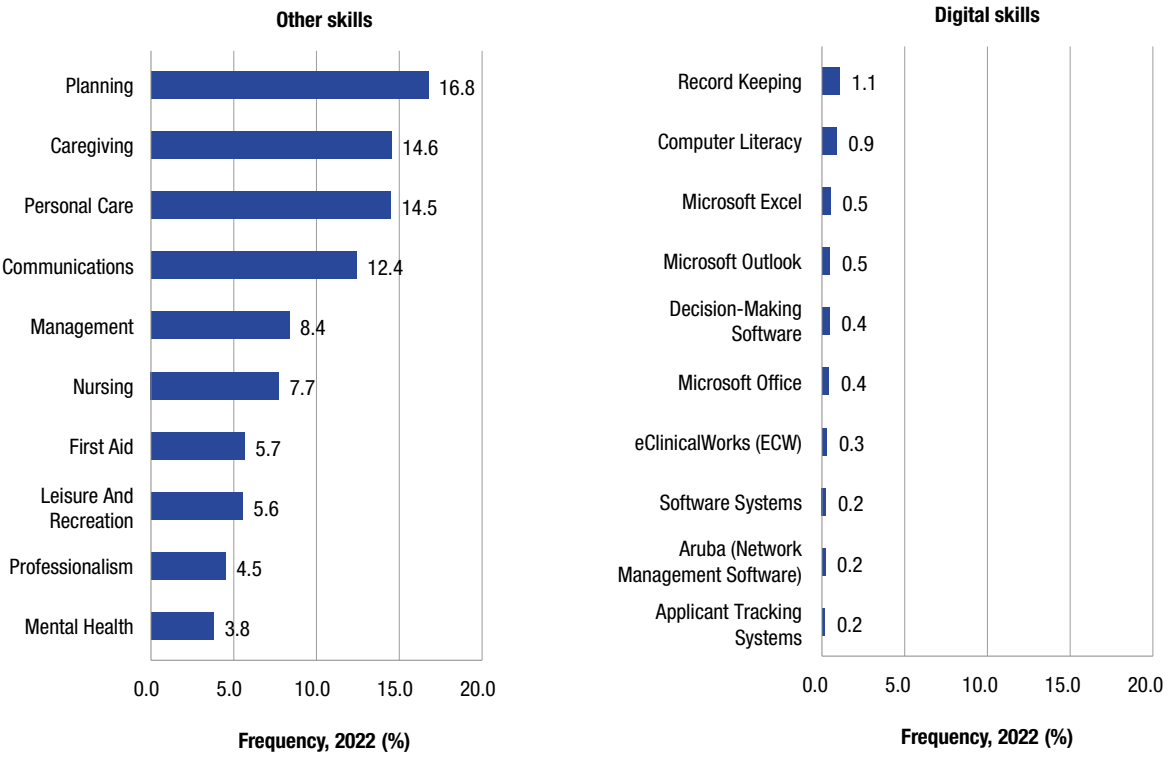
Figure 6. **Demand for digital skills over time in selected healthcare occupations: job postings requiring at least one digital skills, 2019-22 (%)**



Source: Lightcast, job postings data.

Figure 7 further investigates the skill needs of these apprenticeship-reliant healthcare occupations by showing the top 10 digital skills and the top 10 other skills most in demand among employers recruiting for the healthcare-related apprenticeship reliant occupations in analysis in France, Germany, Italy, Spain and the United Kingdom.

Figure 7. **Most in demand digital and other skills in selected healthcare occupations: France, Germany, Italy, Spain and United Kingdom, 2022 (%)**



Source: Lightcast, Job postings data.

It is possible to draw two conclusions from this figure. First, demand for other skills, especially soft skills such as caregiving, communication and management, far outpaces demand for digital skills in these occupations. This is reflective of the people-focused nature of these jobs, which continues to be the central part in these roles, even if, over time, these skills may too be implicitly affected by the digital transition.

Second, the type of digital skills most in demand in these apprenticeship-reliant healthcare occupations seems to suggest it is mostly basic digital literacy and admin-related digital skills that are most needed in these roles. Examples of the former include the knowledge of Microsoft packages, while examples of the latter include record keeping skills as well as the knowledge of health-specific software such as eClinicalWorks.

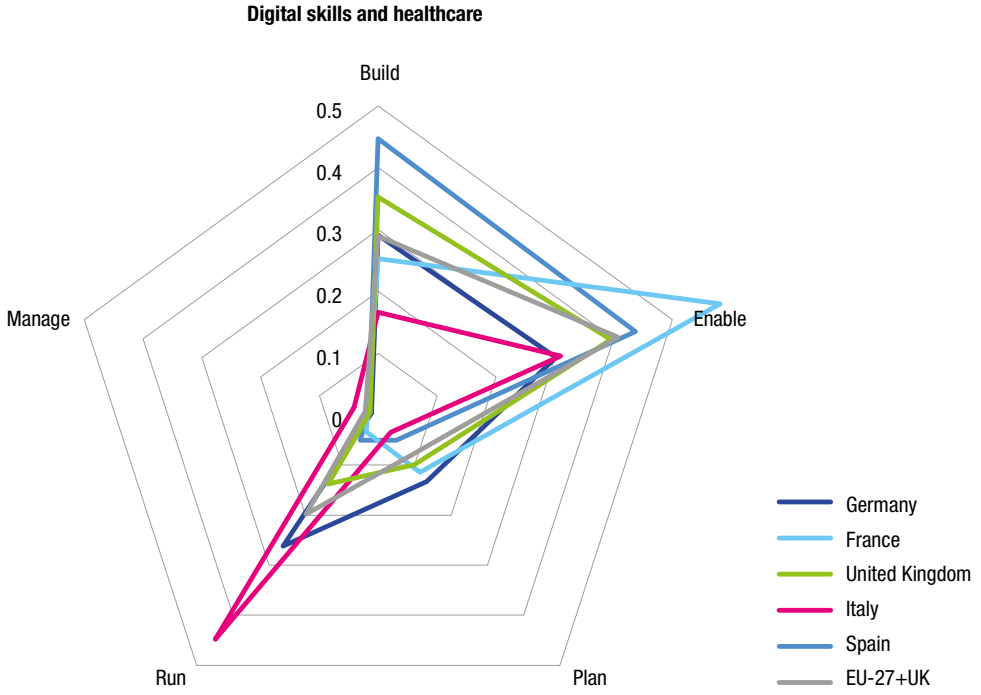
The implication of these findings for apprenticeship provision for healthcare-related occupations is that while demand for digital skills, especially basic administrative skills, is on the rise, digital skills continue to play only a small role in these occupations. The impact of the digital transformation on this sector is likely to affect the way information is collected and stored, while people skills will continue to play a central role.

Figure 8 presents the analysis of skills regarding the e-Competences Framework for apprenticeship-reliant healthcare occupations. Across all countries, the healthcare sector shows a strong emphasis on the ‘run’ segment, followed by the ‘enable’ segment. Within the run segment, there is a prevalence

of skills in using productivity suites and specialised software for managing day-to-day tasks such as spreadsheets and communication tools. In the enable segment there is demand for skills in configuring and operating digital medical devices.

This analysis helps understand the type of role that digital skills play in apprenticeship-reliant occupations in the healthcare sector. It highlights how apprenticeship provision needs to adjust to the digital transition by supporting apprentices in learning digital skills that can help them better carry out tasks related to enabling and running these occupations.

Figure 8. **e-CF Analysis for selected healthcare occupations: France, Germany, Italy, Spain and United Kingdom, 2022 | (%)**



Source: Lightcast, Job postings data.

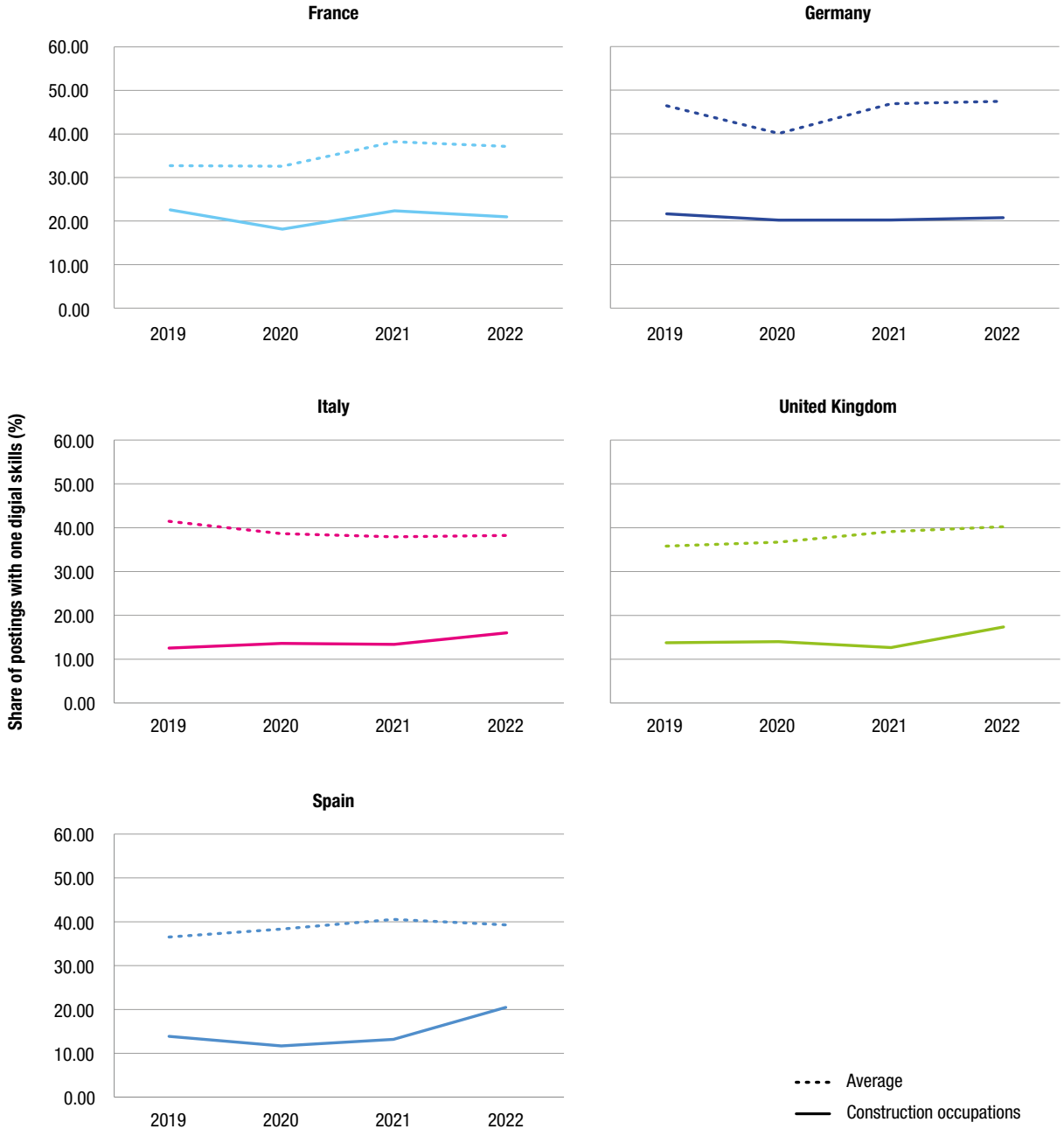
2.3.3.2. *Construction*

Demand for digital skills in the apprenticeship-reliant construction-related occupations selected for analysis is also lower than the average for the whole labour market, but higher than in apprenticeship-reliant healthcare occupations.

The group of construction occupations selected for analysis includes a broad range of skilled-trade occupations, such as electricians, bricklayers, roofers, plumbers, carpenters and plasterers. Demand for digital skills in these occupations ranges from 16% in Italy to 21% in France (Figure 9).

Demand for digital skills in these occupations is on the rise in many countries: compared to 2019, the frequency with which digital skills are mentioned in job postings has increased by 26% in the UK, 28% in Italy and by 48% in Spain, outpacing average growth.

Figure 9. **Demand for digital skills over time in selected construction occupations: job postings requiring at least one digital skills, 2019-22 (%)**

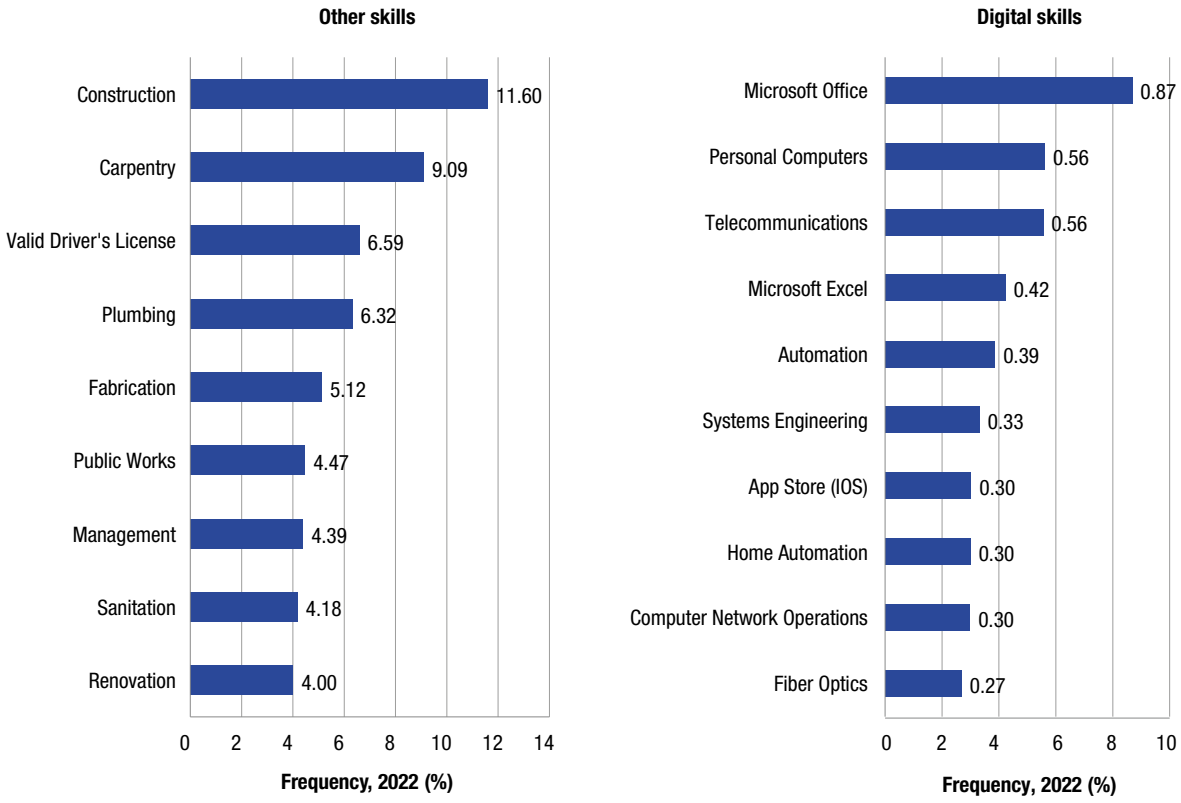


Source: Lightcast, Job postings data.

While demand is on the rise, the frequency with which individual digital skills are mentioned in job postings remains low compared to other skills (Figure 10). This is partly indicative of the smaller role these skills play in these apprenticeship-reliant construction occupations, compared to wider skills such as construction and carpentry skills, but it is also partly linked to the wide range of occupations included in the analysis. Despite all falling within the wider umbrella of skilled construction trades, these occupations require very different skill sets, including in terms of digital skills, meaning no particular digital skill stands out.

This has implications for apprenticeship provision: beyond basic digital skills, which are required across the board, each of these construction-related occupations has its own needs. Deeper insights and tailored training may be required to address these differences and successfully equip young people with the digital skills they need to succeed in these roles.

Figure 10. **Most in demand digital and other skills in selected construction occupations: France, Germany, Italy, Spain and United Kingdom, 2022 (%)**

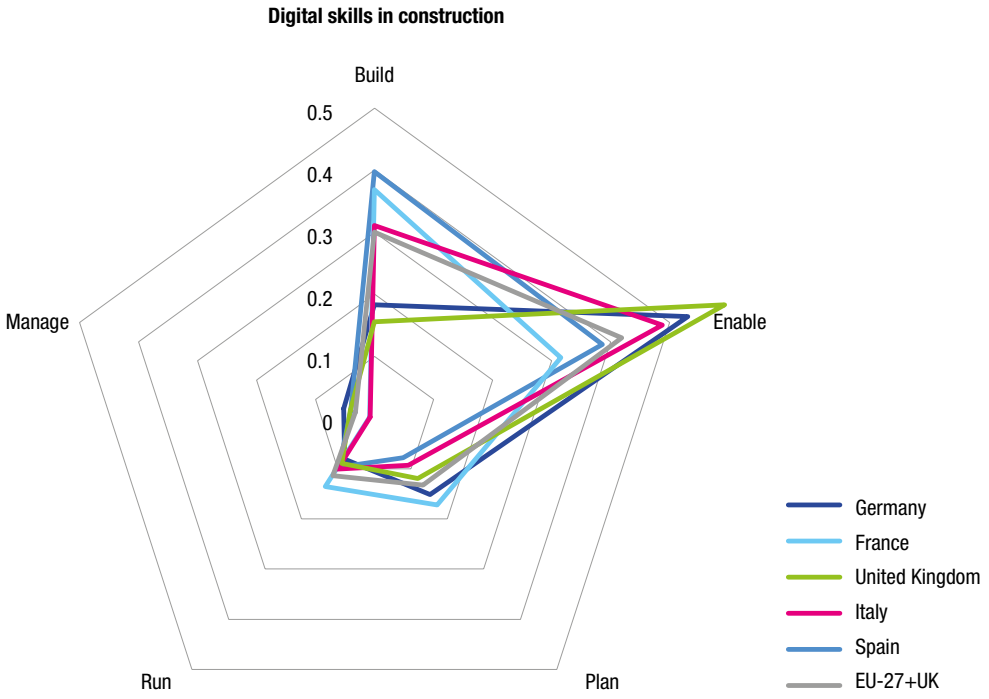


Source: Lightcast, Job postings data.

Figure 11 provides a picture of digital skills required in apprenticeship-reliant construction-related occupations according to the e-CF framework. The two primary dimensions of this profile are 'build' and 'enable'. Within the enable dimension, there are distinct skill sets for geospatial engineering and automation. Within the build segment are a range of competences related to networking and telecommunications, including antenna, fibre optics, cabling, network devices. Home automation and building information modelling appear among the skills of the 'plan' segment.

This appears to suggest that apprenticeship provision for construction-related occupations needs to focus on the particular digital skills required for building and enabling activities in these occupations.

Figure 11. **e-CF Analysis for selected construction occupations: France, Germany, Italy, Spain and United Kingdom, 2022 (%)**



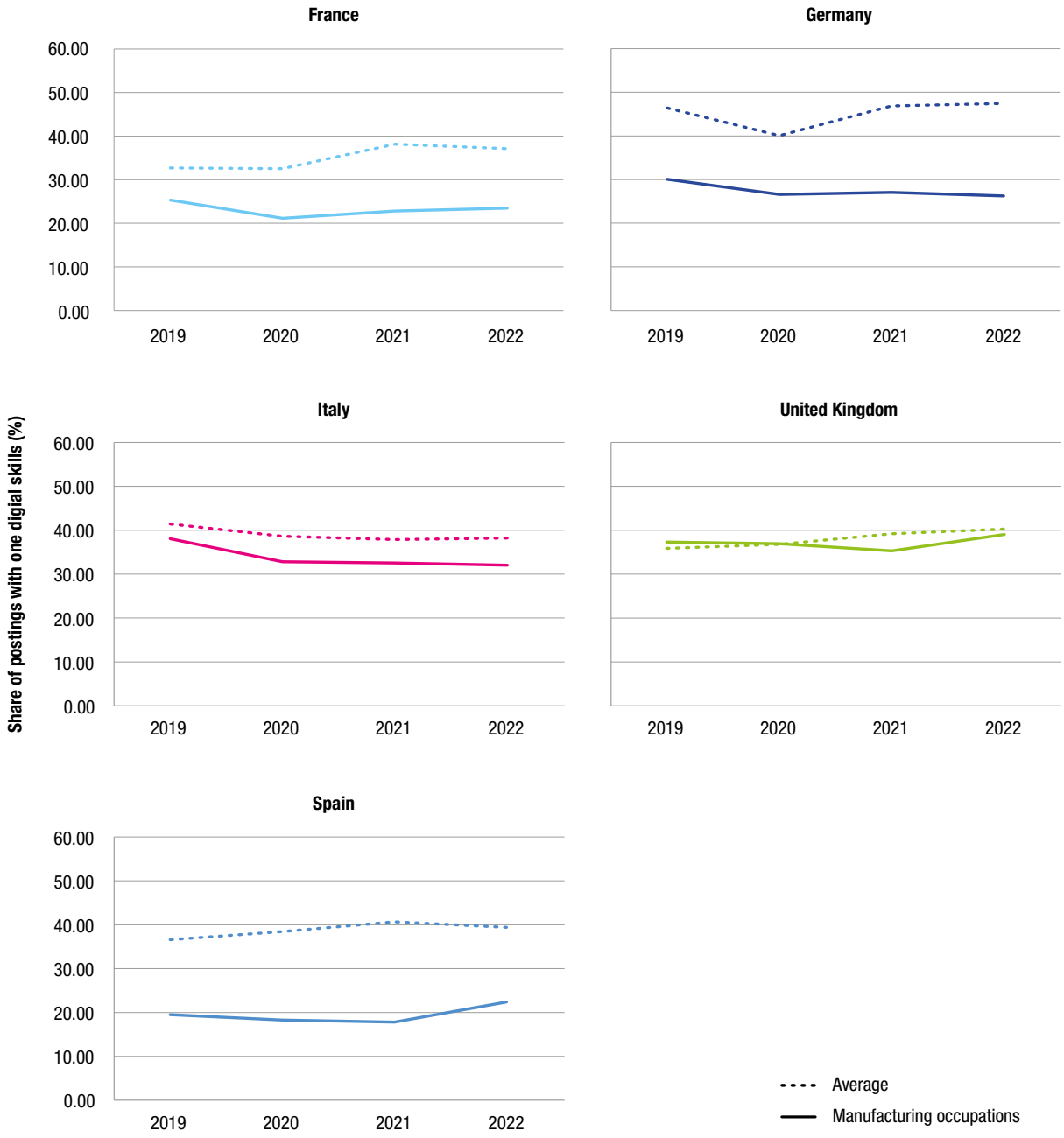
Source: Lightcast, Job postings data.

2.3.3.3. *Manufacturing*

Digital skills play a much more important role in mechanical and metal manufacturing occupations such as technicians and operators. In the UK, four in 10 job postings for these occupations require at least one digital skill, in line with the national average and considerably above the healthcare and construction related occupations analysed so far. Similarly, one in three job postings for these roles in Italy mention digital skills, and 26% in Germany (Figure 12).

While digital skills feature more often in the job postings of these occupations in all countries, there is variation in the trends over time. On one hand, the share of job postings requiring digital skills in manufacturing-related apprenticeship-reliant occupations in France, the UK and Spain has increased over time. In contrast, there has been a decline in demand for digital skills in these roles in Italy and Germany. The decline in demand for digital skills in roles within Italy and Germany may stem from a shift towards occupation-specific or sector-specific skill requirements. As digital skills become more integrated and fundamental to various occupations, employers might assume their presence and therefore omit explicit mentions in job postings. Typically, job postings tend to highlight distinct or specialised skills.

Figure 12. **Demand for digital skills over time in selected manufacturing occupations: job postings requiring at least one digital skill, 2019-22 (%)**



Source: Lightcast, Job postings data.

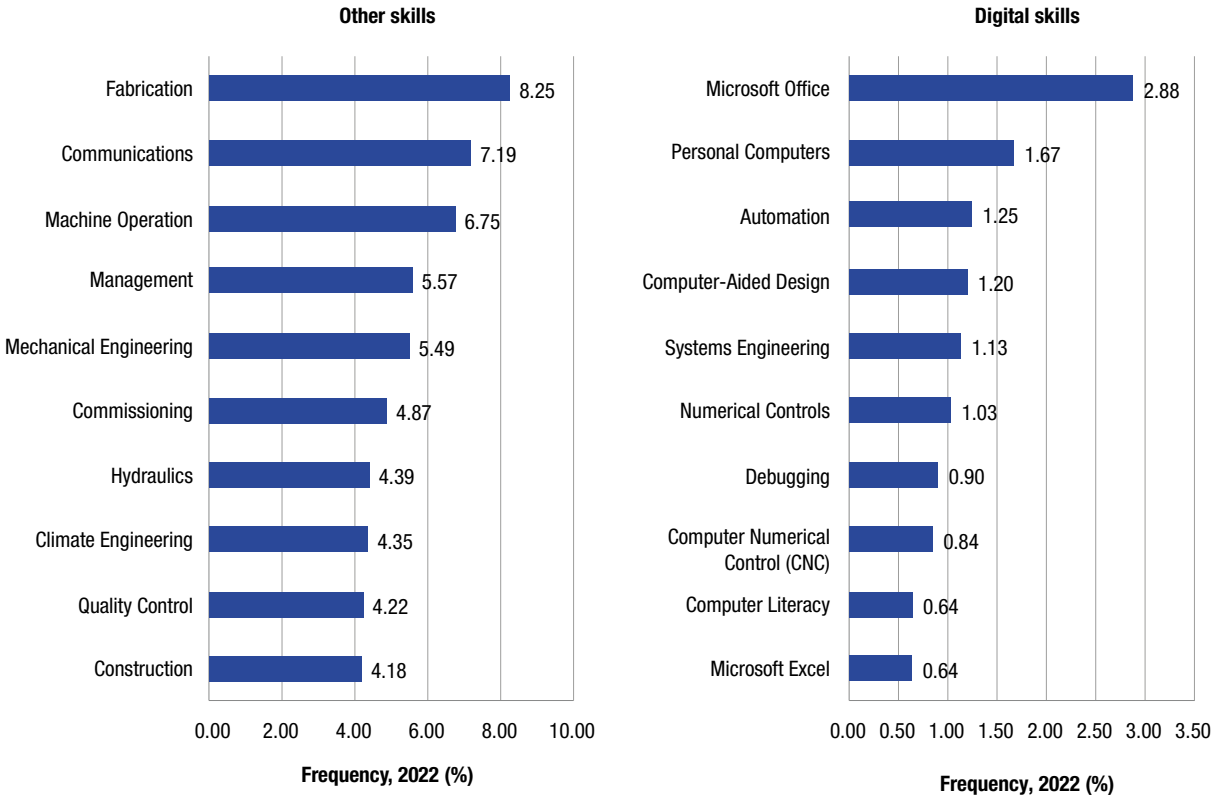
In addition to being cited more often than in other healthcare and construction sectors, the digital skills most in demand in apprenticeship-reliant manufacturing occupations also tend to play a more prominent role relative to other skills. Microsoft Office, the most cited digital skills is overall the 22nd most required skill in these occupations. In comparison, no digital skills appeared within the top 50 skills most in demand in the other two sectors analysed.

Alongside basic computer knowledge, the digital skills most in demand in manufacturing-related apprenticeship-reliant occupations include more advanced digital skills encompassing computer-aided

manufacturing (CAM) such as computer-aided design, systems engineering and computer numerical controls (Figure 13).

This is indicative of higher complexity of the digital skills required for these roles, which together with the higher demand, appears to suggest a greater need for apprenticeship training to focus on digital.

Figure 13. **Most in demand digital and other skills in selected manufacturing occupations – France, Germany, Italy, Spain and United Kingdom, 2022, (%)**

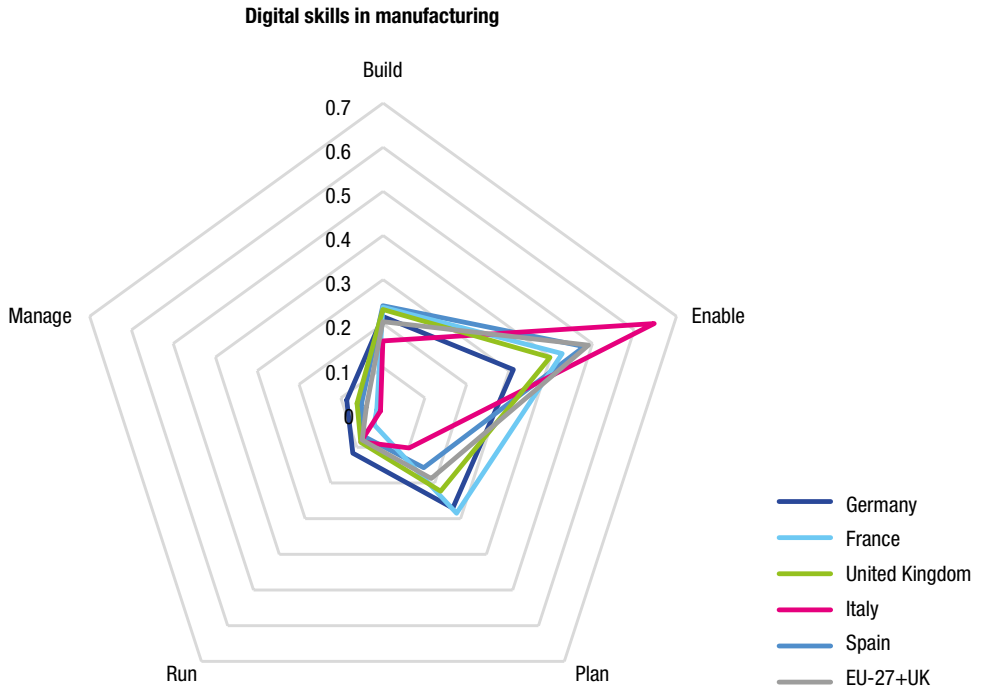


Source: Lightcast, Job postings data

Figure 14 shows the e-CF dimensions for the selected manufacturing-related apprenticeship-reliant occupations. The analysis reveals the significance of the 'enable' and 'plan' segments. Proficiency in industrial automation, computer-aided design (CAD) or CAM systems, and numerical control machines is critical for these occupations within the enable segment. The plan segment highlights the sector's transformation through the incorporation of artificial intelligence, coupled with industrial automation via machine learning and computer vision systems.

These insights help understand how apprenticeship provision needs to adapt to the digital transition, highlighting the role of digital skills in the enablement and planning of tasks related to manufacturing.

Figure 14. **e-CF Analysis for selected manufacturing occupations: France, Germany, Italy, Spain and United Kingdom, 2022 (%)**



Source: Lightcast, Job postings data.

2.4. Conclusions

This paper used cutting-edge big data on online job postings to look at how the digital transition is affecting the labour market in selected European countries, with a particular focus on three sectors linked to VET and apprenticeship.

Overall, the research findings suggest the digital transformation has already affected the labour market, with increased demand among employers for digital skills. This demand is also evolving over time: digital skills and knowledge of particular tools required by employers are changing to reflect the introduction of new technologies and their diffusion in the labour market, although this is not yet visible in all areas, as illustrated by some of the sectors under analysis, such as healthcare.

This has two implications for education provision. First, technology diffusion suggests that basic knowledge of digital skills is becoming increasingly widespread. Second, the speed with which new technologies are being introduced and old technologies are being replaced means training aimed at quickly learning new tools is equally, if not more, important, than the knowledge of the specific digital tools required in the labour market today.

Beyond overarching trends, demand for digital skills, and the specific digital skills required, vary between countries and by occupations, as illustrated by the analysis of healthcare, construction and manufacturing apprenticeship-related occupations. For each of these occupation groups, this paper has identified different digital skill needs and levels.

(a) In the healthcare industry, demand for digital skills is currently lower than in other parts of the labour market, but knowledge of digital medical devices and their use is essential. Proficiency in productivity suite and online communication tools are becoming increasingly relevant, given the changing landscape of the healthcare industry.

(b) The construction industry is also undergoing significant changes. The evolution of new home designs requires the application of home automation, making it an essential skill for construction workers. Workers must be able to handle the installation of networking systems, cabling, and antennae for telecommunications.
(c) In the manufacturing sector, digital skills are high in demand and their complexity tends to be higher than the digital skills required in the healthcare and construction sectors. Machine learning, automation, and computer vision are critical skills that are becoming increasingly important for manufacturing roles. These skills are closely associated with computer numerical control (CNC) machines and CAD/CAM design software.

Taken together, these findings suggest that the way and degree with which education provision needs to adapt to the digital transformation varies significantly by career pathway. Policy-makers working on apprenticeship provision should consider wider technological trends alongside the specificity of each occupation, closely monitoring employer needs.

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CHAPTER 3.

Swiss training firms navigating challenges in recruiting apprentices through the digital transition

By Scherwin M. Bajka ([10])

3.1. Introduction

This chapter offers insights into how training firms experience the recruitment of apprentices in challenging times. Based on novel survey data, this chapter first explores what firm-level factors (e.g. recruiting strategies, firm size) relate to hiring difficulties. Second, the chapter addresses whether there is a link between the digitalisation state of a sector and the difficulties training firms experience in recruiting apprentices (c.f. Le Barbanchon et al., 2022), by comparing firms in digitalised sectors to those in sectors that are less affected by digitalisation. Its findings help offer tailored policy recommendations and recruiting practices addressing apprentice hiring challenges.

Over the last few years, persistent skill shortages have challenged Europe's economies. Policy-makers grapple with the conundrum of balancing employer skill needs with technological advancements while keeping (youth) unemployment levels low and education inclusive (Cedefop, 2018). The pandemic, in combination with immigration levels and demographic change, has exacerbated employer needs for skilled workers (Bonoli & Emmenegger, 2022). Against this background, the European Commission has proclaimed 2023 as the European Year of Skills, promoting (among others) vocational education and training (VET) as a potential solution (European Commission, 2023). VET becomes an attractive policy field for policy-makers when exploring measures to tackle existing skill shortages (European Comission, 2023). According to Cedefop and OECD, expanding the provision of VET can alleviate the unmet need for skilled workers while reducing youth unemployment (Cedefop, 2023; Hoeckel, 2007).

However, when it comes to apprenticeships, this hinges upon whether training firms attract suitable and sufficient apprentices across all sectors. More recently, dual VET systems suffered from an exogenous economic shock and structural changes, such as the digital transition. This last factor has presented a new challenge to this form of VET, as disruptive technological advancements have changed labour market demands faster than dual VET can adapt (Bonoli & Emmenegger, 2022).

To determine what VET factors correlate with a training firm's difficulties in recruiting apprentices, this chapter relies on insights from different disciplines: e.g. political economy, industrial organisations, management, and labour market economics (Le Barbanchon et al., 2022; Bonoli & Emmenegger, 2022; Kraaijenbrink et al., 2010). It also makes use of two surveys:

(a) the first survey includes data from 2 700 Swiss training firms across sectors (Wilson & Bajka, 2022). It encompasses strategies of training firms recruiting apprentices, their organisational characteristics, and institutional embeddedness. Respondents were predominately trainers or staff involved in the recruitment of apprentices;
(b) the second survey provides novel data on occupational preferences from 2 500 Swiss 8th graders. It captures the supply side of VET and allows testing of training firm claims about their sector-specific

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experience of loss of popularity.

Switzerland serves as the empirical case of this chapter (Box 1) though the factors influencing hiring difficulties are likely present in other advanced economies, also in times of digital transitions and emerging skill shortages.

Box 1. **Dual VET in Switzerland**

In the Swiss education system, the dual VET track is the most common path to embark on at upper-secondary level. It offers adolescents a solid occupational foundation, with around 250 occupations to choose from. Most dual VET tracks start after 8th grade, last 3 or 4 years, and end with a nationally recognised VET diploma. The intermediary VET organisations (*Organisation der Arbeitswelt* – OdAs) negotiate diploma requirements in illustration of appropriate coordination (SERI, 2018). This chapter focuses on dual VET with its high enrolment among the cohorts leaving mandatory school. Most training firms are small and medium-sized (SMEs, with fewer than 250 employees). However, large, export-oriented firms have also shaped the political VET reform landscape (Thelen & Busemeyer 2012).

Source: Author.

This paper first introduces the key factors expected to correlate with the difficulties of training firms recruiting apprentices. It then discusses the extent of the potential role of a sector's digitalisation state in shaping hiring difficulties in the Swiss case. The paper also considers supply-side occupational preferences and investigates their link to hiring difficulties. The final section discusses the practical implications and summarises the main findings.

3.2. Hiring difficulties among Swiss training firms

The scholarly and political debate on the potential remedies for hiring difficulties ranges from sector- to firm-level measures (Le Barbanchon et al., 2022; Strietska-Ilina, 2007). For example, employers can tackle lasting shortages with individual-level adaptations of recruitment strategies, e.g. by improving their working conditions and lowering their requirements, expanding their efforts to enlarge the pool of future employees. The human resource management literature sees firm characteristics, such as management styles epitomised by chosen recruitment strategies, as a central contributor to hiring difficulties in the overall labour market (Holtbrügge et al., 2010). A firm does better or worse overall depending on what share of resources (e.g. effort, time, and finances) is allocated to recruiting talent (Wright et al., 2006).

In contrast, proponents of the industrial organisation theory emphasise sector-level factors. The environment in which firms are nested shapes their outcomes, such as recruitment success (Porter, 1981; Kraaijenbrink et al., 2010).

On the level of the entire economy, structural changes like digitalisation might have permanently altered the popularity of certain occupations and whole industries. Hiring difficulties at the training firm level are not likely to be alleviated by the following business cycle upturn, even if employers adapt working conditions significantly (Cappelli, 2015; Fabling & Maré, 2016).

More research is needed to understand better how individual and contextual factors can influence a firm's apprentice recruitment experience (c.f. Le Barbanchon et al., 2022; Wilson & Bajka 2023a, 2023b).

To capture factors relevant to *recruitment difficulties* in VET, this paper relies on Strietska-Ilina's (2007:3) categorisation of the reasons behind hiring challenges, including but not limited to the following ([11]):

([11]) Since the focus here is on the difference between elements 1, 2, and 3, the firm-specific and local component of the element 'skill shortages' will not be considered (Strietska-Ilina's, 2007); it will be controlled for in the statistical analysis, as a robustness test via a separate item, measuring to what extent respondents think that management is satisfied with the current skill supply.

(a) ineffective recruitment practices: poor strategies or methods applied for attracting, assessing, and hiring candidates. In the dual VET context, those could include reluctance of training firms to use social media for advertising apprenticeship openings.
(b) compensation and benefits: inadequate remuneration or unappealing terms and conditions of employment. Translated to the dual VET context, this means, e.g. the support provided by employers to apprentices to attain a vocational baccalaureate during the apprenticeship, which would allow progression to a university of applied sciences. Conversely, compensation does not translate well, as apprentice salaries are regulated and vary only to a certain extent. Hence, they do not make such a difference in the VET market as they would in the adult labour market.
(c) industry perception: a negative or unattractive sector image affects the ability to attract suitable candidates. This logic is also pertinent for dual VET systems, as the matching does not always function perfectly. For instance, in the Swiss construction sector, in January 2022, the number of vacant training positions was twice as high as the average training position (LehrstellenPuls, 2022).

The first two elements capture firm-level causes, while the third covers a sector-level reason for difficulties in hiring apprentices. Recognising and differentiating these terms can help stakeholders and policy-makers pinpoint the root causes and develop targeted solutions. This process can involve improving training and education and recruitment strategies, or addressing sector-specific issues to alleviate recruitment difficulties. The next section focuses on identifying and testing the factors that similarly affect firms across sectors.

3.2.1. Firm-level factors

Although, for most training firms in Switzerland, dual VET is the primary skill acquisition approach, in times of shortages some firms can more easily pursue alternative skill strategies (Wilson & Bajka, 2022). They usually do so when hiring an apprentice becomes comparatively more expensive, and skill needs become more urgent as training apprentices takes time. Cost-benefit calculations then lead these firms towards actions such as hiring apprentice graduates from other firms or retraining workers (NZZ, 2023; c.f. Wenzelmann et al. 2017). Hence, better understanding of recruitment difficulties could also hold implications for the viability of dual VET (Wilson & Bajka, 2023a). Empirical evidence from a survey among 2 700 Swiss training firms across sectors is presented below (Wilson & Bajka, 2022) ([12]).

To measure hiring difficulties, respondents answered the question: To what extent do you find it difficult to hire adequate apprentices? ([13]) One-fifth of the firms found it ‘Very difficult’ 18.8%) and almost half found it ‘Difficult’ (49.1%). Only one- third of the firms has experienced no explicit difficulties (26.6% ‘Neither’, 5.0% ‘Easy’, or 0.5% ‘Very easy’) ([14]).

The question used to measure the selectiveness of a training firm on the VET market was: ‘Do you perceive that you have lowered your demands for the ‘ideal candidate’ lately, in response to the overall decline in candidate quality?’. The answer categories were ‘Yes’ (52%), ‘No’ (45%), and ‘I don’t know’ (3%). A firm’s willingness to hire someone not meeting required firm standards reflects internal recruiting practices that could alleviate hiring difficulties. If a firm does not lower its demand despite experiencing hiring difficulties, it could be reflecting bad recruiting practices (c.f. Strietska-Ilina, 2007).

The paper also considers how much effort a firm puts into advertising a training position. In relation to hiring difficulties, this item measures whether more active advertisers among training firms experience

([12]) Before analysing the survey data empirically, the key factors are introduced and operationalised following Strietska-Ilina’s (2007) understanding of the reasons behind recruitment difficulties in the labour market.
([13]) Inspired by the European Company Survey (2019). However, a fifth category of ‘Neither’ was added to the four original ones to get a more nuanced picture of hiring difficulties at the VET level.
([14]) A dummy variable was created as an alternative measurement, the categories ‘Very difficult’ and ‘Difficult’ were merged into a ‘Difficult’ category, and ‘Neither’, ‘Easy’, and ‘Very easy’ into a ‘Not difficult’ category. This allows for descriptive and statistical subgroup analysis, in cases where the number of observations within each subgroup is rather small. For reasons of external validity, the firms’ perceived hiring difficulties were compared to secondary vacancy data from LehrstellenPuls (2022). The relative differences in vacancies between sectors seems to be reflected by the reported hiring difficulties.

fewer hiring difficulties (positive correlation) or is it only when firms are experiencing hiring difficulties that they start to invest more in advertising (negative correlation) ([15]). The expectation is that the more active firms face fewer hiring difficulties, so an advertising practice dummy variable is added to the analysis and splits the sample into two groups: those that invest a bit more into their recruiting in terms of good recurring practices. This group encompasses 20% of all firms and uses social media for their advertisement as well as visiting schools; the other group uses conventional advertising methods, such as ads on websites and word-of-mouth recommendations (Karácsony et al. 2020).

To estimate how attractive a firm is, the apprentice retention rate was added to the analysis, serving as a proxy for working conditions experienced (c.f. Luscombe et al., 2013; Strietska-Ilina, 2007). If firms retain their apprentice upon graduation more frequently, they are expected to be less likely to become subject to hiring difficulties. Therefore, the respondents were asked: 'How often do you manage to retain an apprentice after graduation when offering a contract?' Potential answers ranged from 'Never' to 'Regularly'. Of the firms surveyed, 71% regularly offer apprentices a position after graduation and manage to retain their talent.

Firms that can substitute apprentices for graduates from general education tracks could be perceived as experiencing fewer hiring difficulties, as they have a larger applicant pool (c.f. Bonoli & Vorpe, 2022). However, this also means they often must compete with larger firms for fewer suitable candidates, so training firms exposed to general education as a competitor are expected to experience difficulties disproportionally. For 32% of the training firms, this perception is accurate. Further, it can be expected that when a firm supports their apprentices in completing a vocational baccalaureate (understood as benefits, as in Strietska-Ilina, 2007), such firms are considered more attractive: this opens the door to increasingly sought-after general education on the tertiary level, as with universities of applied sciences. More attractive firms are expected to experience fewer hiring difficulties. Approximately one-third (30%) of all training firms support their apprentices in that regard.

3.2.2. **Contextual factor**

In line with Strebel et al. (2021), it is argued that *membership in intermediary VET organisations (Organisation der Arbeitswelt – OdAs)* strengthens a firm's bond to VET, fostering coordination between them. Such membership intensifies the investment in and commitment to training. It reduces the likelihood of experiencing hiring difficulties since more firms train for themselves and, in turn, poach fewer young workers from other firms. The institutional embeddedness of training firms in Switzerland includes the tasks of updating the VET curricula and facilitating dialogue between firms (Strebel et al., 2021). Hence, a firm's affiliation to an OdA is measured by asking for their membership status: the response categories were 'No', 'Yes', and 'I don't know'. 56% of all training firms indicated that they are members of intermediary VET organisations.

What other factors can contribute to the hiring difficulties of training firms? In contrast to the behavioural elements, some more stable demand-side characteristics impacting hiring difficulties are considered. The pertinent literature argues that larger and growing firms, with more capital to invest in recruitment, have higher chances of getting the candidates they are looking for (e.g. more capital for advertisements or due to brand recognition) (Barber et al., 2006; Wilson & Bajka, 2023b). For this analysis, firms are organised according to their size in the most conventional categories: 1-9, 10-49, 50-249, or more than 250 employees. Their growth is measured by the number of recently employed workers and is expected to impact positively how they experience hiring difficulties (19% of the firms grew).

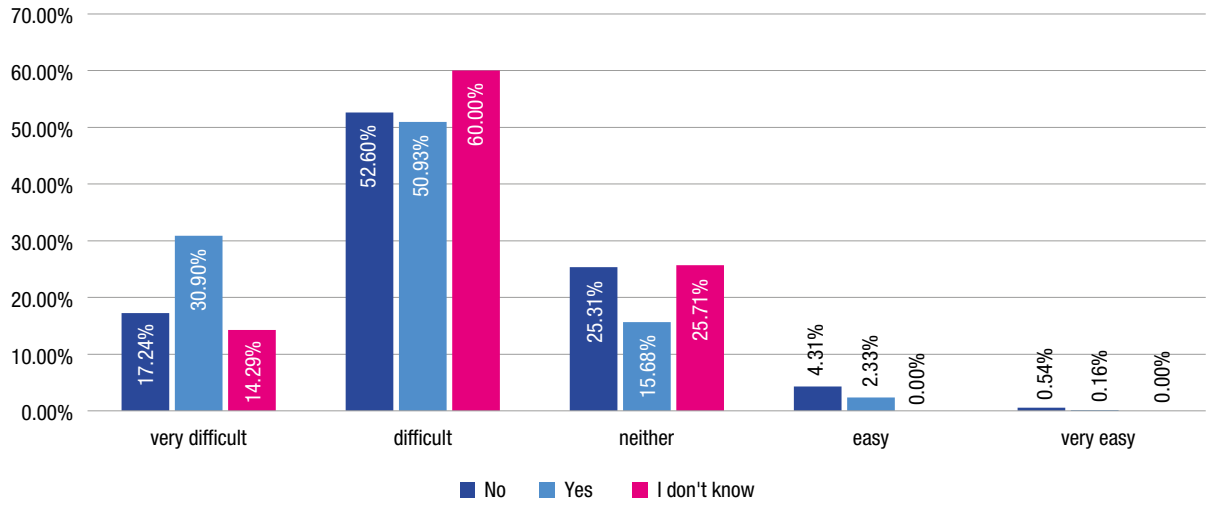
([15]) Following this logic, all factors can also be regarded as reactions to, rather than causes of, hiring difficulties, and the direction of the effect cannot be ascertained. This holds true for most of the variables tested, as the nature of the present study is explorative rather than causal.

3.2.3. **Stylised facts and multivariate regression**

In this section, selected stylised facts are used to demonstrate how the different factors are related to hiring difficulties (16).

When looking at lowering requirements for candidates and the level of effort put into advertising, the relationship to hiring difficulties is significantly negative; the first factor produces the most prominent effect of all those factors considered. Figure 1 indicates that almost a third of all firms that have lowered their requirements are experiencing pronounced hiring difficulties. In comparison, only 17% of the firms from the group that does not lower their demands land in the 'very difficult' category. Most firms did not lower their recruitment standards for all the other categories of hiring difficulties. The same logic applies to a training firm's advertisement efforts: firms seem to put in the extra work when doing poorly in the VET market but, as soon as they do well, they stop their extra efforts and use regular advertising outlets.

Figure 1. **Lowering requirements for candidates and hiring difficulties**



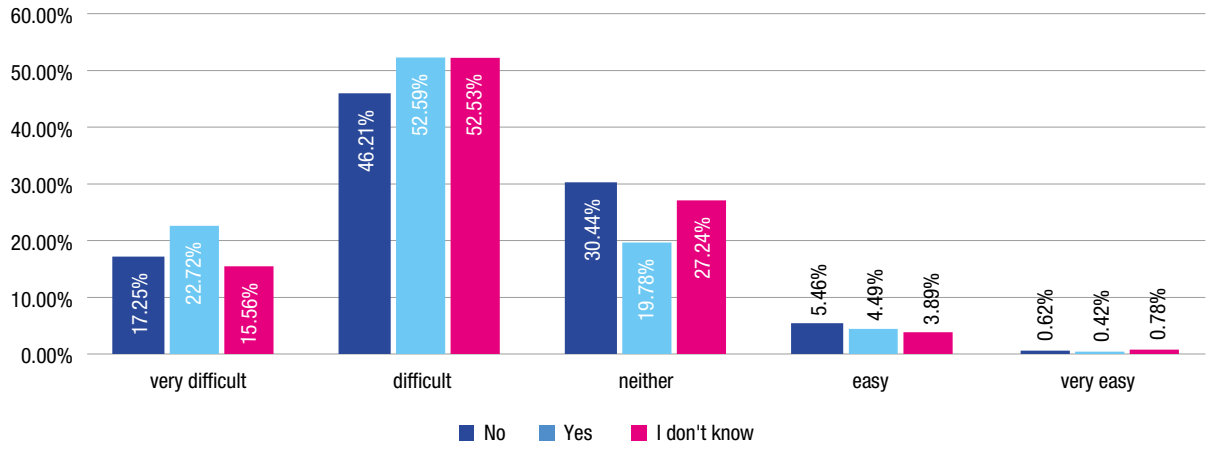
Source: Author's calculations (Wilson & Bajka, 2022).

The findings on apprentice retention suggest that higher retention rates increase with hiring difficulties. One explanation for this could be that firms that struggle to find new talent on the VET level face the same issues with recruitment overall, so they are more likely to offer a contract to their graduating apprentices and retain their apprentices more regularly. This factor seems to indicate how strongly a training firm needs young talent rather than capturing the attractiveness of a firm.

A negative relation to hiring difficulties has been found when having an academic track as competitor. Figure 2 shows most firms with difficulties view the academic track as a competitor in their requirements; for all the other categories the share of firms that did not lower their recruitment standards is the majority.

(16) Along with the stylised facts, a simple OLS regression model was used to estimate and illustrate the significance of relevant factors determining a firm's hiring difficulties.

Figure 2. **Academic track as competitor and hiring difficulties**



Source: Author's calculations (Wilson & Bajka, 2022).

Offering vocational programmes (combined with) a *vocational baccalaureate*, is correlated with a low level of hiring difficulties, so constituting good recruitment practice.

Most of the behaviour-related factors (capturing elements of hiring difficulties related to working conditions, benefits, overall attractiveness), seem to reflect reactions of firms rather than existing elements of hiring difficulties, so the direction of the effect cannot be fully disentangled. The nature of the present study is of explorative rather than of causal nature.

OdA membership might not have a standalone impact when considering other static factors and the benefits associated with OdA membership might already be accounted for by other strategic variables. Firm size and growth appear to play a significant role in hiring ease., with bigger firms and those undergoing growth experiencing fewer hiring difficulties. The act of adapting recruitment strategies, such as working conditions, benefits, and overall attractiveness, might be reactive rather than proactive or preventive within the apprenticeship market.

In the next section, the contextual factor of industry perception becomes a central element for further analysing the differences in hiring difficulties between training firms.

3.3. Hiring difficulties and a digital divide?

If employers follow the EU's initiative and invest more in initial vocational training, the following questions arise for policy-makers. Can one expect firms across sectors to increase their efforts equally? Are firms in specific sectors struggling more than others in recruiting apprentices? The paper takes both a demand-side and a supply-side perspective to address these questions.

Linking the industry perception element of hiring difficulties to digitalisation at sector level helps better understand the differences between firms. Digitalisation is used as an example of a megatrend, since it is one of the main drivers of existing skills shortages and has drastically reshaped occupational preference and work conditions. It also altered the skill landscape; today, high digital literacy has become a standard requirement for many jobs (Berger & Frey, 2016). This section compares sectors based on how digitalised they are and how they experience difficulties hiring apprentices. It aims to discuss whether it can be useful to consider how strongly digitalised the sector is, to help understand firms' recruitment difficulties better.

3.3.1. From a training firm perspective

Firms nested in similar sectors might experience comparable hiring difficulties (c.f. Le Barbanchon, 2022). As some training firms in more digitalised sectors struggle to keep up with rapidly changing skill demands, they might start relying on poaching or hiring temporary workers rather than investing in training apprentices (Bonoli & Emmenegger, 2022; IAB, 2022). Digitalisation also creates uncertainty about the longevity of skills, causing doubt among training firms about their return on investment from training apprentices (NZZ, 2023). These developments could result in diverging recruitment strategies, so belonging to a specific sector can lead to sector-specific hiring strategies of training, e.g. between firms in the ICT and construction sectors.

Both sectors might struggle to recruit apprentices for different reasons. On the one hand, firms in the ICT sector could be challenged by finding apprentices since they have higher entry requirements. ICT apprenticeships cost training firms more than they benefit from apprentices' work and the required high-level digital skills. They have a comparatively small applicant pool (NZZ, 2023; Moretti et al., 2017).

In contrast, firms in the construction sector could experience comparatively more severe hiring difficulties because, e.g. if their sector is losing popularity amongst the young.

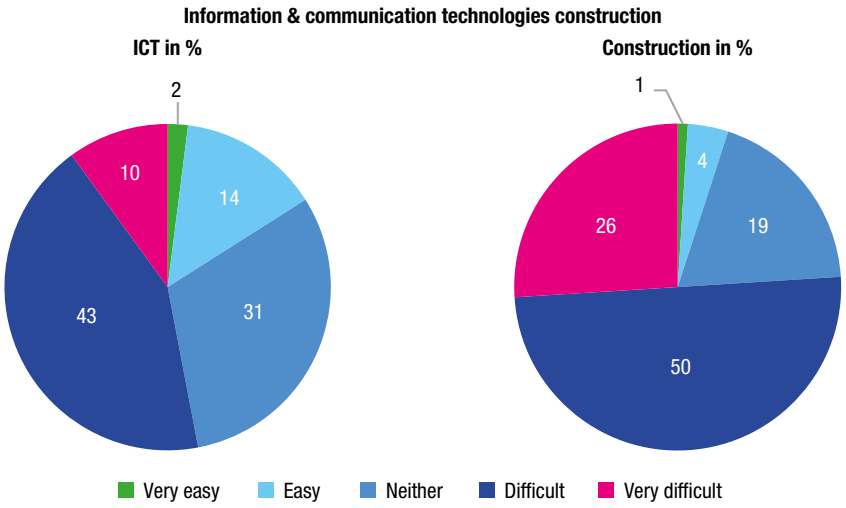
In more general terms, while some firms struggle to remain competitive in an increasingly automated world, where certain labour-intensive jobs (such as physical retail stores) have been replaced by machines, others (more knowledge-intensive and digitalised sectors) are concerned about competition from neighbouring regions or general education due to academisation and increasing levels of digital skills as a requirement for certain occupations (Oswald-Egg & Siegenthaler, 2021; NZZ, 2023; Trampusch & Aerne, 2023). Therefore, sectoral context might matter in shaping hiring difficulties.

3.3.1.1. *Firm- and context-level factors & digitalisation*

The firms were sorted into two sector-based groups for the corresponding analysis. The first group contains the more digitalised sectors, and the second the less digitalised sectors. The relative exposure to digitalisation is measured based on McKinsey's industries' digitalisation state rankings (McKinsey, 2016). The cut-off point serves the highest level of the digitalisation state. It includes three sectors: ICT, professional services, finance & insurance, and wholesale & trade. All other sectors belong to the second less digitalised group.

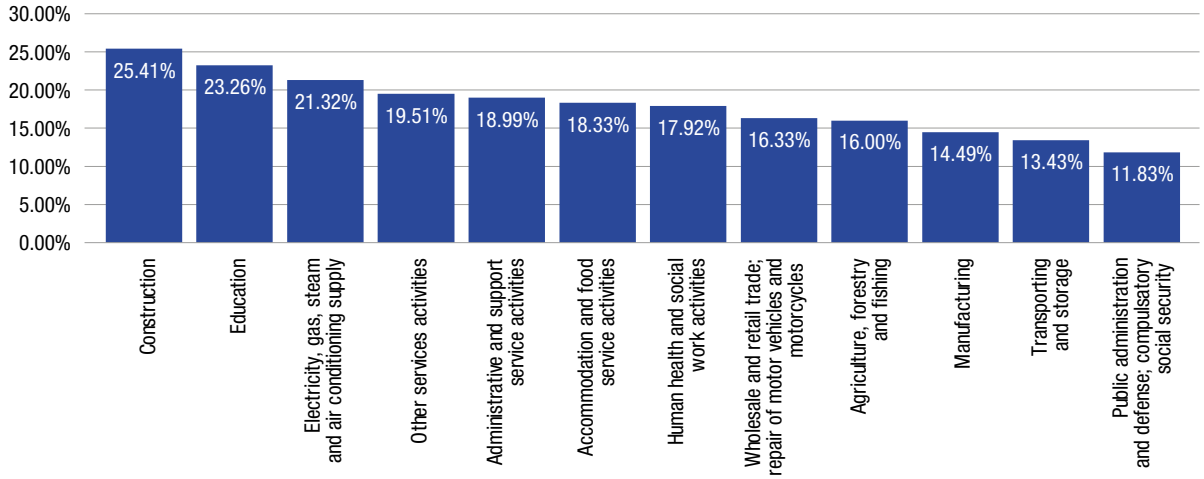
Figure 3 shows that highly digitalised sectors, such as the ICT sector, struggle comparatively less in the VET market. Only 10% of ICT firms fall into the 'very difficult' category, while 26% of all construction firms experience massive difficulties. Figure 4 illustrates that a certain tendency related to digitalisation might exist, when looking at firms that experience severe hiring difficulties. How does this divide translate to the previously introduced factors and their link to hiring difficulties?

Figure 3. **Hiring difficulties in ICT and construction: To what extent do you find it difficult to hire adequate apprentices?**



Source: Author's calculations (Wilson & Bajka, 2022).

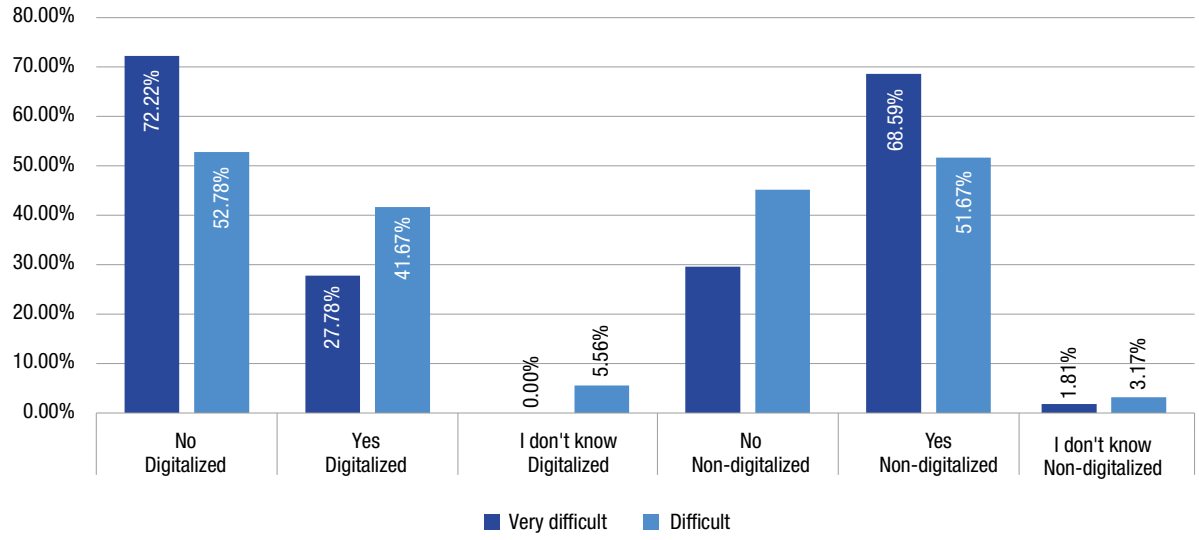
Figure 4. **Pronounced hiring difficulties and firm sectors**



Source: Author's calculations (Wilson & Bajka, 2022).

Figure 5 indicates that the digitalised group of training firms does not seem to be willing or able to lower their requirements, even when experiencing pronounced hiring difficulties. For other firms, it is the opposite: the more they struggle finding the apprentices they need, the more they lower their demands.

Figure 5. **Lowering requirements for candidates and hiring difficulties by sector digitalisation state**

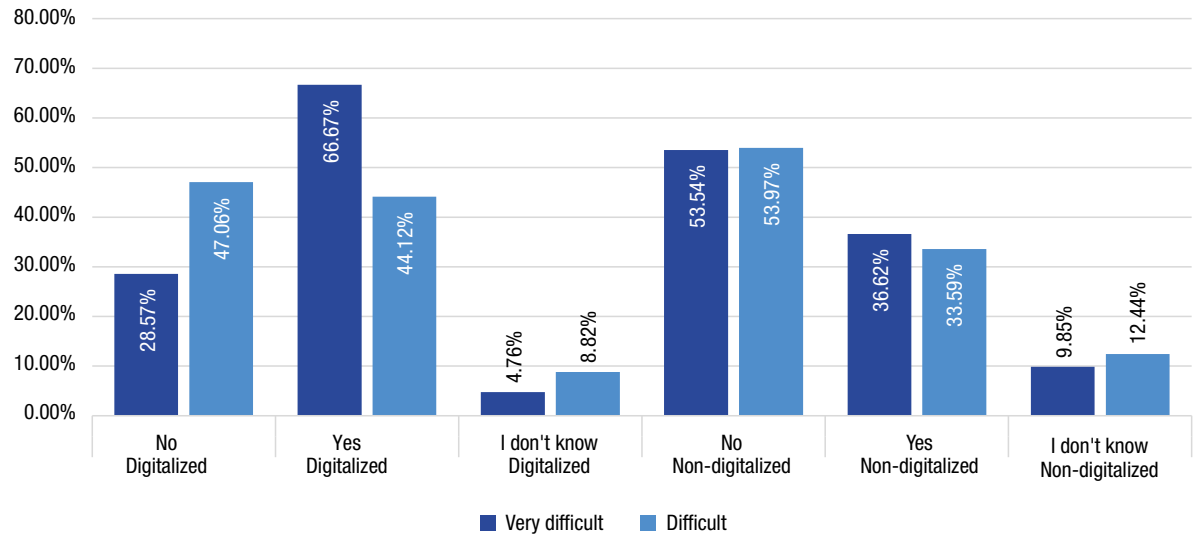


Source: Author's calculations (Wilson & Bajka, 2022).

The analysis showed that there were no systematic significant differences between the two sector groups when it comes to advertising. This might be surprising, as it might be expected that firms in more digitalised sectors would also rely comparatively more on digital media or others in the face of hiring difficulties. A substantially higher share of firms that suffer from hiring difficulties in more digitalised sectors might offer a vocational baccalaureate and manage to retain their apprentices than is the case for firms in less digitalised sectors.

Figure 6 shows that the digitalised group sees the academic track more as a competitor, especially if experiencing pronounced hiring difficulties. The opposite is true for firms nested in the less digitalised sectors. On a side note, this finding provides another reason to believe that the self-reported testimonies of training firms are accurate. At least, this seems to be the case in a comparative manner, as the expected firm types seem to voice anticipated concerns.

Figure 6. **Academic track as competitor and hiring difficulties by sector digitalisation state**



Source: Author's calculations (Wilson & Bajka, 2022).

3.3.1.2. *Hiring difficulty reasons*

In this sub-section, the reasons stated by firms for hiring difficulties are scrutinised to test if firms from different sectors have different perceptions of the problem and, therefore, have developed different strategies to cope with their impediments.

Table 1 presents data on reasons for hiring difficulties declared by training firms in relation to the candidates applying (N=1505), with the percentage of the total number of respondents for each reason. First, the data suggest that the most popular reasons among respondents include the young candidates' lack of overall qualities required for the training (929 obs., 62% of the total). Second, the reason that the young are not willing to do the type of burdensome work the training requires (685 obs., 46% of the total), followed by their lack of motivation to follow through with the training (615 obs., 41% of the total). This indicates that there may be different underlying reasons for the hiring difficulties, which strengthens the assumption that there are consequential differences between firms based on sector factors and the likelihood of facing hiring difficulties.

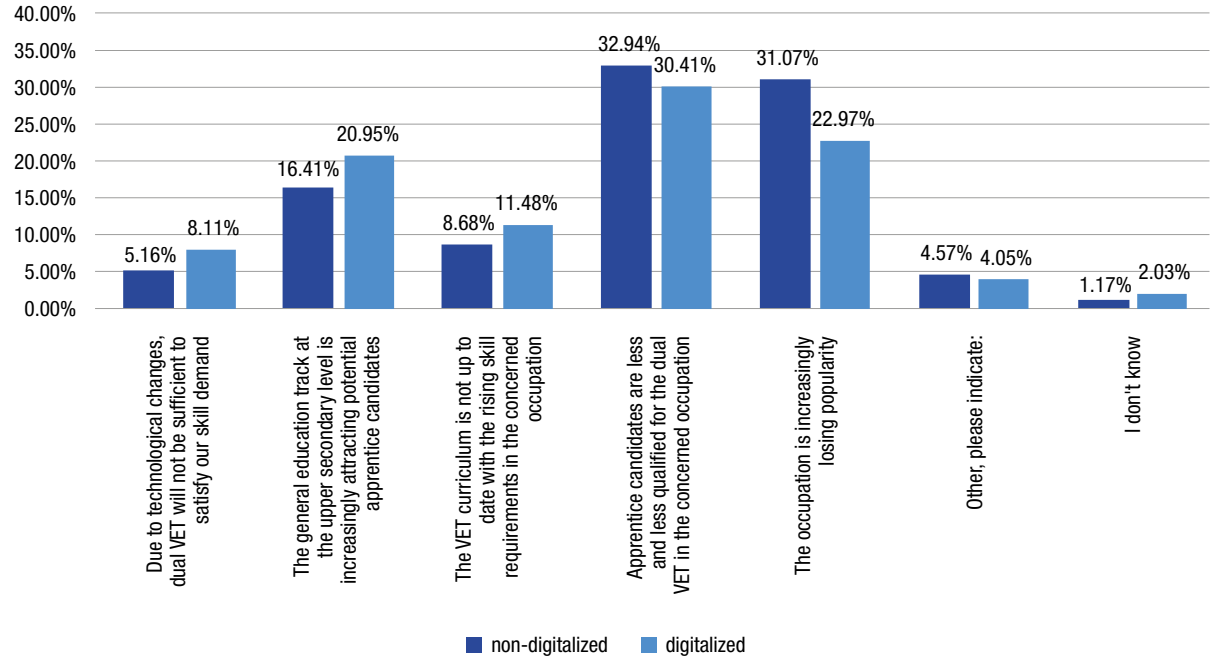
Table 1. **Stated reasons for hiring difficulties when hiring candidates**

Reasons for hiring difficulties*	N	%
...are not willing to do the type of burdensome work the training requires	685	46
...lack the motivation to follow through with the training	615	41
...lack the overall qualities required for the training	929	62
...usually lack the language skills required	358	24
We receive few or no applications for the vacancies we post	623	41
Other	114	8
* Multiple options allowed	Total = 1505	

Source: Author's calculations (Wilson & Bajka, 2022).

Across sectors, firms state two main reasons explaining how their hiring difficulties and resulting skill shortages are related to dual VET (Figure 7). First, they state that applicants lack the required qualities. Second, the offered occupations have lost popularity among the young. This loss is less frequently reported by firms in more digitalised sectors (21%), whereas firms in less digitalised sectors quote it more often (32%). Only 5% of training firms in less digitalised sectors see technological advancement as a source for the link between hiring difficulties and dual VET. In the more digitalised sectors, about 8% of the firms make this link.

Figure 7. **Reasons for hiring difficulties by firm sector**



Source: Author's calculations (Wilson & Bajka, 2022).

In sum, while the shortage of suitable candidates and declining interest in offered occupations are common challenges across sectors, the extent of these issues and the choice of strategies to meet them varies. More digitalised sectors exhibit a lower decline in the attractiveness of their roles compared to more labour-intensive sectors, indicating potential shifts in candidate interests and not necessarily only in their essential abilities.

3.3.2. Candidate perspective

The modern ICT sector offers more positions than ever (the trend points towards further growth), while the opposite is true for construction. Construction also experiences more dropouts, indicating that there might be truth to the generational shift in 8th grader perceptions toward less labour-intensive preferences. (LehrstellenPuls, 2022, 2023).

As digitalised sectors are growing, the occupations they offer could be regarded by potential applicants as more future-proof (offering higher job security, expected higher salaries, more general orientation of required skill sets). Hence, it might be helpful for firms in non-digital sectors, such as construction, to change the image of their sectors by indicating their digitalisation elements; this might include the introduction of new technology or a guarantee of the longevity of a career in the specific vocational field.

When looking at the two categories (firms that experience hiring difficulties intensely and those that do to a lesser degree) and the supporting facts, sector-related exposure to digitalisation is a dividing

factor. Digitalisation might (e.g. via losing popularity in specific sectors) influence the hiring difficulties that certain firms face in the apprenticeship market.

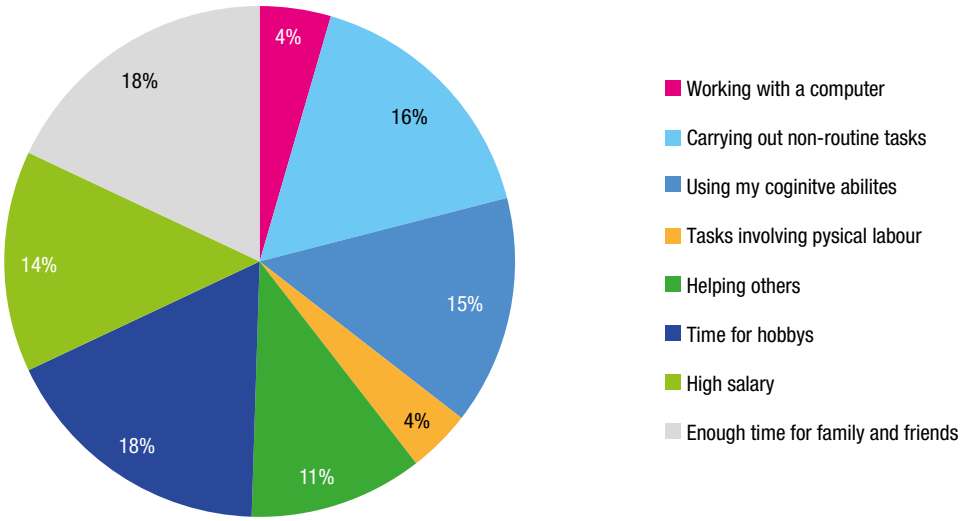
To explore whether this is true for at least the 2022/23 cohort of Swiss VET candidates, this chapter looks at the occupational preferences of 8th graders. The novel survey data used was collected in autumn 2022 among 2,500 Swiss 8th graders (14 to 15-year-olds) who are about to enter the VET system (Bajka et al., 2022). In the 8th grade, Swiss learners are typically in the middle of their occupation selection process. By the end of this school year, most learners have made their choices. Switzerland is an ideal location for this study because there are minimal restrictions on occupational training preferences, allowing examination of the full range of options available to the respondents. Additionally, there are no admission restrictions to Swiss apprenticeships from a school perspective, so it does not matter which school the respondents attended. The survey was fielded in two Swiss cantons, Luzern and St. Gallen, which are both comparatively diverse in terms of economic structures and combine both rural and urban areas. In both cantons, VET is a popular choice for upper-secondary education, and both cantons feature a growing ICT sector.

The top three preferred training occupations stated by the respondents are commercial training, nursing, and IT specialist (most frequently chosen not preferred occupations, c.f. SERI, 2022:12). Occupations that relied on more physical and routine-oriented tasks were found towards the end of that list.

This trend is also confirmed when looking at what respondents stated to be very important factors for them when choosing an occupation (Figure 8). Among those factors ranked very important, the general factor capturing that 'tasks involving physical labour' should be part of their future job, made up 4%, whereas the factor capturing non-routine tasks made up 16%. The factor 'working with a computer' at 4% among the factors that matter strongly is also a strong signal pointing in the same direction. This finding is reflected by a recent survey conducted by SwissSkills among 600 representatives of the country's youth (18 to 27 years old) where access to modern infrastructure and technology is the fourth most important factor for an occupational choice (SwissSkills 2023).

To conclude, there seems to be truth to the claim that applicants may show less interest in more labour-intensive apprenticeships in less digitalised sectors.

Figure 8. **Supply-side occupational preferences**



Source: Authors' calculations; Bajka et al. (2023).

3.4. Discussion and conclusion

This chapter has provided valuable insights into the difficulties faced by training firms in dual VET in recruiting apprentices, particularly in the context of digitalisation. The findings suggest that the level of digitalisation in a sector may influence the challenges that training firms face.

Economic efficiency perspective

Firms that reported hiring difficulties were found to rely heavily on VET for skill supply. For these firms, the supply-side appears to be part of the problem. Recommendations for these firms include strengthening institutional affiliations, such as with OdAs, to work more closely with other firms on the image of their sector and addressing demand-side issues, e.g. by offering access to a vocational baccalaureate.

To bolster apprentice recruitment in highly digitalised sectors, targeted strategies are key. This involves dynamic marketing campaigns showcasing innovation, and government incentives to support strengthening the partnerships with education institutions. Tailored approaches can be effective in assisting low-digitalised firms facing apprentice recruitment challenges. First, implementing subsidised or cost-free digitalisation training programmes is paramount. These initiatives aid firms in seamlessly integrating digital tools, heightening their appeal to potential apprentices. Allocating resources to improve skills aligns these firms with evolving industry standards, fostering modern practices and, again, making them more attractive to prospective apprentices.

Firms not experiencing hiring difficulties were somewhat reliant on VET and slightly less institutionally affiliated. These firms seem to have a good balance between supply and demand. The recommendation for these firms is to train more in general if they can afford it.

Strategic initiatives are crucial to support highly digitised firms experiencing fewer recruitment challenges. First, promoting knowledge-sharing endeavours is a critical strategy. Encouraging these firms to mentor or collaborate with struggling counterparts fosters an exchange of best practices in apprentice recruitment and skill development. Second, extending continued support for growth and offering more training positions becomes imperative if the circumstances allow it. Facilitating further expansion and innovation ensures sustained availability of apprenticeship positions, aligning with the continued growth trajectory of high-digitised sectors.

Tailored policies for low-digitised firms with fewer recruitment hurdles focus on stability promotion and networking. Emphasis on long-term security attracts apprentices, while collaborations with education institutions and sharing success stories enhance sector appeal for aspiring talent. This approach balances modernisation with stability, catering to varied firm needs while boosting apprentice recruitment.

Social inclusion perspective

From an inclusiveness perspective, firms can, as the Swiss INVOL initiative promotes, open their doors for young refugees or young people with migratory background (SEM, 2023) ([17]). When looking at specific industries, the construction sector, which is less digitalised and faces more severe hiring difficulties, could benefit from diversifying their skill supply strategy, updating recruitment strategies to reach the supply side, and increasing digitalisation in their infrastructure, where possible.

For the highly digitalised ICT sector, which faces more severe hiring difficulties, recommendations include advertising among general education graduates or dropouts, investing more in digital advertising, and offering more training positions. Inclusiveness can mean different things for different sectors.

([17]) First pilot projects seem promising; however, it is too early yet to draw final conclusions, since a scholar verdict of the programme is still awaited (SEM, 2023).

As in the case of the construction sector, it could rather mean to continue to expand the scope toward foreign talent or talent among refugees. For the ICT sector, a recommendation could be to continue to incorporate more inclusiveness from a gender-perspective and in terms of lowering certain requirements.

This paper underscores the importance of tailored recruiting practices and policies to address hiring challenges in different sectors based on their digitalisation state. It is crucial to acknowledge several limitations within this study that might impact the validity and generalisability of the findings. The survey's inclusion of a limited number of ICT firms (N = 60; in the group of more digitalised sector firms, N = 733) might constrain the extrapolation of results to this sector. The relatively small sample size within this category could impede a comprehensive understanding of the nuances specific to the ICT industry. Further, the study only encompasses data from a single survey wave, precluding the ability to analyse trends or changes over time. The absence of multiple waves prevents any temporal analysis or the identification of longitudinal patterns within apprentice recruitment or sectoral digitalisation. This limitation restrains the study's capacity to draw robust conclusions regarding the dynamic nature of skill shortages and recruitment challenges across different sectors.

Future research could further explore what hiring difficulties mean for the viability of VET systems and the quality of training provided and how inclusiveness gaps can be bridged. The findings of this paper offer practical implications for both policy-makers and staff of training firms in and beyond Switzerland, helping them navigate the challenges of apprentice recruitment in an increasingly digitalised world. By understanding group congruences among the specific issues faced by different sectors, more effective strategies can be developed to ensure the continued success and relevance of dual VET.

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CHAPTER 4.

Apprenticeship for digital skills training: preparing the new generation of workers for the digital future

By Mairead Matthews, Mansharn (Toor) Sangha, and Olena Podolna ([18])

4.1. Introduction

4.1.1. Digitalisation and labour market needs

Digitalisation has caused rapidly shifting labour market needs and increased demand for digitally skilled talent. Digitalisation is increasing demand for technology workers across the economy, including data analysts, user experience and user interface designers, devops engineers, hardware engineers, software developers, artificial intelligence (AI) experts, cloud systems engineers, and cybersecurity analysists (Ivus & Kotak, 2021). In Canada alone, an additional 250,000 technology jobs will be added to the economy by 2025, aggravating an already tense labour shortage (Ivus & Kotak, 2021).

Digitalisation is also increasing demand for digital skills among non-technology workers: increasingly, healthcare professionals, food and agriculture producers, retail and supply chain workers, and corporate roles require digital skills, and because of this, demand for candidates with a blend of soft and technical skills is growing (Hamoni et al., 2021; Ivus et al., 2021). Finally, digitalisation is creating new jobs while making others obsolete. Companies are increasingly using cloud solutions, AI, and machine learning to automate tasks: approximately one-third of the hours worked in 60% of jobs could be automated by 2030, while roughly 8% to 9% of the workforce could work in occupations that do not exist today (Manyika et al., 2017).

4.1.2. Demand for digital skills training

Businesses in Canada and around the world are facing a shortage of digitally skilled talent (Ivus and Kotak, 2021). Consultations with employers and labour market analytics identify a shortage of people with the required digital skills (Taylor-Smith et al., 2019; Ivus 7 Kotak, 2021; Hamoni et al., 2021; Ivus et al., 2021). While 'school-based' training is the primary mechanism to train technology workers, evidence suggests that alone does not result in 'job-ready' workers; academic institutions are one step removed from industry trends, making it hard for them to constantly realign their curricula with industry needs (Handley, 2018). School-based training also does not immerse students in the culture of their vocational community, thereby reducing their ability to develop industry-relevant domain knowledge, soft skills, and culture (Pratt, 2002).

Employers in IT perceive the knowledge and skills taught by universities to become quickly 'out of date' (Taylor-Smith et al., 2019). ICT employers repeatedly express concern about IT graduates' job readiness, noting that graduates who are highly skilled in technical competences often lack valuable 'general workplace competences' or soft skills (Jones et al., 2017). Both ICT graduates and employers have identified deficiencies in new graduates' workplace readiness, particularly concerning interpersonal and professional communication, business awareness, and problem-solving (Pilgrim, 2011).

([18]) Information and Communications Technology Council (ICTC), Canada.

Training programmes that incorporate key features of apprenticeship are a practical solution to these challenges. Apprenticeship programmes supplement school-based training with direct industry experience, helping students acquire industry-ready skills; giving them the opportunity to integrate with the culture of their vocational community; and facilitating a faster transition from training to the workforce. Building on past literature, this paper looks at the relevance of apprenticeship for digital skills and workforce development. It finds that apprenticeship-based training is an effective way for learners to develop industry ready skills and that demand for apprenticeship-style digital skills training is growing.

Section 4.2 of the paper uses existing literature to define apprenticeship training. Section 4.3 provides a case study of the Information and Communications Technology Council's (ICTC) Work Integrated Learning (WIL) Digital Programme, a digital skills training programme that incorporates key features of apprenticeship training. The case study relies on primary data, including a student (N=952) and employer (N=486) survey, and research interviews with programme administrators. It considers what aspects of apprenticeship training are used in the programme design and how these features contribute to its challenges and success.

4.2. Defining apprenticeship

Apprenticeship is one of the five common perspectives on teaching (Pratt & Johnson, 1998). It is rooted in the belief that people learn best when working on real-world tasks, in real world settings; it places significant value on work-based training (Pratt & Johnson, 1998). Apprenticeships go beyond the acquisition of skills to include the enculturation of learners into vocational groups; they therefore place significant value on cultural learning, including domain knowledge and soft skills development (Pratt & Johnson, 1998).

Apprenticeships generally involve a work-based trainer, a learner, and a third-party coordinator(s) or oversight body(ies). The primary responsibility of a trainer is to show learners the processes that underlie skilled performance (Pratt, 2002), for instance, by verbalising their internal thought processes, providing learners with practical 'tips and tricks,' or guiding them through meaningful, real-world tasks (Pratt, 2002; Billet, 2016).

Apprenticeships are not without their challenges. Trainers may find it difficult to identify relevant and meaningful tasks, match these tasks with learners' abilities, allow independent work while ensuring safety and quality, and clearly explaining their knowledge and skills (Pratt, 2002). Nonetheless, apprenticeship remains a valuable approach to training.

4.2.1. **Key features of apprenticeships**

While specific applications of apprenticeship vary – for instance, with respect to their duration, skill requirements, and credentials – they are rooted in a common set of 'key features'. These features, outlined below, include both 'design features', which pertain to the overall design of apprenticeship programmes, and the individual responsibilities assigned to the work-based trainer, learner, and third party(ies).

Figure 1. **Key features of apprenticeship**

Source: ICTC, 2023.

4.2.1.1. *Design features*

In terms of design features, apprenticeships feature a combination of vocational and academic training; a structured, one-to-one relationship between a learner and trainer; and cultural immersion in a vocational community.

(a) Combination of school- and work-based training: the principal design feature of apprenticeship is a combination of school- and work-based training. While the degree of emphasis placed on work- versus school-based training can vary, nearly all apprenticeships include both types. Generally, greater emphasis is placed on vocational, work-based training, which is usually accompanied by a smaller amount of 'cognitive', 'academic', or 'classroom-based' learning (Bates, 2015). Many countries have enshrined this combination of school- and work-based training into legislative or regulatory definitions for apprenticeship. In the European Union, for example, the European Framework for Quality and Effective Apprenticeships points to a combination of work-based experience and learning (Council of the European Union, 2018).

(b) Structured, one-to-one relationship between trainer and learner: since their early use in craft guilds, apprenticeships have involved a structured, one-to-one relationship between a work-based trainer (e.g. a contractor, a supervisor, a manager, depending on the context) and a learner. Here, structured refers to the existence of a formal relationship where the responsibilities of each party have been agreed to in advance. One-to-one refers to the direct relationship that exists between the work-based trainer and the learner (compared to transmission-based learning, whereby one instructor teaches an entire group of students simultaneously) (Pratt, 2002). That said, in practice, work-based trainers will often oversee more than one learner.

(c) Cultural immersion in a vocational community or group: apprenticeships prioritise the enculturation of learners into vocational communities, differing substantially from academic training on this point: while academic training gives students the opportunity to learn the language, values, and practices used in academia, it does not do a good job of teaching learners about the culture of their future vocation (unless they plan to work in academia) (Bates, 2015; Billet, 2016; Fuller & Unwin, 2014). This can lead to a cultural mismatch between the language, values, and practices used by recent graduates and those required by their employers.

4.2.1.2. *Responsibilities of third parties*

Apprenticeships usually involve a third party – or a combination of third parties – responsible for standardisation, quality assurance, and credential recognition. Depending on the context, this could be a professional body, government organisation, academic institution, or some combination of the three (Fletcher, 2017).

(d) Ensuring standardisation and quality assurance: many apprenticeships rely on third parties that are not loyal to the work-based trainer, nor learner, to provide oversight, standardisation, and quality assurance (Fletcher, 2017). This helps to ensure that learners meet the minimum entry and graduation requirements; trainers provide a quality training experience and both parties receive fair treatment. For example, a third party might monitor the number of learners a work-based trainer can take on simultaneously, the number of hours worked by the learner, or the rate of pay.

(e) Enabling credential verification and recognition: apprenticeships often involve some form of credential recognition (Lerman, 2013). Learners take part in apprenticeships to be recognised for their skills and eventually become qualified to work independently. A neutral third party is often needed to verify that learners have completed their training and are qualified to work.

4.2.1.3. *Responsibilities of the workplace trainer*

The workplace trainer is generally responsible for three items: providing an authentic work experience, deciding what to teach and how to structure learning, and compensating the learner for their time. Depending on the context, the workplace trainer may be an individual contractor, a supervisor, or a man-

ager. This trainer draws from real-world contexts and examples to develop the learner's competences.

(f) Providing an authentic work experience: while attempts have been made to replicate work experiences in the classroom through vocational training, a core feature of apprenticeships is that training must take place in an authentic work setting (Pratt & Johnson 1998; Pratt, 2002). Under the apprenticeship model, work-based trainers are responsible for providing learners with an authentic work experience, including everything from the authenticity of the specific tasks to the authenticity of the cultural environment.

(g) Deciding what to teach and how to structure learning: work-based trainers are responsible for deciding what to teach and how to structure learning. They must choose tasks that are relevant and meaningful to their vocational community (Pratt, 2002). To ensure the learner takes on new tasks at an appropriate pace, trainers must break work into smaller tasks that progress from 'simple and marginal' to 'complex and central' (Pratt, 2002). Unlike academic training, apprenticeships directly involve real-world companies and organisations in skills training.

(h) Compensating the learner for their time: unlike a co-op placement, which may or may not be paid, apprenticeships require learners to be paid for their time; work-based trainers are responsible for paying learners, albeit usually at a lower rate than would be earned by a fully qualified worker. While the learner benefits from the work-based trainer's knowledge, the trainer benefits from access to a skilled worker at a reduced cost.

4.2.1.4. *Responsibilities of the learner*

The learner is also responsible for three items: taking on an active role in their learning, adopting a continuous learning mentality, and working for their trainer for a reduced rate.

(i) Taking on an active role in their learning and education: apprenticeship differs from other approaches to training in that it requires the learner to take a highly active role in their learning (Billet, 2016). In contrast, the transmission approach to training views students as 'containers' that educators must 'fill with knowledge' (Pratt, 2002). In an apprenticeship, learners learn by doing; as they progress, they become increasingly independent.

(j) Adopting a continuous learning mentality: founded in the skilled trades, apprenticeships treat learning as a continuous and unending process (Billet, 2016). Learners are encouraged to adopt a continuous learning mindset and view themselves as practitioners who never stop perfecting their craft.

(k) Work for their trainer at a reduced rate: n return for their work-based trainer's knowledge and training, learners are often expected to work for their trainers at a reduced rate. This agreement lasts until the learner is fully qualified in their profession.

Figure 2. **Summary of apprenticeship's key features and underlying beliefs**

Underlying Beliefs	• People learn best when working on real-world tasks, in real-world settings • Learning goes beyond the acquisition of skills to include the enculturation of learners into a vocational community or group
Design Features	• Combination of vocational and academic training • Structured, one-on-one relationship between instructor and learner • Cultural immersion in vocational community or group
Responsibilities of Third Parties	• Ensuring standardisation and quality assurance • Enabling credential verification and recognition
Responsibilities of Work-based Trainer	• Providing an authentic work experience • Deciding what to teach and how to structure learning • Copensating the learner for their time
Responsibilities of the Learner	• Taking an active role in their learning and education • Adopting a continuous learning mentality • Working for their instructor at a below market rate

Source: ICTC, 2023, based on data sources: Pratt and Johnson, 1998; Pratt, 2002; Lerman, 2013; Fuller and Unwin, 2014; Bates, 2015; Billet, 2016; Fletcher, 2017.

4.3. Case study on apprenticeship for digital skills training

Apprenticeships are a practical solution to the challenges outlined in this paper's introduction: apprenticeship programmes supplement school-based training with direct industry experience, helping students to acquire industry-ready skills, and giving them an opportunity to integrate into the culture of their vocational community. While apprenticeship-based training is increasingly relevant for technology roles, Canadian apprenticeships have generally been limited to skilled trades roles, such as electricians, plumbers, heavy equipment operators, technicians, mechanics, cooks, and machinists (Goodyer, August 7, 2022). To date, no formal apprenticeship programmes have been designed for digital technology roles, such as software developers, data scientists, machine learning developers, and user experience designers.

Programmes that adopt aspects of apprenticeship-based training have nonetheless become popular among digital economy employers (Pilgrim, 2011; Davenport et al., 2020). Work-integrated learning (WIL) programmes, for example, incorporate aspects of apprenticeship-based training into traditional post-secondary education ([19]) and are popular among digital economy employers (Cutean et al., 2023). While not a formal apprenticeship programme, WIL combines school- and work-based learning, giving students the opportunity to work closely with a work-based trainer and develop industry-ready skills in an authentic workplace environment (Pilgrim, 2011).

WIL tends to be seen positively by workforce development stakeholders, learners, and employers. In a survey of Australian universities, lecturers identified WIL as the best feature of their degree programmes because of how it aligned degree programmes with industry needs (Pilgrim, 2011). In the same study,

([19]) In Canada, post-secondary education refers to the formal education delivered by universities, colleges, and institutes (Canada. Government, 2022).

ICT graduates indicated WIL programmes are necessary to address fully their training needs, while ICT employers indicated students need work placements to gain industry experience before entering the workforce (Pilgrim, 2011). Further studies show that there is strong demand for WIL from both students and employers (Davenport et al., 2020) and that students with WIL experience have increased employment rates and increased the likelihood of earning a higher wage (compared to graduates without WIL experience) (Davenport et al., 2020).

4.3.1. Case study of ICTC's WIL digital programme

ICTC's WIL digital programme helps students develop the foundational and technical, work-ready skills that are needed to succeed in Canada's digital economy. WIL Digital has been in place since 2017 and is delivered with funding from the Government of Canada's student work placement programme (SWPP), which seeks to provide post-secondary students with work experiences related to their field of study (ESDC, 2022). WIL Digital was created because many formal degree programmes in Canada do not require students to obtain work experience as part of their studies. This reduces their employability post-graduation and increases onboarding times. WIL Digital overcomes this challenge by helping students supplement their class-based learning with work-based training prior to graduation.

As the employer delivery partner for WIL Digital, ICTC is responsible for:

(a) incentivising digital economy employers to hire post-secondary students for 4-month work-based training placements (ICTC provides employers with a wage subsidy worth between 50% and 75% of the student's wages, up to 7 500 Canadian dollars);
(b) finding work-based training opportunities for roughly 2 000 students per year; and
(c) ensuring the quality of work-based training experiences for employers and learners and certifying that the placement has taken place.

WIL Digital incorporates many of apprenticeship's key features (Table 1). Students learn through a combination of school- and work-based training in an authentic work environment, and work-based trainers are sourced directly from Canada's ICT sector.

Table 1. **Comparison of apprenticeships and WIL Digital**

Features of the Apprenticeship Model		Comparable Features in WIL Digital
Design features	Combination of vocational and academic training	Students receive training in both academic and work settings
	Structured, one-on-one relationship between trainer and learner	Students are paired with a supervisor who is responsible for their learning outcomes for the work-based learning component
	Cultural immersion in vocational community or group	Students are culturally immersed in their industry
Third party(ies) responsibilities (Government of Canada and ICTC)	Ensuring standardisation and quality assurance	The Government of Canada and ICTC work to ensure standardisation and quality assurance through programme design and by vetting providers and students
	Enabling credential verification and recognition	ICTC provides students with a certificate of completion if they participate in ICTC's WIL Digital eLearning courses

Features of the Apprenticeship Model		Comparable Features in WIL Digital
Work-based trainer responsibilities (Supervisor, manager, etc.)	Providing an authentic work experience	Supervisors are responsible for giving students valuable work experience that will help them acquire at least three skills relevant to their future careers
	Deciding what to teach and how to structure learning	Supervisors are responsible for working with the student to develop a learning plan; they then must assign tasks to the student to meet the learning plan's goals
	Compensating the learner for their time	Employers must compensate students for their work (at least minimum wage)
Learner responsibilities (Student)	Taking on an active role in their learning and education	Students are responsible for working with their supervisor to develop a learning plan (which is then approved by ICTC)
	Adopting a continuous learning mentality	Students are encouraged to take advantage of ICTC's WIL Digital eLearning courses
	Working for their trainer at a reduced rate	Students are usually paid at a student rate, which would be less than the amount paid to a fully qualified worker

Source: ICTC, 2023.

4.3.1.1. *Programme evaluation and impact*

To evaluate the impact of WIL Digital, ICTC asks employers and students to complete an impact survey at the midway point and at the end of student placements. Students and employers are asked to evaluate whether the intended learning outcomes were met and comment on the students' skills development. Roughly 92% of respondents indicated that they were very satisfied with their WIL Digital placement. Respondents generally felt that the programme had improved students' soft skills and understanding of employer expectations, and that students had contributed positively to their employers' needs. Employers felt that the programme gave them an opportunity to screen future candidates and build a more diverse workforce.

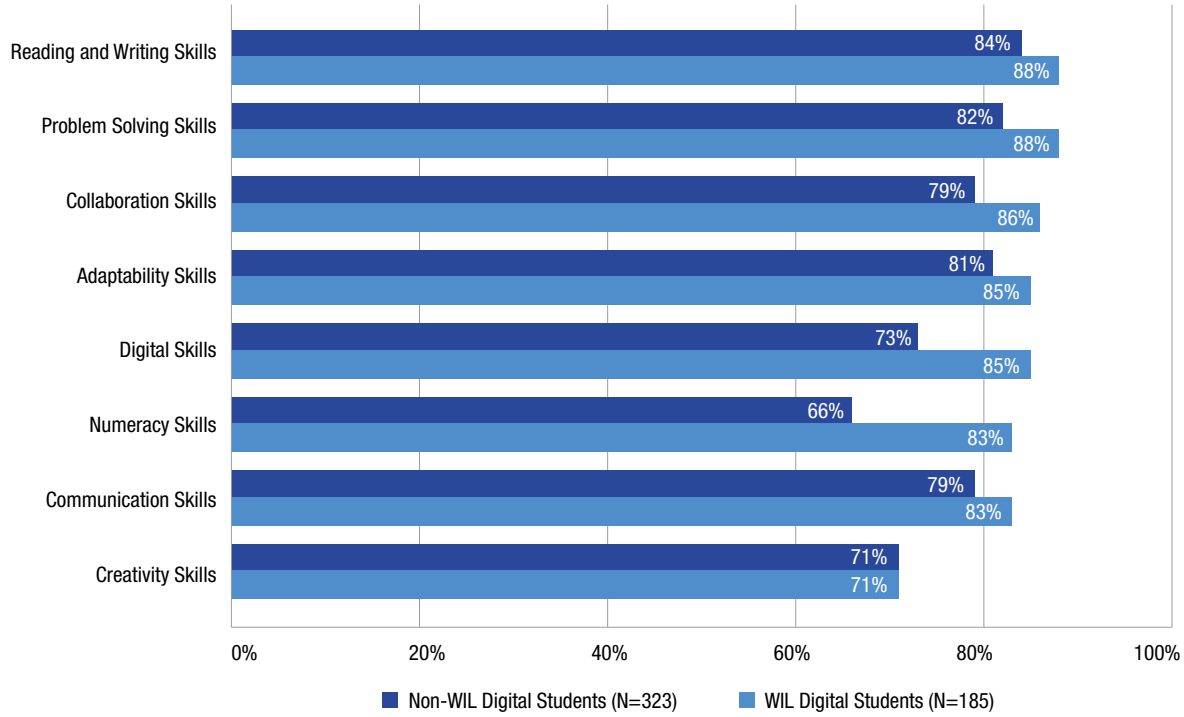
WIL Digital employers are often young, small organisations: 66% of participating employers had between 1 and 99 employees while 33% were in the start-up and seed-stages of their business. High participation by small and early-stage businesses suggests that WIL Digital is an attractive option for employers that are still building organisational capacity. In line with this, many employers saw the wage subsidy as the most significant benefit of the programme, enabling them to reduce the financial burden of new hires while also growing organisational capacity. At the same time, programme administrators discussed how the high number of small and early-stage businesses increases the need for a neutral third party that can ensure participating businesses have sufficient time and resources to train and mentor students and ensure the appropriate payroll and onboarding processes are in place.

Work-based trainers are responsible for designing a learning plan for their students; it must include at least three learning outcomes relevant to their field of study. Programme administrators commented that it is important for apprenticeship-type programmes to have a neutral third party who can vet the students' learning outcomes and ensure they are in line with programme objectives. Otherwise, trainers could disregard the programmes' training goals and instead provide students with unrelated tasks. To help reduce this risk, WIL Digital includes a mid-point check in where programme administrators meet with students, ensure they are being provided appropriate tasks, and ensure their learning outcomes are being met.

Overall, employers felt WIL Digital helped students strengthen their soft (e.g. communication, self-direction, working both independently and collaboratively) and technical skills (e.g. project management,

coding, programming, excel). To understand better the impact of WIL Digital on the students' skill development, ICTC asked students who had and had not participated in the programme to self-assess their skills. As seen in Figure 3, for all the assessed skills, students who had participated in WIL Digital assessed their skills more positively than students who had not (the latter category of students were sourced using an external survey vendor).

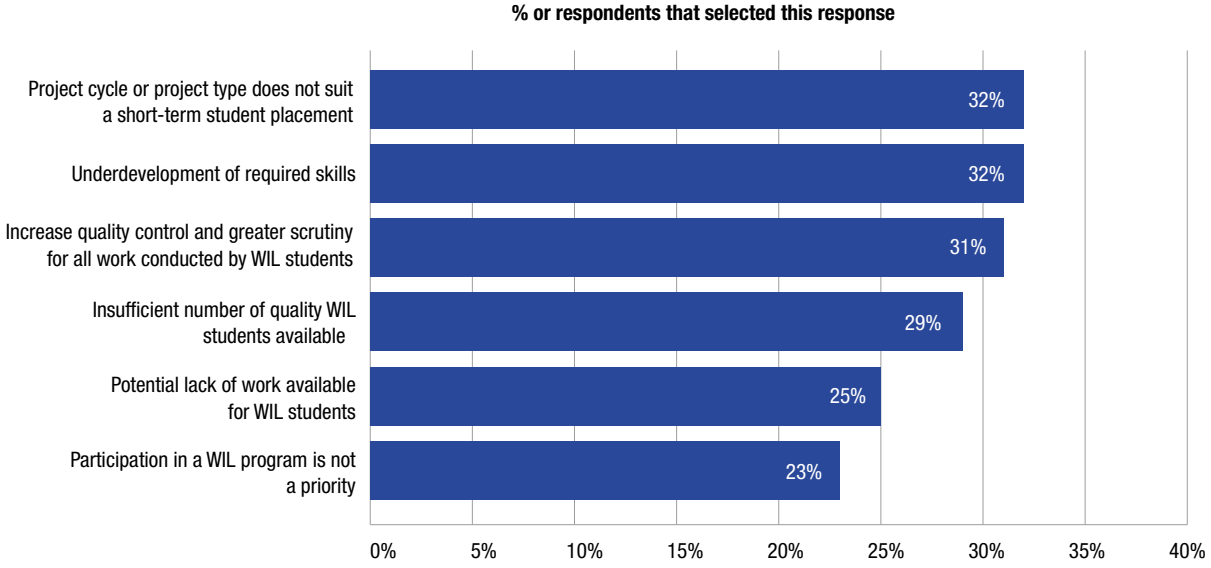
Figure 3. **WIL Digital and non-WIL Digital students' self-assessment of skills**



Source: ICTC survey data.

Some employers had negative perceptions of the WIL Digital programme. Approximately one-third of employers felt WIL Digital work placements were too short for their needs, possibly contributing to an underdevelopment of the required skills (the standard work-based training placement lasts for 4 months). Work-based trainers were also concerned about their ability to find work for students to work on, and their ability to ensure quality control and scrutiny for the work conducted by students, given that the students are not fully trained professionals. Similar challenges are identified in the apprenticeship literature as being commonly associated with apprenticeship programmes (Pratt & Johnson, 1998; Bates, 2015). In response to employer concerns about students' 'underdevelopment of the required skills', many SWPP delivery partners have begun offering supplementary training for technical and transferable skills (ee.g. ICTC's WIL Digital eLearning courses).

Figure 4. **ICTC's WIL Digital employer exit survey: what did not go well?**



Source: ICTC survey data.

4.4. Conclusion

Because of the fast pace of technological advancement, traditional post-secondary education providers can find it difficult to align academic curricula with industry needs. School-based training is not well suited to teaching industry domain knowledge, culture, and soft skills, leaving students ill prepared for the workplace. As a result, young people are transitioning from the classroom to the tech sector without the skills needed to succeed at work. Apprenticeships help alleviate these challenges by combining school- and work-based training, exposing students to the culture of their future vocational community, and assigning students authentic tasks in authentic workplace settings.

The apprenticeship model of education and learning is highly relevant to the digital economy and can provide ample benefits to the ICT labour market. While WIL Digital is not a true apprenticeship programme (for instance, WIL Digital includes a smaller component of work-based versus in-school learning, is less standardised, and does not result in a qualification), it does incorporate many aspects of true apprenticeship programmes: it features a combination of school- and work-based learning, a strong belief in the ability to 'learn by doing,' cultural immersion in students' future vocational communities, a robust focus on domain knowledge and soft skill development, and the presence of a third party to ensure standardised programme delivery. The success of the WIL Digital programme as a result of these features helps demonstrate how relevant apprenticeship-based training is for digital skills development.

WIL Digital improves student employability while providing significant benefits to employers. Employers get access to additional labour capacity and relevant skillsets at a reduced rate, can contribute to direct skills development and can evaluate potential new hires. Students report improvements to their technical and transferable skills, a better understanding of their industry and role, and an improved ability to secure gainful employment upon graduation.

Yet, programme administrators and participants also experience challenges. It can be difficult for employers to properly integrate students when placement terms are too short, which can in turn impact skill development. Employers may also be dissatisfied with the quality of students, while students may be dissatisfied with the relevance of tasks provided to them by employers. Participating students do not receive an industry-recognised qualification for having completed their work-based learning placement,

thereby reducing the associated benefits of participating in WIL Digital.

Further aligning WIL Digital and other work-integrated learning programmes with apprenticeships could help alleviate the above challenges. For instance, it could help ensure that the length of work terms is better aligned with employer and student needs, that the type of work assigned to students is more standardised and more aligned with programme objectives, and that completion of the work-based learning placement results in an industry-recognised qualification that students and employers can use to communicate and assess skill levels. A 2023 study of the Government of Canada's student work placement programme ([20]) associates work-integrated learning programmes that incorporate aspects of the apprenticeship model ([21]) with better learning outcomes than work-integrated learning programmes that do not (Cutean et al., 2023).

If involving more small- to medium-sized businesses in training is a priority for the local region, wage subsidies can be used to help offset training and onboarding costs, which often prevent small to medium-sized businesses from providing training and mentorship opportunities. If certain demographic groups are underrepresented in the region's digital economy roles, stacked subsidies can be used to incentivise companies to individuals from those underrepresented groups.

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([20]) E.g. Not just ICTC's WIL Digital programme.

([21]) E.g. where work-integrated learning is paid and is part of a standardised programme versus a non-standardised co-op, internship, volunteer placement, or other work placement.

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CHAPTER 5.

Digital transition of apprenticeship in China's tourism sector: an 'alternation of working and learning' apprenticeship scheme in Hainan Province

By Wang Feiyu ([22]) ([23])

5.1. Introduction

5.1.1. China's apprenticeship systems and the start of digital transition

China has a long history of traditional apprenticeship in various fields of industry using informal modes. From 2015, formal apprenticeship systems (Table 1) have been initiated by the government: Modern Apprenticeship (2015) and New Apprenticeship (2018). The former was targeted at vocational students and pre-service workers offering degree programmes and certificates; the latter was focused on contract workers with more flexible learning modes such as workplace training and alternation of working and learning.

Table 1. **China's apprenticeship systems**

	Modern Apprenticeship (2015)	New Apprenticeship (2018)
Target learners	Vocational school students and pre-service workers	Contract workers
School/workplace	50% School + 50%workplace	Workplace-based
Key stakeholders	Vocational schools; companies	Companies
Modes	Learning & internship	Workplace training/school learning/ alternation of working and learning/short-term training
Qualifications	Diploma/Degree; National Vocational Qualification (NVQ) Vocational Skill certificate; *1+X certificate	Credit-based diploma/certificate; NVQ; Vocational Skill certificate

Source: Author.

In the digital economy era, China has followed innovative technologies and digital transformation of industries and upgraded vocational education with new degree programmes and training programmes to improve student and worker digital literacy. Apprenticeship systems, as part of China's vocational education, have been going through a period of digital transition in terms of digital techniques, digital

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teaching and learning, and digital management (Ministry of Education of PRC, 2022).

5.1.2. New Apprenticeship in Hainan Province

Hainan Province, with tourism as its key industry, has been rigorously promoting vocational education with enterprise-school collaboration, with a focus on the tourism sector. Since 2015, Modern Apprenticeship has been introduced in Hainan to offer degree programmes to vocational school students and pre-service workers. However, the tourism sector still faces severe challenges: increasing unemployment in the tourism industry, reduced payment of workers in the tourism downturn, and the 'lying flat' syndrome among young workers with low levels of education. According to OECD policy responses to coronavirus released in 2020, one of the key impacts of the COVID-19 crisis on apprenticeship is a reduced offer from certain industries, leading to a decline in vocational education enrolment.

Facing similar challenges, Hainan government has initiated the Alternation of working and learning (AWL) scheme as part of its New Apprenticeship, offering vocational education opportunities to tourism industry workers. Degree and certificate programmes (Table 2) of different educational levels have been offered to tourism contract workers with financial support from the Hainan government.

Table 2. **Hainan AWL scheme**

Level of degree programmes	List of AWL programmes	Education stage	ISCED level
Secondary vocational education	Chinese Cooking	Upper-secondary	ISCED 3
Higher vocational education	Hotel Management and Digital Operation, Big Data and Accounting, Human Resource Management, Marketing, Business Management, E-Commerce, Cooking and Nutrition	Post-secondary, non-tertiary	ISCED 4
Vocational education bachelor degree	Hotel Management, Administrative Management, Financial Management, Human Resource Management	Tertiary	ISCED5-8
1+X certificate	Logistics Management, 1+X Smart Finance and Taxation, 1+X Human Resource Shared Service	-	Similar to microcredentials (pilot certificate mechanism aligned with the reform of China's vocational education)

Source: Author.

Since the initiation of the AWL scheme in 2019, especially during 2020-21 COVID-19 pandemic when in-class teaching was locked down, the Hainan government has raised the speed of the digital transition to facilitate its digital delivery.

First, a WeChat mini programme, Registration for continuing education in the Hainan tourism industry, was designed and put into use for programme promotion, student enrolment and management.

Then, online classroom service platforms, such as Wisdom Tree, Xuexitong, Zhidao, and Tencent Conference, were upgraded to stabilise online teaching platforms (Hainan Culture and Tourism Department, 2021).

The 1+X certificate (known as 1+X certification system), an optional microcredential organised by authorised third-party agencies, were offered as AWL complements to address the skill gap between education and employment. Three types of 1+X certificate were provided to the tourism sector: logistics management, 1+X smart finance and taxation, and 1+X human resource shared service.

5.1.3. Research objectives and structure of the paper

This research aimed at exploring the digital transition of the AWL scheme of the tourism sector during 2019-22 in Hainan Province. It focused on three stages of digital transition of apprenticeship in the tourism industry: the design of the digital transition, the preparation for the digital transition, and the digital delivery of AWL. Adopting from Talcott Parson's AGIL framework of social action and the International Labour Organization (ILO) Toolkit for quality apprenticeships lifecycle of apprenticeship programmes, the study analyses the following four dimensions during the transition: adaptation, goal-attainment, integration, and latency. In the conclusion section, the study offers four policy recommendations to promote the digital transition of AWL regarding its social functions and proposes an evaluation framework for apprenticeship programme digital transition for further research.

5.2. Methodology

5.2.1. AWL case study through digital transition stages

According to the ILO Toolkit for quality apprenticeships, the life cycle of an apprenticeship programme consists of four stages: developing the programme, preparing the programme platform, delivery of apprenticeship, and post-training transition and evaluation (ILO, 2020a). In terms of the digital transformation of apprenticeships, ILO published the report *The digital transformation of apprenticeships: emerging opportunities and barriers* in 2022, adopting the apprenticeship life cycle as a framework for technology-enhanced apprenticeship practices and country-based case studies. This life cycle also provides a systematic view of success factors and limitations for policy recommendations and further research (ILO, 2022).

This study adopts ILO's apprenticeship life cycle as the analysis framework for the Hainan AWL scheme but only with the first three stages. As AWL was newly initiated in 2019 (programme cycle:2.5-3 years), it is currently in the middle of transition, the fourth stage 'post-training transition and evaluation' lacks data evidence.

The three stages of AWL digital transition are the design of the digital transition (Stage 1), the preparation of the digital transition (Stage 2), and the digital delivery (Stage 3).

5.2.2. Talcott Parsons' AGIL system of social action

As one of the key sociologists of structural functionalism, Talcott Parsons developed the AGIL system of social action (Table 3), according to which a social action is to be understood as the interaction of four different functions: 'adaptation (the economy), goal-attainment (the polity), integration (cultural system of general values which is concerned with law and social control), and latency (the normative problem of motivation to fulfil positions in the social system)' (Parsons, 1951). Among the four functions, adaptation and goal attainment are designed to respond to outer environment, while integration and latency refer to connections within the system. In terms of social exchange, money is the medium of exchange of the adaptive subsystem, power is the major medium of exchange of goal attainment, influence for integration, and commitment for latency. Application of the AGIL system (and the four functions) to the AWL programme helps diagnose problems and propose policy suggestions.

Table 3. **Parsons AGIL system of social action**

Function	Subsystem	Medium of exchange
Adaptation (external)	Economy	Money
Goal Attainment (external)	Polity	Power
Integration (internal)	Cultural system	Influence
Latency (internal)	Motivation	Commitment

Source: Parsons, 1951. p.19.

The success of the digital transition of AWL lies in the four social functions through the three stages (Table 4). The adaptation function of the AWL scheme is mainly reflected in stage 1, the design of the digital transition; the goal attainment function refers to programme objectives and achievements covering all three stages. The integration function refers to the interactivity of stakeholders regarding digital resource allocation in stage 2-preparation of digital transition. The latency of digital transition of AWL, mainly covers stage 3 regarding the social attitude of digital competence development and the promotion of the AWL programme brand.

Table 4. **AGIL matrix in relation to the three stages of introduction of the Hainan AWL programme**

Adaptation (stage 1) Sub-dimensions: • Ease of access and participation • Digital competence development	**Goal Attainment (stage1, 2, 3)** Sub-dimension: • alignment between policy objectives and achievements
Integration (stage 2) Sub-dimension: • Interactivity of stakeholders of digital transition	**Latency (stage 3)** Sub-dimensions: • Social value/commitment of digital competence in China's New Apprenticeship • Brand building of AWL

Source: Author.

5.3. Findings

5.3.1. Adaptation

According to the AGIL matrix of the Hainan AWL programme, the adaptation of AWL was assessed in the following sub-dimensions: ease of access and participation, and its digital competence development.

5.3.1.1. *Ease of access and participation*

In terms of financial support, the highlight of the AWL scheme is the design of digital degree programmes with government funding. Tourism industry workers with enterprise contracts of more than 3 years with can have tuition fees reimbursed by the government after graduation, paying only for half of tuition during registration; workers with less than 3-year contracts prepay tuition fees and are reimbursed after graduation. The 1+X certificate (similar to a microcredential) is free for enrolled learners as part of the AWL package, which is aligned with China's vocational qualification system reform. However, the financial burden of pre-payment tuition may hinder worker access to AWL, especially for low-income groups.

In terms of participation, AWL set up three levels of education stages for learners with different ed-

ucational backgrounds: secondary vocational education, higher vocational education and vocational education bachelor degree. The degree programmes and certificates cover major tourism administrative sectors with urgent need of digital upgrading, such as human development, accounting, marketing, and tourism management. A registration application was developed for learners to receive AWL promotion, online consulting and enrolment. In 2019, 3,153 learners were enrolled in AWL, with registration open only to workers in the hotel industry; in 2020, the enrolment number increased to 7,193, with the registration scope opened to all sectors of tourism including travel agency and tourist attractions.

5.3.1.2. *Digital competence development*

According to the Digital competence framework DigComp 2.1, global digital competence consists of five competence areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving (EC et al, 2018). Based on the analysis of AWL degree programmes, the curriculum design covers four domains of digital competence: information and data literacy, communication and collaboration, digital content creation and problem solving (Table 5). AWL initiated curriculum reform targeting digital competences in sub-sectors of tourism such as hotel management and digital operation, intelligent taxation, big data and smart tourism, and e-marketing. However, the domain 'digital safety' was not mentioned in the curriculum design.

Table 5. **Analysis of Digital competence development of AWL**

Global digital competence framework (DigComp 2.1)	Digital competence development in AWL curriculum design	Sample courses of AWL
Information and data literacy	√	Office Software; Financial Analysis
Communication & collaboration	√	Business English; Marketing
Digital content creation	√	Web Design
Safety	-	-
Problem solving	√	Hotel Strategic Management; Big Data and Smart Tourism

Source: Author.

5.3.2. **Integration: interactivity of digital transition stakeholders**

Four key stakeholders are involved throughout the AWL digital transition: the Department of Vocational Education and Adult Education of Hainan Province, vocational schools, tourism enterprises, and training agencies of 1+X certificate. Tourism enterprises were engaged individually in field research into market demands for digital skills, while the design of digital programmes for AWL was government-led and excluded enterprise participation. The quality assurance of digital degrees was controlled by the government through annual upgrading of training providers and digital degrees:18 vocational schools selected in 2019 were screened by the government as suitable to offer AWL across 11 degree programmes. In 2021, training providers were reduced to 10 schools but with an increasing number of degree programmes (Peng Pai News, 2022). However, tourism enterprises were excluded from this decision-making process.

According to the stakeholder approach (Freeman,1984), the allocation of AWL resources among key stakeholders was off-balance (Table 6): the Department of Vocational Education and Adult Education of Hainan Province as the key player in digital transition provides programme design, policy and financial support for AWL while allocating digital vocational schools and 1+X certificate training agencies as programme providers.

However, tourism enterprises were neither financially nor technically involved, which may lead to their neutral or passive responses to AWL. For example, according to fieldwork, Sanya Mandarin Oriental hotel

(an international brand of luxury hotels and resorts) had no workers enrolled into the AWL programme in 2021, as the hotel ran little promotion for it.

Table 6. **Stakeholder analysis of AWL**

Stakeholders	Type of resources	Sample resources	Position on AWL programme
Department of Vocational Education and Adult Education of Hainan Province	Design, policy and financial and support	AWL White Paper; Execution Plan of Hainan New Apprenticeship	Positive key player
Vocational schools	Digital products and services	Digital teaching platforms such as Xuexitong; digital learning resources such as Wisdom Tree; teachers; learning packages	Positive participant
Tourism enterprises	Tourism workers	Potential trainees	Neutral or passive participant
Training agencies of 1+X certificate	1+X training platforms	1+X Teacher training resources, VR classrooms/labs	Positive participant

Source: Author.

5.3.3. Goal attainment: policy objectives and achievements

According to the AWL scheme White Paper, the major objective of AWL is to improve tourism workers' educational backgrounds during the tourism off-season for future upgrading of digital skills targeting workers' tourism-related skills and digital literacy. However, with the average spend of RMB 7900 per learner (including financial support to learners) from the government, the effectiveness of AWL implementation is far from satisfactory. Based on data from first-round (2019-22) enrolled learners, the graduation rate of AWL degree programmes only reaches 17.5%. Though the effectiveness of AWL should be evaluated through long-term programme cycles, the 2019-22 cycle reflects the short-term failure of its goal attainment. Possible factors can be suggested for AWL learner dropout: the challenge of AWL degree programmes to learners, especially with low educational backgrounds; less support from low-engagement companies for workers' off-workplace learning; and the indistinct employment advantage of AWL for learners. There was also no formal evaluation framework designed to monitor the implementation of AWL, which may lead to dissatisfaction with AWL achievements.

In terms of the digital development of the tourism industry, the key objective is the integration of smart tourism, according to the Smart Hainan strategic plan (2020-25) and the Hainan AWL white paper. The innovative techniques of AWL such as the internet of things, cloud computing, and artificial intelligence are mainly incorporated in the construction of 1+X certificate digital teacher training platforms, learner certificate training, and comprehensive training. Initiated by the third-party training agencies of 1+X, the 1+X digital platform utilised virtual reality and augmented reality to integrate theory and practice through big data analysis of target sub-sectors of smart tourism such as 1+X smart finance and taxation and 1+X human resource shared service. However, AWL degree programmes were mainly focused on basic skills of tourism industry instead of smart tourism.

5.3.4. Latency

5.3.4.1. *Social Value of digital competence in apprenticeship*

At the national level, the social value of digital competence development has been embedded into China's promotion of New Apprenticeship. According to the Advancing the New Apprenticeship system with skilled personnel policy paper released in 2021 by the Ministry of Human Resources and Social Security of China, digital skill development was one of the key training objectives of New Apprenticeship; its achievement was presented at the World Vocational and Technical Education Development

Conference in 2022 through digital skill competitions and the School-Enterprise Cloud Expo. However, apprentice attitudes towards digital competence in their career development remains unclear. Based on a nationwide survey on the development of China's vocational education in 2021, the proportion of apprentice interviewees only takes 1.91% of the entire survey population (Wang et al., 2021), showing that the social commitment of industry workers to China's transformation of vocational education has not attracted much attention. This leads to the lack of evidence for research on social values of digital competence among industry workers.

5.3.4.2. *AWL brand building*

At the regional level, the latency of digital transition refers to the promotion of digitalisation and brand building of AWL. According to Hainan government websites (2019-22) ([24]), 54 news items on AWL policy instructions, promotion, and policy effects were released with the focus on the convenience of digital learning during the tourism off-season. Based on the word frequency account of the 2021 AWL White Paper, 'online learning' 'internet+' were mentioned 13 times related to contexts of convenience, efficiency, and service. It is clear that the value of digital transition has been promoted and advanced by the local government through policy strategies. As a provincial brand of New Apprenticeship, the Hainan AWL scheme was selected as one of sample programmes by the National Development and Reform Commission for New Apprenticeship promotion (Hainan Provincial Bureau of Tourism and Culture, 2022).

5.3.5. **Summary: AWL success factors and barriers**

According to the AGIL framework analysis of the AWL digital transition, the success factors and barriers were reflected in the following four functions (Table 7).

(a) Adaptation: the overall design of AWL is aligned with the national education framework, covering International standard classification of education (ISCED) level 3-8. The wide range of education levels and financial support provide tourism workers with easy access and participation through digital degrees. However, the pre-payment of tuition fees may hinder learners' access to AWL in low-income families. Another barrier might be the lack of digital safety in the curriculum design of digital degrees.
(b) Integration: the major success of AWL is the integration of vocational school digital resources and 1+X certificate digital platforms, whose partnerships were well established as part of the national reform of New Apprenticeship before AWL. However, the major barrier to integration is the negative participation of enterprises, with possible drawbacks of government policy strategies excluding enterprises from the decision-making process throughout the AWL design, preparation and delivery.
(c) Goal attainment: based on the above analysis, the barriers of social functions of AWL might lead to the short-term failure of goal attainment based on the low graduation rate of AWL digital degrees. Lack of formative assessments of AWL digital transition may worsen the mismatch between policy objectives in 2019 and programme attainment in 2022.
(d) Latency: both at national and provincial levels, the promotion of digital skill development in apprenticeship was well designed through policy works and spread through conferences, digital skill competitions and online exhibitions. However, tourism worker perceptions of digital transition remain unclear so far, as social attitudes among apprentices or industry workers are neglected in large-scale surveys of China's VET.

([24]) Hainan government websites include official websites of Hainan Provincial Bureau of Tourism and Culture, and Provincial Bureau of Education.

Table 7. **Success factors and barriers in the digital transition of AWL**

Social functions	Success factors	Barriers
Adaptation	Digital degree programmes aligned with national education framework and global digital competence framework; ease of access to registration	Financial barrier to learners from low-income families; lack of digital safety in the curriculum design of digital degrees
Integration	Integration of digital resources through Vocational schools and training agencies of 1+X certificate	Lack of policy support for enterprise engagement; Lack of positive participation from enterprises throughout the design, preparation and delivery of AWL
Goal attainment	Basic skills delivered	Limited effectiveness of AWL; lack of upgraded skills related to smart tourism in degree levels; Lack of digital transition evaluation framework for apprenticeship
Latency	Promotion of digital skills development at national and provincial levels	Lack of investigation of social attitudes among tourism workers towards digital transition of AWL

Source: Author.

5.4. Policy recommendations

Four policy recommendations of promoting the digital transition of apprenticeship programmes in the tourism industry are offered.

5.4.1. Recommendation 1: Upgrade and design digital degree programmes according to global digital competence framework and smart tourism for better adaptation to outer environments

According to the rising demand for innovative techniques of Hainan Smart Tourism, artificial intelligence technologies such as the internet of things and cloud computing should be considered in upgrading the digital degrees of AWL to optimise the digital management of tourism workers. The dynamics of digital curriculum design should be aligned with changing digital environments of apprenticeship, such as adding emerging digital skills and digital safety into the curriculum.

5.4.2. Recommendation 2: Improve enterprise engagement for better integration among key stakeholders

The AWL scheme was government-oriented throughout the design, preparation and delivery, which led to low engagement of enterprises. In order to improve enterprise engagement, the local government should better allocate policy tools such as financial and other incentives to promote social dialogue with enterprises in terms of digital skill demand, digital skill training of enterprise trainers, and equitable funding for digital transition. For example, employers could be involved into the design of AWL digital degrees targeting skill mismatch in the tourism industry, the delivery of AWL in terms of easy access and participation with more support to workers, and testing digital tools for the transition to smart tourism.

5.4.3. Recommendation 3: Initiate large-scale survey and fieldwork on digital transition in the tourism industry to strengthen the latency of digital apprenticeship programmes

(a) Governmental sectors such as the Hainan Culture and Tourism department could carry out surveys among tourism industries and workers on their perceptions of digital transition at the workplace.

(b) Vocational schools and 1+X training agencies can initiate fieldwork for enrolled learners on their attitudes towards digital degrees and 1+X certificates in terms of digital competence development.
(c) Enterprises and AWL providers could mobilise promotion strategies through digital techniques (channels) such as cloud stream and social media marketing.

5.4.4. Recommendation 4: Build an evaluation framework for digital transition of apprenticeship programmes to monitor goal attainment.

In terms of goal attainment, a summative assessment of digitalisation of apprenticeship at the end of AWL is far from enough; as an innovative approach to apprenticeship, a formative and formal evaluation framework would monitor outcomes in different stages of digital transition through key indicators.

Following the IAG-TVET indicators (Inter-agency Group on Technical and Vocational Education and Training, 2014), this study proposes an evaluation framework for the digital transition of apprenticeship programmes (Table 8). The evaluation framework can be developed in four dimensions: efficiency of digital transition; social inclusion; teaching, learning and effectiveness; and socioeconomic effects.

In terms of the efficiency of digital transition, three sub-indicators are designed to assess the financial support from key stakeholders: total spending on digital transition programmes, digital spending per apprentice, and the proportion of companies and digital apprenticeship providers.

In terms of social inclusion, five sub-indicators are designed to assess the ease of access and participation. From the macro level, policies on articulation with digital apprenticeship and the typology of digital admission policies are gathered for policy analysis; from the micro level, the digital enrolment by programme type of apprenticeship, transition paths of programmes and digital enrolment rate of apprenticeship are designed to evaluate the actual participation of digital apprenticeship.

In terms of teaching, learning and effectiveness, three sub-indicators are designed to assess the quality of apprenticeship: the share of apprentices completing digital programmes or training, the digital competence of apprenticeship providers, and the actual use of digital skills in the workplace by trained apprentices.

In terms of socioeconomic effects, two sub-indicators are designed to evaluate the relevance to labour market transition: the satisfaction of apprentices during apprenticeship and after graduation, and the satisfaction of employers regarding apprentices' digital competence. These are measured through surveys and interviews.

Table 8. **Evaluation framework of the digital transition of apprenticeship programmes**

Key issues of apprenticeship programmes	Areas of proposed indicators	Proposed indicators
Efficiency of the digital transition	Finance	1.1 Total spending on digital transition programmes 1.2 Digital spending per apprentice 1.3 Proportion of companies and digital apprenticeships providers
Social inclusion	Access & participation	2.1 Policies on articulation with digital apprenticeship 2.2 Typology of digital admission policies 2.3 Digital enrolment by programme type 2.4 Transition paths of digital programmes 2.5 Digital enrolment rate of apprenticeship
Teaching, learning and effectiveness	Quality	3.1 Share of apprentices completing digital programmes 3.2 Digital competence of vocational school teachers and in-company trainers 3.3 Utilisation of acquired digital skills in the workplace during apprenticeship and after graduation
Socioeconomic effects	Relevance to labour market transition	4.1 Satisfaction of apprentices with digital programmes 4.2 Satisfaction of employers with apprentices' digital competence

Source: Author based on IAG-TVET indicators, 2014, pp. 9-10.

5.5. Conclusion

In the digital economy era, the digital transition of apprenticeship has covered a variety of industry sectors in terms of innovative techniques, digital competence development, digital teaching and management, comprehensive training, and digital apprenticeship system. Focusing on the tourism sector, this study discussed three stages of digital transition of apprenticeship through a case study on Hainan AWL programmes using the AGIL social function framework. Key findings show that the digital degrees and 1+X certificate aligned with national education framework have played essential roles in the digital transition path of AWL. However, barriers of adaptation, integration and latency of AWL hindered the goal attainment of the programme.

To monitor the process of digital transition of apprenticeship for better goal attainment, this study proposes an evaluation framework for digital transition of apprenticeship programmes for further research work through qualitative and quantitative methods, which might be applicable for empirical studies on digital transition of apprenticeship in various industry sectors.

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CHAPTER 6.

Digitalisation of apprenticeship training: the view of apprenticeship providers

By Romain Pigeaud ([25])

6.1. Introduction

In France, apprenticeship operates under an employment contract between an employer and an apprentice. This contract is characterised by alternating training in the company and training in an apprentice training centre (CFA). It includes a qualification, which is the objective of the contract. The 'apprenticeship contract' scheme is open to young people aged 16 to 29. The length of the contract, from 6 months to 3 years, depends on the qualification sought. The qualification must be recorded in a register that guarantees the acquisition of a qualification recognised on the labour market and by the State (National registry of professional qualifications – RNCP). Within the company, an apprenticeship supervisor provides practical training for the apprentice and helps him or her to obtain the qualification. The apprenticeship training centre (CFA) must hold the national quality certification Qualiopi, which takes into account the specific features of apprenticeships. Between 2016 and 2021, the number of young people trained under the apprenticeship contract rose from 438 000 to 799 000, an increase of 82% ([26]).

Apprentice training centres have been offering apprentice distance training (FOAD) since 2016. A 2022 survey of distance learning beneficiaries (27) showed that distance or digitalised training is a means of acquiring skills that is adapted to certain professions and certain beneficiary profiles. The survey shows that distance training is followed by certain profiles of young people, with a significant proportion of women, and with the aim of acquiring new skills for a particular profession. Most participants believe that it is an appropriate teaching method. Since the FOAD audience is young, wishing to train for a job, apprentices seem to be the target audience for the digitalisation of training.

When the COVID-19 pandemic broke out in 2020, not all training organisations were experts in e-learning. They had to rethink their pedagogical practices and deploy new tools urgently to ensure continuity. The crisis gave a strong boost to the digital transformation of apprenticeship providers (CFAs). According to a 2022 Centre-Inffo survey, 92% of the members of the CFA network had deployed a remote training solution during COVID-19; before 25% did not have one in place (28). In detail, 64% of CFAs chose an educational content platform; 43% chose a platform that includes interactive exercises (compared with 28% before the health crisis) and 40% chose virtual classes (compared with 15% before the health crisis). This meant that 2020 was the year of generalisation of distance training for apprentices and their training centre.

Three years after the health crisis and the development of digitalisation for apprenticeships, it is necessary to analyse the way in which digitalisation is legally supervised (29), how the pedagogy of

([25]) Expert in Law and Training policies at Center-Inffo, France
([26]) Le contrat d'apprentissage
([27]) Pole-emploi – insights and summaries (2022, December) La formation ouverte à distance (FOAD) : une modalité d'apprentissage adaptée à certains métiers et profils de demandeurs d'emploi. [Open distance training (FOAD): an apprenticeship method adapted to certain jobs and profiles of jobseekers].
([28]) Centre-Inffo (2022, avril). La FOAD au temps du COVID-19 Enjeux, ressources et pratiques, dossier documentaire.
([29]) Including articles: L6211-2 and D6313-3-1 of the French Labour Code

apprenticeships has adapted to distance learning, and what feedback there is. It is also important to observe the most recent initiatives around digitised training, sometimes called 'distance training' (FOAD), or even 'digitised' or 'hybridised'.

6.1.1. **A legal framework fully enabling apprenticeship digitalisation**

The concept of digitalisation of apprenticeship training in France is not recent and was not invented during the health crisis. Since 2014, it has gradually become part of the legal texts surrounding vocational training, then also for apprenticeships.

Law No 2014-288 of 5 March 2014 on vocational training, employment and social democracy changed the definition of training by allowing the possibility of doing all or part at distance ([30]). This innovation was aimed at people far from training centres and considered the development of new technologies ([31]). It was intended for vocational training and did not concern apprenticeships and the CFAs as, at that time, apprenticeship was not included in formal vocational education and training (as it is nowadays).

It was not until 2016 that apprentice training centres were able to offer apprentices distance training (Law No 2016-1088) ([32]). This law has made it possible for all or part of the training provided by apprentice training centre to be carried out remotely (Art. L6211-2 of the amended Labour Code). The educational dimension and support for apprentices have been taken into account by the same law: During distance training, apprentice training centres were tasked to monitor and support apprentices (Art. L6231-1 of the amended Labour Code).

Recently (2020), additional regulation complemented this opening up to the FOAD for learning ([33]);training actions ([34]), in whole or in part, remotely include:

(a) appropriate technical and educational assistance to support the beneficiary in the progress of his/her pathway;
(b) information to the beneficiary on the educational activities to be carried out remotely and their average duration;
(c) evaluations that mark or conclude the training action.

The possibility of opening up apprenticeships to digitalisation is, therefore, relatively recent ([35]), and supervised, facilitated by the new definition that authorises and encourages digital training methods. Digitalisation of apprenticeship training is not an experiment, nor is it reserved for a limited number of apprentices. It is enshrined in the law and its implementing texts.

Apprenticeships have become a form of alternating education combining training acquired by the professional activity within one (or more) company(ies) with teaching followed within a CFA 'face-to-face' or remotely. However, there are specific educational requirements to be fulfilled when training courses are digitised: when set up by a CFA, digitised training courses contain more educational requirements than face-to-face courses.

([30]) Loi n° 2014-288 du 5 mars 2014 relative à la formation professionnelle, à l'emploi et à la démocratie sociale. [Law No 2014-288 of 5 March 2014 on vocational training, employment and social democracy].
([31]) Projet de loi relatif à la formation professionnelle, à l'emploi et à la démocratie sociale. [Draft law on vocational training, employment and social welfare].
([32]) Loi n° 2016-1088 du 8 août 2016 relative au travail, à la modernisation du dialogue social et à la sécurisation des parcours professionnels. [Law no 2016-1088 of 8 August 2016 on work, the modernisation of social dialogue and the securing of career paths].
([33]) Décret n° 2020-373 du 30 mars 2020 relatif à la rémunération des apprentis et portant diverses adaptations de la partie réglementaire du code du travail relatives à l'apprentissage. [Decree no 2020-373 of 30 March 2020].
([34]) Provisions are identical for vocational training.
([35]) The new definition of the training action is from the law of 2018: Réforme 2018: de l'action de formation aux actions concourant au développement des compétences.

The features of the educational supervision of the CFA, when it chooses to implement distance training, were recently specified by the Mission for the Pedagogical Control of Apprenticeship Training (*Mission de contrôle pédagogique des formations par apprentissage*) ([36]). This shows that the digitalisation of learning is not only well supervised, but also controlled, and that pedagogical issues relating to the digitalisation of training are addressed ([37]). The Mission stated that:

(a) it is up to the CFA to organise the digitised training. These new procedures require the CFA to carry out specific pedagogical training engineering, and to monitor and evaluate the procedures implemented ([38]). Regardless of the training method proposed, it is up to the CFA to verify and demonstrate the relevance of the training methods that it chooses to implement and organise so that they can fully meet the training needs of the apprentice and his or her employer;
(b) it is up to the CFA to implement distance training as a training method, and to set in place the specific support required, as long as the educational strategy put in place is in line with the law. Apprentice training centres are responsible for 'monitoring and supporting apprentices when the planned training is provided in whole or in part remotely' (French Labour Code, Article L.6231-2); and
(c) it is not the training method that defines the educational/training approach best suited to the apprentice, but rather the prescribed training course allows to define whether the remote method is compatible with the targeted training objectives. The CFA must be able to specify how apprenticeships for professional gestures and skills are implemented, the remote implementation of which can be made difficult.

A CFA has full autonomy to organise digital training but remains fully, legally responsible for its training missions and is required to put in place specific monitoring and support for apprentices. Digital training, therefore, adds to obligations for the CFA, including having to justify its educational/training choices.

6.2. Cases of apprenticeship training digitalisation

A series of initiatives have come to support and encourage the digitalisation of apprenticeship training.

6.2.1. **National initiatives**

At the national level, a vast Training transformation and digitalisation plan with a budget of EUR 300 million was launched in December 2021, as part of the *France Relance* plan. The objectives are to take training to the next level of transformation and make France a world leader in educational innovation ([39]).

As part of this plan, two surveys were carried out with training organisations, including the CFAs, on their tools and needs to accelerate the digitalisation and hybridisation of training ([40]).

This plan supports innovative projects for digitalisation and modernisation of training emanating from players in the field or economic sectors, and large networks of training organisations. Following a call for proposals (*Dispositifs France Formation Innovante Numérique* – DEFFINUM), in November 2022, 62 winners were selected for projects of national or inter-regional scope that include ([41]):

(a) commitment to pool the production, support and tools created and deployed, at the level of the sector or network concerned;

([36]) Vademecum Mission de contrôle pédagogique des formations par apprentissage – March 2022. Ministry of National Education. The Mission runs an inspection to ensure that the training provided as part of the preparation for a vocational diploma enables students to acquire the expected knowledge and skills, as set out in the general education syllabus and the reference framework, under the right conditions and with a view to passing the diploma.
([37]) A local example: Mission de Contrôle Pédagogique des Formations par Apprentissage (MPCFA)
([38]) Vademecum sur la mission de contrôle pédagogique des formations par apprentissage.
([39]) Plan de transformation et de digitalisation de la formation. [Training transformation and digitalisation plan].
([40]) Résultats de l'enquête nationale à destination des établissements de formation et des CFA. [Results of the national survey for training establishments and CFAs].
([41]) Press release, Ministry of Labour, November 2022

(b) strong dynamic of educational/training innovation, particularly by integrating the contributions of digital and immersive technologies, cognitive sciences and training in the workplace.

Each project is driven by groups made up of several players (on average seven): training providers, CFAs, professional branches, skills operators (OPCOs), as well as education technology content publishers, private companies and research laboratories.

All the projects selected provide for the construction of numerous educational solutions: hybrid training courses, digital educational modules, immersive educational modules, self-positioning tools, co-production solution, storage and distribution of digital resources and tools.

Box 1. **Artificial intelligence to support adaptive learning**

The project Intelligent adaptive learning for CFAs in the automotive services division (AAI-Auto) is supported by the National Association for Automotive Training (ANFA). AAI-Auto's objective is to test and measure scientifically the effectiveness of personalised training using artificial intelligence.
To carry out this project, ANFA cooperates with 4 CFAs working in the field of automotive services and a company specialising in artificial intelligence for education and training.
One stage of the project is the digitisation of educational resources for automotive technology training, which is currently delivered face-to-face. These resources will be deployed on a Moodle platform and enriched with artificial intelligence software, to create an intelligent adaptive learning device. A set of professional concepts will be taught through a pool of learning resources in which artificial intelligence will identify the most effective resources for each learner trained.

Source: ANFA.

As part of the national plan, financial aid has been put in place for the CFA: financial support for the acquisition of equipment (laptop, tablet, 4G key), up to a maximum ceiling of EUR 500 per apprentice, so that apprentices can follow their distance learning. The beneficiaries are apprentices who do not have this equipment. The CFA must retain ownership of this equipment to make it available to future generations of apprentices. This assistance is funded by the skills operators (OPCOs).

6.2.2. Initiatives from professional branches and skills operators

Skills operators (OPCOs) have also taken initiatives to digitise training. For example, Akto, the skills operator of the professional branch of training providers, also provides answers to players seeking to modernise guides, testimonials, digital maturity diagnostic tools, expected skills repository, and career management elements to manage future employment and skills. ([42]).

The professional branches are also active in digitising apprenticeship training. By way of example, the CCCA-BTP (*Comité de concertation et de coordination de l'apprentissage du bâtiment et des travaux publics*), a national association for building and public works with joint governance, launched on 23 January 2023 a call for expressions of interest, including to:

(a) test innovations in real-life environments and speed up their dissemination to construction industry training organisations throughout France;
(b) test the systems for educational innovation: immersive training, individualisation of pathways, access to certifications, design of learning and professional training pathways, upskilling of employees, pooling of spaces, and relations between the establishment and learners. ([43]).

([42]) AKTO. Formation Ouverte et à distance (FOAD) [Akto. Open and distance training.]
([43]) Le CCCA-BTP lance un appel à manifestation d'intérêt pour le pilotage d' expérimentations. [CCCA-BTP launches a call for expression of interest for the pilotage of experiments].

6.2.3. CFA network initiatives

For CFA networks, pedagogical innovation is a key factor in structuring networks and adding value to them. For example, for the Network of CFAs of the Ministry of Agriculture, pedagogical innovation appears to be a fundamental necessity to solve problems, anticipate changes and renew practices, in the service of academic and educational success and social promotion.

A plan to boost and promote educational innovation in agricultural education has been put in place, updated in 2022 ([44]).

This plan includes a component that aims to integrate better the opportunities opened up by digital education for the success of learners. A specific action plan for the development of digital education in agricultural education will include actions to enrich pedagogy, develop digital resources, and train and support the education community.

Another component informs the work of the national committee of expertise on educational innovation in agricultural education. The purpose of this committee is to formulate proposals aimed at better identifying innovative actions in agricultural education, to analyse and assess innovative actions carried out by educational teams, and to propose to the administration methods for promoting and (or) generalising these actions. This committee was set up in September 2014, which shows that the issues of educational innovation are not new.

6.2.4. Initiative of a professional association

The professional association on digital training and educational innovation, The Forum of Digital Training Stakeholders, has taken an initiative to provide training stakeholders with a methodological framework to initiate and deploy a hybrid approach to their offers: Hybrid'Box.

Financially supported by the Ministry of Labour and the skills operator Uniformation, this toolkit gives CFAs diagnostic tools to assess their ability to transform and to take stock of their digitalisation. Questionnaires are accompanied by a reading guide offering courses of action.

In the Hybrid'Box, the CFAs also have resources to initiate their project once the inventory has been carried out. This means they have a grid to define their needs, prepare their specifications and identify expenses, whether they are associated with external services, investments or the mobilisation of internal resources. A map of funders can help them find the right contact to support them in their project.

The Forum also has initiatives specifically directed at CFAs ([45]): Multimodality and CFAs, a practical implementation guide gives CFAs a roadmap to address a training hybridisation project ([46]).

6.2.5. Regional initiatives

Regions support the educational innovation of CFAs. For example, the Normandy region encourages quality and innovation in apprenticeship training in the Normandy CFAs, with the construction of a regional label, in the form of digital badges, known as the 'innovative CFA' label. The objectives of the label are to encourage CFAs to initiate or amplify their transformations, to bring together and connect CFAs to each other, to share best practices and resources. Obtaining badges is also of financial interest. The Normandy Region has made it a criterion for awarding grants for a digital project.

To be awarded the label of Innovative CFA, a CFA needs to complete 10 badges, choosing from a list of 22, five of which are mandatory. The badges cover:

(a) monitoring of digital changes relating to the trades in which the CFA trains;
(b) the technical solution/platform of digital skills provided to apprentices;
(c) the implementation of a continuous training plan for staff in training integrating digital technology;
(d) the ability of the CFA to set up online content for its audiences;
(e) facilitation via online tools of the tripartite relationship between apprentices, apprentice masters and

([44]) Plan de dynamisation et de valorisation de l'innovation pédagogique dans l'EA. [Plan for revitalising and promoting educational innovation in EA].
([45]) The first initiative concerns all training providers, including CFAs.
([46]) Multimodalité et CFA. [Multimodality and CFA].

pedagogical referents of the CFA.

While digital technology is at the heart of the collection of badges offered, the label also promotes innovations relating to sustainable development, the involvement of apprentices and employers in CFA improvements, and equal access for apprentices to distance training.

More than 60 CFAs (representing 70% of apprentices in Normandy) have signed up to the scheme. In February 2023, 20 CFAs had already been awarded the 'innovative CFA' label ([47]).

6.2.6. **Single CFA initiatives**

Apprentice training centres also run their own initiatives as digitalisation is a major focus of their development. For example, on the inauguration of the CFA campus *Sud des métiers de Nice*, this CFA announced a new educational experience with the aim of giving apprentices the means to acquire a profession and qualifications. 'The customisation of pathways and the training combined with the possibilities opened up by digital technology and the experimentation with new technologies within the learning lab will promote the success of learners and their integration into the company,' states the CFA ([48]).

The educational innovation of the CFA is regularly highlighted, as evidenced by the Innovation Awards of the WinLab incubator and trendsetter of the CCCA-BTP, launched in November 2021. The winner of the Grand Jury Prize awarded on 24 May 2022 is L@bConnect: CFA trainers have imagined transforming the training resources and assistance centres into L@b, a third place dedicated to digital, technological and educational innovation. Here CFAs and their environment can interact by pooling their knowledge and experience. Provision of equipment (3D printer, interactive tablet, etc.) helps foster interconnection between learners, trainers and partners. Educational innovation is at the heart of the system, including multi-modal training courses ([49]).

6.3. Educational repercussions of digitalisation of apprenticeship training

Reverse pedagogy, digitalisation, web 3.0, metaverse: all these new terms seem to age the notion of alternating pedagogy. However, the players and witnesses of these digital transformations do not seem to forget the pedagogy. 'The quality of educational/pedagogical engineering is the foundation. It is only once the conditions for the impact of training have been defined in the real world that digitalisation can be tackled,' says Jérémy Lamri, joint founder of 'tomorrow théory', an entrepreneur specialising in the transformation of organisations through innovation ([50]).

A pedagogy of dual training is defined, in general, as the articulation of two different learning places. Its real strength lies in the fact that they are complementary (Tilman, 2012) and that their attendance is made in a rhythmic manner, with regular back-and-forth (Durand, 2012) that gives it its full meaning.

One question, nevertheless, arises: how in the context of emerging digital approaches/solutions/pedagogy to understand and identify the factors, configurations, strategies and teaching/training models that would promote the acquisition of skills by apprentices.

([47]) L'apprentissage [Apprenticeship]. Normandy confirms its 'innovative CFA' labelling approach. Centre-Inffo, the daily training programme, 23 February 2023.
([48]) La formation des jeunes par l'alternance, axe majeur du nouveau Campus sud des métiers. [Training for young people through work-study programmes, a major focus of the new Southern Campus of Trades]. Centre-Inffo, 11 September 2019.
([49]) Apprentissage : première édition des Trophées de l'innovation du WinLab. [Learning: first edition of the WinLab Innovation Trophies].
([50]) Metaverse and Web 3.0 will decentralise practices Centre-Inffo: day-to-day training, 18 Jan 2023.

6.3.1. **Digitalisation as an educational tool**

A recent practical guide on the pedagogy of apprenticeships ([51]), by the Joint Metallurgy Observatory, identifies as an action area for the acquisition of skills the design of hybrid training environments combining physical and digital training environments, interactive or not: virtual reality, augmented reality, simulator, web, digital twins, videos, platforms, mobile learning, and e-learning. The guide also details the benefits of the hybridisation of training:

(a) For trainers:
   (i) design training scenarios that would be impossible to implement in real-life situations;
   (ii) assess learning outcomes;
   (iii) individualise training paths;
   (iv) monitor the development of trainees and assess their skills;
   (v) combine training initiatives and making them more attractive;
   (vi) hybridise training actions and make them more attractive.

(b) For apprentices:
   (i) perform safe tasks, make mistakes safely;
   (ii) develop an understanding of how a machine, tool, situation, production line or workshop works;
   (iii) understand what is happening or could happen, consider problem solving scenarios;
   (iv) develop digital literacy skills;
   (v) be more independently trained, have permanent access to teaching resources.

Box 2. **Digitalisation offers a safe learning environment**

> The nuclear industry is set to recruit 100 000 people over the next 10 years. Thanks to virtual reality and the emergence of digital mock-ups of buildings, learners can carry out tasks in complete safety, enter highly technical premises, repeat industrial gestures and follow teaching scenarios in rare conditions to remove any hesitation the day they are carried out in real conditions ([52]).

Source: Author.

The Construction and Public Works (*Batiment et Travaux Publics* – BTP) CFA in Brétigny-sur-Orge has put in place digital virtual reality solutions that make it possible to carry out professional actions through immersion and therefore to learn without wasting raw materials (e.g. paint) and safely. From an educational point of view, it offers the acquisition of skills through the possibility of making mistakes and starting over. For example, for the handling of refrigerants, electrical certification, welding or scaffolding, the CFA notes that this educational method is interesting and works. Hybridisation allows greening of training through reduction in the raw materials used in training ([53]).

Digitalisation also helps this CFA to ensure educational and pedagogical continuity: apprentices can use additional modules outside and in addition to their teaching time and programmes. The aim here is to encourage individual motivation, to allow apprentices to go as far as possible in their capacity, and to go further than the training itself.

([51]) Guide pratique: la pédagogie de l'alternance. Observatoire de la Métallurgie. [Practical guide: work-study pedagogy. Metallurgy Observatory]. November 2022.
([52]) 1) IFP School décroche le label '4Digital'; 2) Des formations innovantes, 3) Le digital renforce la sûreté nucléaire d'EDF
([53]) Interview with David Fabre, Director of Training and Educational Innovation // BTP CFA ILE-DE-FRANCE

Box 3. **Digitalisation to preserve traditional skills**

To avoid 'the loss of certain skills' in the arts and crafts sector, with certain specialities on the verge of disappearing, the French government wants to develop the 'digitalisation of craft skills'. For example, with the art of lacemaking, which could have been lost if it had not been preserved in the national lace factories of Le Puy-en-Velay and Alençon, a preservation that is now enabling the sector to flourish once again.
Preserving this patrimony is therefore essential, and new technologies offer new possibilities. The creation of a digital action bank will support this strategy by ensuring the conservation of know-how through the digitalisation of ancestral gestures and techniques threatened with extinction. Future apprentices will be able to rehearse rare gestures in virtual universes before mastering them fully in contact with the material.

Source: French government, Stratégie nationale en faveur des métiers d'art, 30.5.23.

The pedological choice of hybridisation makes it possible to implement a specific situation, a specific context, and a coordinated and diversified set of resources. This choice seems to fit with a definition of competence: 'Competence is the implementation by a person in a given situation, in a given context, of a diversified but coordinated set of resources. This implementation is based on the choice, mobilisation and organisation of these resources and on the relevant actions that they enable for the successful handling of this situation' (Jonnaert et al., 2004).

Digitalisation also makes it possible to project apprentices into the professions and organisations of tomorrow, and to raise awareness among learners of technological developments. Apprentices can project themselves into a potential development of their professional career and assert their added value within the host company. The CFA can guarantee a training course linked to the professional realities of companies and trends in development.

6.3.2. Educational approach to reinforce individualisation and engagement

The digitalisation of training does not exclude the individualisation of training pathways and the engagement of apprentices. Digitalisation makes it possible to combine multiple and different training methods and teaching methods, to consider the uniqueness of individuals, their pathways, their routes, their motivations, their projects, their strengths and their weaknesses. This involves, for example, offering individuals simulation exercises or training modules to fill gaps, develop or complete certain skills (Box 4).

Box 4. **Digital simulations to support individualisation of apprenticeship training**

The CFA of AFPOLS, the Association for Continuing Professional Training of Social Housing Organisations (*Association pour la formation professionnelle continue des organismes de logement social*) set up in 2018 a serious game for building caretaker and site manager training. In practice, this is a game simulating a residency with which the learner is confronted with roleplay.
This digital simulation has been a technical and pedagogical challenge for the CFA, taking 2 years to design and create the module. This shows that digitalisation of training requires the appropriate investment of time.
The face-to-face session uses digital technology to create a professional situation.
Digitalisation brings pedagogical innovation that involves apprentices. They have to take part in the digitised training to progress through the course.
Training is adapted to the apprentice's level, so that they can spend more time on points of difficulty, on the different modules, depending on their problems and the skills they have already acquired. Success can also be achieved quickly, which is a source of satisfaction for the apprentice.
The CFA shared the positive feedback from apprentices who participated in the game. They appreciated this pedagogical method: time passes more quickly, training is active and felt differently with a new pedagogy that favours the fun approach.

Source: Interview with Benoit Barré, Head of EMIS – Certifying Division at AFPOLS.

From a pedagogical point of view, the apprentice is placed in an active situation that allows her/him to meet and resolve different situations that will allow to increase in skills. Digitalisation allows for a pedagogical approach that encourages the individualisation of the learner, who must resolve the difficulties, with a view to a challenge to be met. The apprentice will take ownership of the training, the skills at their own pace, with the available resources.

The observed shift to a multi-modality training approach reflects the fact that training centres have become aware that the change benefits and attracts their apprentice audience, their news expectations and practice. Apprentices want a training approach that is both more fun and more involving.

The digitalisation of apprenticeship training raises questions about the role of teachers and trainers: their role is no longer to pass on skills directly to apprentices but that of a coach. Feedback on the deployment of a learning management system (LMS) platform in the building and public works CFAs shows that its implementation had to be accompanied by training for the CFA training staff with the aim of enabling digital education ([54]). For the trainer, the challenge is high: it is a question of transforming training.

6.3.3. **Learning reliant on reference frameworks**

In France, apprenticeship training must lead to certification. This certification must contain a set of reference frameworks: activities that describe the work situations and activities carried out, the trades or jobs concerned, a skills reference framework that identifies the skills and knowledge, including cross-functional knowledge that result from it, and an evaluation reference framework that defines the criteria and procedures for evaluating acquired skills ([55]).

These reference frameworks are the gateway to thinking about the training engineering of apprenticeship training pathways. These repositories are used to structure skills development. They are a tool for regulating training, a point of support for the training centre, whether in terms of training engineering or evaluation. They guide pedagogical action and allow the pedagogical sequences to be designed as closely as possible to the professional realities of employment.

Regardless of the pedagogical method of training, digital or face-to-face, learning is always aimed at skills included in a reference framework. The pedagogy of apprenticeship is based on these guidelines.

The skills are included in the reference framework and are assessed at the end of the apprentice's training. This assessment does not consider whether the training is face-to-face or digital. If the apprentice does not have the skills, s/he will not be certified. These skills are also important for employers.

The pedagogical methods used to acquire these skills are the responsibility of the CFA which is obliged to communicate the results of the assessments ([56]). In conclusion, the reference frameworks must always be applied, including for digitalised training. Reference frameworks are increasingly being adapted to the digitalisation of apprenticeship training.

6.3.4. **Digitalisation is not enough, educational innovations are important**

Digitalisation of training has no point without an educational objective. To implement digitalised training, a pedagogical scenario needs to be adopted. Digitalisation is a means, a tool, an element of comfort, not a miracle product. Digitalisation alone cannot guarantee success in an assessment, skills acquisition or professional integration.

Digitalisation cannot respond to all the problems of learners (who sometimes experience terminations of their learning contract, social difficulties). Digitalisation requires apprentices to be proficient in IT tools (keyboard, office suite software). For example, the BTP CFA of ILE-DE-France has specifically trained

([54]) Aptyce, the deployment of an LMS platform in construction and engineering CFAs, Apprenticeships in construction and engineering: innovation on the move, Permanent education excluding CCCA-BTP, 2020.
([55]) Article L6211-1 of the French Labour Code and Article L6113-1 of the French Labour Code.
([56]) Article L6111-8 du Code du travail.

apprentices on these tools; it takes time to take ownership.

There is sometimes a delay in the ability of stakeholders to learn. For example, the BTP CFA of ILE-DE-France was able to analyse that the electronic logbook ([57]) did not work well: employers do not master all digital tools and cannot integrate all digital monitoring tools.

Education innovation does not always involve digital technology alone. For example, a comfortable training area for apprentices can allow for more active teaching, collective learning based on exchange, and collective production. By way of illustration, it can include furniture that can evolve, a training room or modernised braces, better organised and flexible. Overall education settings should encourage advancement of skills in integration with digital technology ([58]).

6.4. Conclusions

The paper examined different ways in which apprenticeship providers in France adapt their training practices and approaches to digitalisation. The examples (Section 6.2) and the reflections followed (Section 6.3) help derive some key messages for apprenticeship providers that wish to boost their digitalisation.

Digitalisation brings numerous benefits to apprenticeship providers. It offers the possibility of remote training, and therefore offers training opportunities to people who are far from the training centre. It provides access to a range of resources (including sharing resources with the industry), makes it possible to produce training courses that consume less raw materials, to produce training courses that simulate places that are difficult to access, and that offer a teaching method that allows trainees to make mistakes without fear of failure.

Digitalisation offers apprenticeship providers benefits in terms of motivation and engagement of learners, who prefer digital ways of learning. It also allows customisation of training so that each apprentice benefits the most according to his/her level, difficulties and preferences. This could have a positive impact on attracting learners to apprenticeship occupations. Alongside digital occupations, learners can see how even traditional ones are being modernised with the use of digitalisation in their processes and also in the training per se.

But digitalisation also brings challenges. Prominent among these is the need to train teachers and in-company trainers to use digital tools and pedagogies. There are also expenses generated by digitalisation.

The French examples presented in this paper help understand the conditions under which digitalisation of apprenticeship can go forward:

(a) digitalisation must enable training to be provided in line with the skills foreseen in vocational qualifications and the corresponding assessment frameworks;
(b) the link between the employer, the apprentice training centre and the apprentice need to be maintained;
(c) digitalisation must be able to complement other pedagogical methods, providing apprentices with a new approach to training.

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Jonnaert, P. et al. (2004). Contribution critique au développement des programmes d'études: compétenc-

([57]) This is an IT tool particularly for employers, which aims to monitor, inform and evaluate the apprentice via a secure internet access.
([58]) Interview with David Fabre, Director of Training and Educational Innovation, BTP CFA ILE-DE-FRANCE

es, socioconstructivisme et interdisciplinarite. [Critical contributions to programme development: competencies, socioconstructivism and interdisciplinary approaches]. Revue des sciences de l'éducation, 30(3), 667–696. https://www.erudit.org/en/journals/rse/2004-v30-n3-rse989/012087ar.pdf

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CHAPTER 7.

Apprenticeships in the Digital Era: the Erasmus+ project DigiGo and the work-based development of digital skills for apprentices and company mentors

By Maniadaki K. ([59]), Kazantzidou N. ([60]) and Gennarelli A. ([61])

7.1. Introduction

Today's world is characterised by the digitalisation of every aspect of life. The fourth industrial revolution, known also as Industry 4.0, is introducing a new way of working that is defined by tasks which are completed with the help of machines (McKinsey & Company, 2022). Thanks to digital technologies, everything is done in an easier and faster way. Given the evolution of technology and the emergence of artificial intelligence, everyone needs to adapt to these changes, to meet the needs of this new era. The COVID-19 pandemic accelerated the penetration of digital technologies in everyday business and disrupted the way we work.

Digital skills play an important role not only for professional development but also for personal life, since everything now is displayed in a digital format (ILO, 2022). The development of digital skills in education has been a priority in the EU the recent years, with digital competence one of the key competences of lifelong learning (2006 Recommendation of the European Parliament and of the Council). Since then, the development of digital skills has been one of the main priorities of European education and training policies, in policy documents, as well as in the main programme for education, training and youth, Erasmus+.

The Digital Education Action Plan 2021-27, launched in 2020, identified two key priorities and produced measures that would help education institutions address the challenges of digital transformation. The first priority refers to the development of a high-performing digital education ecosystem and the second to improving digital skills and competences for the digital transformation. For these two priorities, the EU has launched 13 actions that will produce blended learning approaches for a high-quality and inclusive education; it will also promote the digital transformation of the whole education system, including the digital readiness of institutions and the cultivation of digital skills for teachers and students (Directorate-General for Education, Youth, Sport, and Culture, 2020).

However, many young people cannot reach a basic level of digital skills and less than 40% of educators and trainers felt ready to use digital technologies (Directorate-General for Education, Youth, Sport, and Culture, 2020).

The purpose of this paper is to demonstrate the possibility of the development of digital skills with the implementation of apprenticeships, first through the upskilling of mentors and then the application of a digital tools-oriented methodology for apprenticeships in the workplace. This assumption will be supported by the results of the pilot phase of the project DigiGo (Box 1), and it will provide important

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insights into how to close the gap between education institutions and companies when it comes to the digitally ready workforce in the context of an ever-more digitalised workplace.

Box 1. **DigiGo project**

Considering the implications of COVID-19 and the extended lockdowns as crucial factors, in 2020 the European Commission launched the Erasmus+ call for proposal Digital education readiness, for projects that would improve online, distance and blended learning in all levels of education, thus supporting a more inclusive approach to digital learning opportunities.
One of the selected projects in this call for proposals was DigiGo: Apprenticeships in the digital era, with a duration of 24 months It was submitted by CDE Petra Patrimonia, a social enterprise which is engaged in promoting the development of competences of the future workforce, in cooperation with other companies and VET centres. Six European countries are represented in this project, creating the opportunity for the discussion of evidence and results in a wider international context: France (CDE Petra Patrimonia), Greece (IDEC and IEK DELTA), the Netherlands (Inqubator), Portugal (CECOA), Malta (Eurodimensions), and North Macedonia (SABA).
The objectives of DigiGo project were threefold. First, it took into consideration the importance of carrying out apprenticeships that would require both stakeholders and apprentices to know how to use digital technologies as well as organising work-based educational arrangements. Second, it aspired to provide the necessary tools to educators, mentors, and apprentices through a unified and coherent approach to carrying out apprenticeships in the digital era. Last, the DigiGo partnership created a work-based learning methodology that would improve the digital skills of apprentices.

Source: Authors.

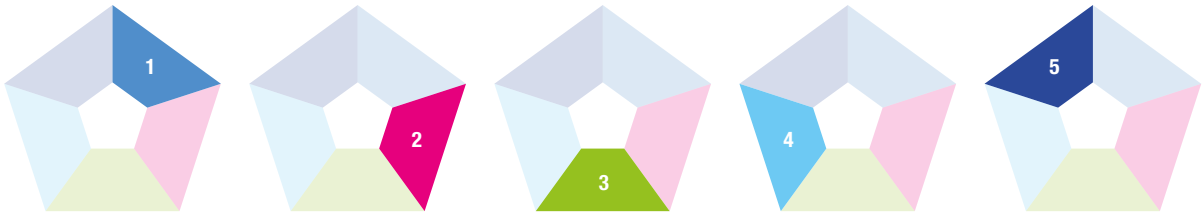
7.2. Theoretical background

7.2.1. **Digital Competence Framework (DigComp)**

Over recent years, numerous significant initiatives have been launched by the European Commission with the aim to improve digital performance in all sectors. The most well-known action is the Digital Competence Framework (DigComp) which establishes five areas and 21 competences that are mapped with four overall and eight granular levels ([62]). The five main competence areas of the DigComp framework are: information and data literacy; communication and collaboration; digital content creation; safety; and problem solving (Figure 1).

([62]) DigComp was developed by the Joint Research Centre, together with other stakeholders and policy-makers from several sectors (e.g. education, employment, training), as a scientific project. It provides information regarding knowledge, skills, and attitudes that will make people digitally empowered and a tool that will improve the digital competences in VET education (JRC, 2017). The DigComp Framework aligns with the Digital Education Action Plan 2021-2027, within the European Commission's priority A Europe fit for the Digital Age and Next Generation EU (Directorate-General for Communication, 2020). In March 2022, the JRC published the latest update to this Framework, DigComp 2.2, which features up to 250 new examples of knowledge, skills, and attitudes that apply to each competence (Vuorikari et al., 2022).

Figure 1. **Description of the five areas of digital competences**



Information and date literacy

To articulate information needs, to locate and retrieve digital data, information and content

To judge the relevance of the source and its content.

To store, manage, and organise digital date, information and content.

Communication and collaboration

To interact, communicate and collaborate through digital technologies while being aware of cultural and generational diversity.

To participate in society through public and private digital services and participatory citizenship.

To manage one's digital presence, identity and reputation.

Digital content creation

To create and edit digital content.

To improve and integrate information and content into an existing body of knowledge while understanding how copyright and licences are to be applied.

To know how to give understandable instructions for a computer system.

Safety

To protect devices, content, personal data and privacy in digital environments.

To protect physical and psychological health, and to be aware of digital technologies for social well-being and social inclusion.

To be aware of the environmental impact of digital technologies and their use.

Problem solving

To identify needs and problems and to resolve conceptual problem situations in digital environments.

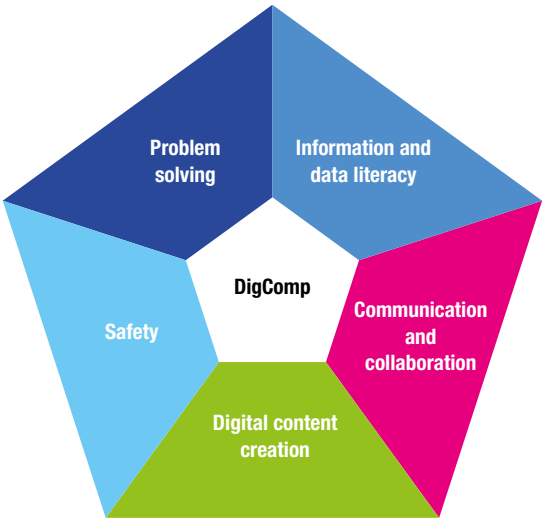
To use digital tools to innovate processes and products.

To keep up-to-date with the digital evolution.

Source: JRC, EU, 2022: 7.

Each of these five areas is assigned the relevant competences to which certain learning outcomes have been attributed (Figure 2). The 21 competences are mapped through progression levels which guide learners in order to identify the goals that they need to set so that they will improve their performance.

Figure 2. **The 21 competences of the DigComp**



Information and data literacy

1.1. Browsing, searching and filtering data, information and digital content
1.2. Evaluating data, information and digital content
1.3. Managing data, informantion and digital content

Communication and collaboration

2.1. Interacting through digital technologies
2.2. Sharing information and content through digital technologies
2.3. Engaging in citizenship through digital technologies
2.4. Collaborating through digital technologies
2.5. Netiquette
2.6. Managing digital identity

Digital content creation

3.1. Developing digital content
3.2. Integrating and re-elaborating digital content
3.3. Copyright and licences
3.4. Programming

Safety

4.1. Protecting devices
4.2. Protecting personal data and privacy
4.3. Protecting health and well-being
4.4. Protecting the environment

Problem solving

5.1. Solving technical problems
5.2. Identifying technical needs and technological responses
5.3. Creatively using digital technologies
5.4. Identifying digital competence gaps

Source: DigComp: The European Digital Competence Framework.

There are four overall levels of progression levels (foundation, intermediate, advanced, and highly specialised) and the eight granular levels are used to refine the learning outcomes. Each of these levels can be applied for different uses; in most cases, the overall levels are used for the setting of goals, while the granular levels are used for the definition of the learning outcomes (European Commission. DG Employment, Social Affairs and Inclusion, 2019).

7.2.2. Apprenticeships and digital transformation

It is widely known that apprenticeships are an effective way to upskill qualified professionals with essential competences, making it easier for individuals to enter the labour market. All parties involved benefit from this collaborative form of training: employers, apprentices, organisations, and the State itself. Apprenticeships are considered efficient in supporting the transition from school to work since they increase the employability of young people. Together with other forms of work-based learning, they combat serious problems, such as youth unemployment, low soft skills, constant changes in the labour market, social exclusion and others (ILO, 2022).

There are three different angles in discussing apprenticeships in the context of digital transformation.

The first is the digital apprenticeships, i.e. those related to the new digital jobs. According to the International Labour Organization, digital apprenticeships are vocational training programmes aiming to cultivate the skills and knowledge that are linked to digital tasks, such as digital marketing or software engineer. They are considered an important element in the upskilling of individuals since they combine workplace training with classroom teaching, thus homogenising the theoretical and practical experience they offer (ILO, 2022).

The second is virtual apprenticeships, i.e. those that are conducted either entirely remotely or in a hybrid way. COVID-19 has reshaped the way that apprenticeship programmes were delivered, bringing the need for remote or hybrid work and this tendency has also affected apprenticeships. Some companies started to invest more in developing the digital skills of apprentices and the delivery of such training was also adapted to a more hybrid/virtual model, combining workplace learning through distance education and telework. Virtual apprenticeships were also a way of digitalising apprenticeship programmes; they are conducted remotely and they require the use of digital tools to enable apprentices to communicate with their trainers and accomplish their tasks (Cedefop, 2022). They are more flexible because they better meet the needs of individuals, increasing diversity and inclusion. Such apprenticeships also help employers choose from a variety of applicants and recruit in remote areas to fulfil educational demands (European Commission. DG Employment, Social Affairs and Inclusion, 2021). Some companies did not only stick to the specific professional field of study, but also invested in broader qualifications, thus improving their career opportunities as well as the company's performance (Cedefop, 2022).

The third is what we call digitalisation of apprenticeships that can defined as apprenticeships (in any sector, not necessarily in IT industry) that have as objective to develop digital skills. This digitalisation process of apprenticeship programmes is a challenge not only for apprentices, but also for companies because they still do not know how to incorporate the acquisition of digital skills in established apprenticeship programmes. According to recent studies, 32.2% of company trainers lack extra support in terms of digital teaching and learning approaches (Flake et al., 2019). At the same time, many organisations do not possess the technical infrastructure necessary to digitalise their apprenticeship programmes. This infrastructure is, in many cases, very expensive, making it difficult for both organisations and apprentices to buy such equipment. Technical infrastructure is not the only problem when it comes to difficulties in digitalising apprenticeships; some organisations have not adopted, in general, a strategy which will facilitate this process. An illustrative example of this situation was the lockdown to prevent the spread of COVID-19, where many companies suspended their apprenticeship programmes, or they did not know how to digitalise them (ILO, 2022).

7.3. Digitalisation of apprenticeships: methodological approach

7.3.1. **Apprenticeships in the digital era: background research**

The research conducted in the context of the DigiGo project explored the role of digital technologies in a more sustainable and digitalised economy, in the context of apprenticeship implementation.

The project first identified the current situation in terms of the digitalisation of apprenticeships. The results were achieved through a threefold methodology targeting VET teachers and company mentors and employing the following research methods:

(a) desk research on the legal framework on apprenticeships, current practices, key actors and stakeholders, and the state of digital skills training;
(b) five focus groups at the national levels, gathering in total around 60 participants;
(c) an online survey gathering around 150 responses across six countries.

Many survey participants did not know about the DigComp framework. Although most respondents acknowledged the importance of digitalising apprenticeship programmes and focusing on the development of digital skills in them, none knew how they could implement such apprenticeships as they have not received the appropriate training from their organisations.

Even though the new generation (Gen Z) is very familiar with digital technologies, it does not know how to use them in a professional context.

The survey indicated that VET institutions must upgrade both the digital tools and the approach re-

quired to nurture the digital skills of apprentices, especially when overarching curricula are not updated with richer digital-based activities.

Within the scope of DigiGo, it was essential to produce a methodology that would empower both teachers/trainers and apprentices to develop the digital competences that are needed for the job market. Certain key points were taken into consideration, such as an effective way to trigger the motivation of apprentices themselves while focusing specifically on the digital skills that teachers and trainers valued as necessary, such as information management, digital cooperation and protection of personal data.

The findings from the survey on the status of digital skills development through apprenticeships cannot be considered satisfactory. Extensive work must be carried out in different areas and sectors, from the role of the institutions involved to the actual implementation of apprenticeship programmes.

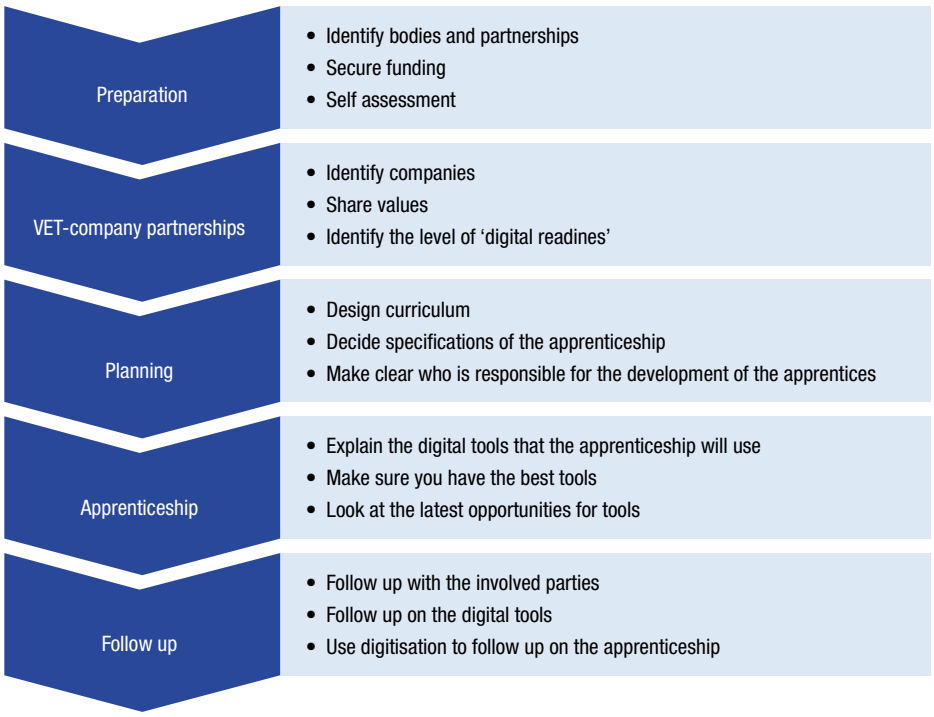
The DigiGo project consortium developed a methodology to support actors to digitalise apprenticeships.

7.3.2. **The DigiGo methodology**

The DigiGo methodology (DigiGo, 2022) assists teachers, trainers and mentors in helping apprentices develop digital competences through a methodological framework, training, useful tips and examples. Project outputs included an e-learning programme for VET teachers and company trainers/mentors involved in the organisation of apprenticeships and a collection of success stories that were published in an e-book as well as videos. The methodology offers valid information and explains in detail which skills should be built and how. Virtual apprenticeships also fell under the scope of these objectives since distance working is inextricably linked to the use of digital tools to coordinate work.

The digitalisation process of apprenticeships and the definition of the learning objectives were based on the DigiComp framework, focusing on the development of apprentice digital competences. The content of the methodology consisted of guidelines, instructions, practical examples, and templates: it comprised 5 steps (Figure 4).

Figure 4. **Steps of the DigiGo methodology**



Source: DigiGo project.

The first step of the DigiGo methodology was to prepare the ground for the digitalisation of apprenticeships. For apprenticeship actors initiating such a process it was important to have support bodies and partnerships in their own network which would help to mediate between VET education and the business world. These bodies and partnerships would allow sharing both experiences and tools to improve the procedure. Preparation also involved exploring funding possibilities regarding the digitalisation of apprenticeships and securing digital resources and tools. A self-assessment of the VET institution or the company in relation to its capacity regarding the digitalisation process contributed to the identification of strengths and areas for improvement. Through this self-assessment, the VET institution or the company could then take appropriate steps to train their teachers or trainers/mentors in the use of digital tools; they would then assist apprentices.

The second step of the methodology was to form VET school and company partnerships. This involved the identification of companies that could host apprenticeships and could contribute with expertise in using digital tools in the training process as well as developing apprentices' digital skills. VET institutions also needed to assess their own methodologies for preparing apprentices for their working and learning experiences in the companies. Once it was clear whether an institution or company could offer an apprenticeship that would develop the digital skills of students, it was important to ensure that the partnership had similar values. In respect of the digital aspect of VET school and company partnerships, there had to be a clear understanding of what one organisation could offer the other to fill their gaps.

The last point in this step was to make clear what the company expected from apprentices. This point did not concern learning goals for the workplace training, but the work ethic and personality traits that apprentices had to identify to see if they matched the company culture.

At the planning phase (step 3), companies together with VET institutions defined the intended learning outcomes, as well as the practical aspects, like the digital tools to be used and other arrangements. The definition of the learning outcomes was based on the five main areas of the DigComp framework.

Another important aspect of the planning phase (step 3) was the assignment of a company trainer/mentor who had already received training in the use of digital tools and was familiar with the DigComp framework to assist apprentices. The company trainer/mentor could decide on the digital competences from the five areas and adapt the workplace training programme, after identifying the level of digital skills and interest of apprentices in the five main areas.

Supporting virtual apprenticeships was recommended, as they would develop apprentices' digital skills and allow them to become more autonomous in managing tasks. However, it was essential for companies and VET institutions to establish an online platform so that they could keep up to date with apprentice progress and plan regular meetings.

The implementation of the apprenticeship workplace training (step 4) was based on the use of different digital tools, either in communication and daily business operation or for specific tasks. It was important to explain to apprentices the use of the digital tools and make clear their added value to the learning programme and the apprenticeship. It was also important for apprenticeship providers to train apprentices to use the tools that were relevant to the learning outcomes of the apprenticeship, since they were based on the areas displayed on the DigComp framework. For example, in apprenticeships focused on content creation (area 3 on DigComp), host companies could encourage apprentices to use digital platforms, such as YouTube or Loom that are related to creating content online.

It was also essential to plan regular appointments between the apprentice and the representatives of the VET institution and the company. This procedure would strengthen cooperation between the institution and the company and there would be a better overview of apprentice performance. Regular appointments would allow exchange of advice for the provision of digitalised apprenticeship between these two entities.

The last step concerned a follow-up system after the workplace training, to help with the further development of the apprenticeship, and detail the value of the programme (if its goals were met). This system involved all parties in two steps:

(a) follow up the use of the digital tools by the parties involved. As digital tools can change and new ones come out quickly, it was important to follow up on how apprentices, institutions and companies experience these tools. Then it can be seen if the experience matched the objectives of the apprenticeship and, if not, it look for new opportunities;
(b) follow up the progress of apprentices, also via digital tools, e.g. analytics, to see how they were doing at certain companies, as well as at the VET institutions. This follow-up would not only show whether apprentices were able to use some digital tools but also if they had developed the skills identified in the five main areas of the DigComp framework.

7.4. Pilot and evaluation of the DigiGo methodology

7.4.1. **Pilot**

The methodology was piloted with two to four apprentices for each partner, and each pilot lasted 2 months. The methodology was implemented in apprenticeships that lasted from 2 months to 2 years. The partner organisations that are VET centres (CDE Petra Patrimonia, SABA, IEK DELTA, CECOA) piloted the methodology with apprentices that they sent to companies, while the rest of the partners (IDEC, Inqubator and Eurodimensions) piloted it with apprentices of companies with whom they have close and direct cooperation. The table below provides information about the digital apprenticeships that were conducted in the context of the DigiGo project.

Table 1. **Pilots per partner organisation**

Country	Apprentice – field of studies	VET provider	Host company	Duration
Portugal	Beauty, Massage and Well-Being Technician	CECOA	Dermstetik	5 months
Portugal	Beauty, Massage and Well-Being Technician	CECOA	BodyConcept	2 months
Greece	Programming, Game Development	IEK ALFA	IDEC	6 months
Greece	Software Development	S. E. I. M.	IDEC	7 months
Greece	International Relations	University de Deusto	IDEC	7 months
Greece	Public Administration	Universidad de Castilla-La Mancha	IDEC	4 months
Greece	Marketing School	IEK DELTA	IEK DELTA (Marketing Department)	7 months
Greece	Graphic Design Department	IEK DELTA	IEK DELTA (Marketing Department)	9 months
France	European studies	Université de Cergy-Pontoise	CDE Petra Patrimonia	2 years
France	(Not stated)	CFA Neos	Cooperative d'Initiatives Jeunes	1 year
Netherlands	(Not stated)	NHL Stenden University	Inqubator Leeuwarden	2 months
Netherlands	(Not stated)	(Not stated)	Inqubator Leeuwarden	2 months

Country	Apprentice – field of studies	VET provider	Host company	Duration
North Macedonia	Business Administration	Private high school SABA	Touristic agency Kamelija	4 months
North Macedonia	Business Administration	Private high school SABA	Touristic agency Kamelija	4 months
Malta	(Not stated)	University of Malta	Malta Business Bureau	Ongoing employment as full time
Malta	(Not stated)	University of Malta	Malta Business Bureau	4 months
Malta	(Not stated)	University of Malta	Malta Business Bureau	Ongoing since February 2023

Source: Authors.

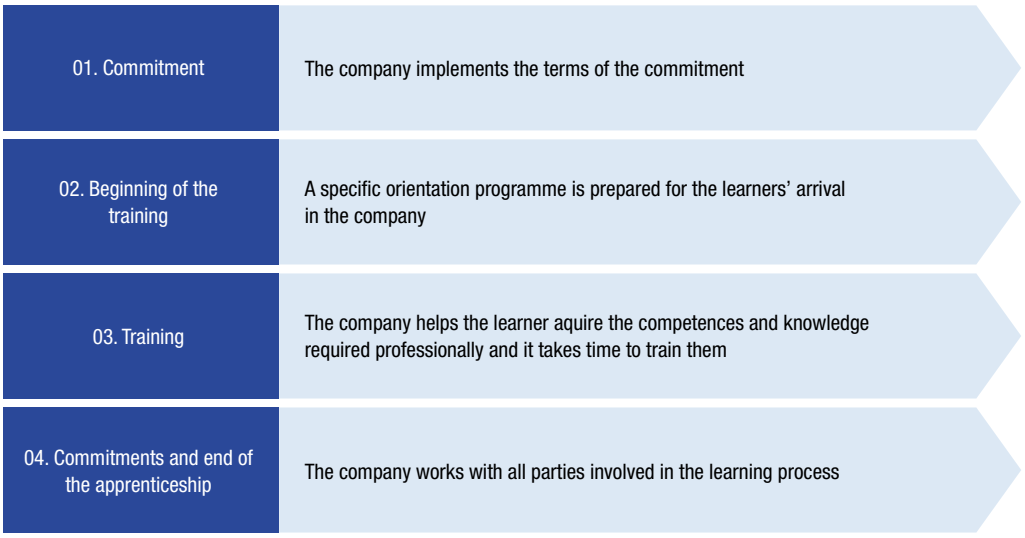
7.4.2. **Evaluation of the DigiGo methodology**

The methodology was evaluated by both trainers/mentors and apprentices based on the areas of the DigComp framework.

7.4.2.1. *Evaluation by trainers/mentors*

During the apprenticeships, the trainers/mentors followed a quality improvement process which involved using the quality improvement tool. This tool comprised indicators that evaluated the quality of the apprenticeship training, offering tips for further improvement. The companies had to assess each ranking in an objective way, 1 being the lowest level and 5 being the highest.

Figure 5. **Criteria of self-assessment for the providers of the training**



Source: DigiGo project.

The first evaluation point was related to the commitment of companies. They had to report whether criteria were defined in relation to the expected profile of apprentices, and whether they interviewed the applicants that were selected. This process would help identify the digital skills level of apprentices so that companies could then shape the workplace training. Companies also had to state whether they explained the working conditions to the applicants, together with any other contractual clauses.

Companies then had to report whether they prepared a specific orientation programme, if trainers/mentors were designated according to the DigiGo methodology, and if apprentices were aware of the importance of work-based learning in an environment that requires the use of digital tools.

The third point had to do with the core training stage. Companies had to report whether they helped apprentices acquire the necessary digital skills and knowledge according to the areas of the DigComp Framework. More precisely, they had to define whether trainers/mentors provided frequent feedback to apprentices and whether their tasks were checked from a qualitative and quantitative point of view so that they would be discussed at a later stage. Companies also had to report if apprentices had clearly understood the importance of apprenticeship training for developing digital skills.

The fourth point was related to the overall commitment of companies in the apprenticeship programme. They had to assess whether they provided trainers/mentors with the essential time and financial and digital tools for their training and whether they supported apprentices during this experience.

7.4.2.2. *Evaluation by apprentices*

Apprentices filled in a questionnaire at the start and at the end of the workplace training, assessing their level of digital competences at each point. They had to assess their level of understanding on the competences mapped on the DigComp Framework and also fill in a second questionnaire which would help understand their performance. This meant they could see which skills they needed to improve further after the end of their apprenticeship, so helping them become more responsible for their own future learning paths.

7.5. Results

The results of the pilots were very positive. Although outcomes varied across partners, all led to the same result: the DigiGo methodology was proven to be very helpful in supporting the digitalisation of apprenticeships in VET schools and companies.

Apprentices managed to refine their digital skills and learn how to use new digital tools that are needed in the workplace. Specific outcomes can be related to the Digital Competence Framework.

(a) Information and data literacy: apprentices reported that they learned how to search for data, information, and content in digital environments. At first, they were shown how to access these data and then they became competent in proposing personal search strategies. They were also able to carry out an evaluation of the credibility and reliability of different sources of data and they could store them for retrieval.
(b) Communication and collaboration: apprentices learned how to use a variety of digital tools to interact with their trainers/mentors and collaborate with their colleagues when they were working remotely. They also became competent in adapting communication strategies according to the cultural and generational aspects of each audience.
(c) Digital content creation: apprentices learned how to apply copyright and licences related to digital information, and they showed respect towards these rules when working with digital content. They were also able to customise digital environments according to their personal needs.
(d) Safety: apprentices learned how to protect themselves and the devices from malware content when navigating online or when downloading unprotected files. They were in a position to select safety measures and explain to others appropriate ways to avoid threats related to physical and psychological well-being when using digital media.
(e) Problem-solving: apprentices were able to differentiate the technical problems and choose the right tools to solve these problems. They were also capable in helping others overcome technical problems when navigating through digital environments.

Although most of these actions are considered easy to implement, in practice they are more complicated, and require a lot of knowledge related to managing digital content in the workplace. Before the programme, learners had basic knowledge about these competences, so it was an important experience for them to learn how to use digital media in a professional context.

On the trainer/mentor side, based the evaluation provided from the quality improvement tool, it was shown that the objectives of apprenticeship training had been attained and the trainers/mentors were designated according to the DigiGo methodology. They claimed that they offered apprentices adequate information about the learning outcomes and that they supported them throughout the apprenticeship. They also stated that the methodology was applied consistently to this training experience.

7.6. Reflections

The methodology developed within the DigiGo project was generally suitable for supporting the digitalisation of apprenticeship programmes. Apprentices received innovative quality training, as the methodology helped develop their digital skills. It also helped participating companies to digitalise their apprenticeship programmes. The companies established an online platform to support their involvement, so that there would be effective communication between apprentices and trainers, and the work would be coordinated effectively.

Another important element was that the guidance and instructions provided by trainers/mentors was proven to be effective. They supported apprentices in how to solve digital problems and they made them feel comfortable when asking for help. The supervision that was offered by someone more experienced encouraged apprentices to learn more things about these tools. The trainers/mentors demonstrated professionalism, cooperation, and patience so that apprentices would feel comfortable with them. They were also able to recognise the strengths and weaknesses of apprentices so that the training would be adapted to their needs.

The adjustment of apprenticeships in the context of the DigiGo programme did not only benefit the students' digital skills; they also cultivated other competences that are important for both professional and everyday life. Apprentices used digital platforms that helped them organise and coordinate their work. They enhanced their creativity through creating graphic materials for promotional purposes, and they developed their communication skills as they used apps to collaborate with their trainers/mentors and colleagues. They improved their critical thinking since they learned how to identify secure pages and how to avoid parasitic content online.

However, given the fact that these apprenticeships were conducted on a pilot basis, there are bound to be some areas for improvement. In their evaluation, all apprentices indicated that the methodology had to be implemented for more than 2 months, especially for those that focused on several areas of the DigComp framework. Increased duration would ensure that there would be more time for them to develop their digital skills and become familiar with the digital tools that they would use. At the same time, some apprentices claimed that lengthening the apprenticeship programme would allow them to invest in more challenging projects and tasks that would stretch their capabilities and require them to learn new skills.

Since the DigiGo apprenticeships were also conducted virtually, there were some issues related to connectivity problems. Sometimes, internet connection was poor and, consequently, communication with the trainers/mentors was not immediate and the work delivered late. Although apprentices claimed that distance learning helped them become more autonomous, there were times that they felt that remote work was not of the same quality as when requiring physical presence; they supported that, in physical work, the communication was more direct when they needed guidance and they felt more confident in what they were doing. They also noted the need for a system to connect them with experienced professionals through meetings, events, or mentorship programmes. This procedure could potentially contribute

to their future growth since it would provide valuable insights and expand their professional network.

Overall, apprentices learned how to work in an environment based on hybrid way of working and how to manage new tools to make their tasks more relevant to the evolution of the digital era. The experience helped them grow professionally and know their potential in the workplace.

7.7. Conclusions and recommendations

Through the research conducted in the framework of the DigiGo project, it is concluded that the digitalisation of apprenticeships programmes is gaining prominence: it is important to digitalise apprenticeship programmes to meet the needs of the current era and develop skills which are essential for the labour market. This process will help apprentices better understand their potential and create a strong professional portfolio.

However, digitalisation of apprenticeship programmes calls for several changes.

(a) Companies should upgrade workplace training/curricula so that they can host digital apprenticeships and provide apprentices with useful knowledge. This also means that they should modernise their infrastructure by buying new equipment and they should adopt a strategy that supports the development of digital skills in training programmes.
(b) Companies should also be able to provide quality apprenticeship programmes that would focus on digital skills development. Apprentices should be introduced to digital platforms and tools that are relevant to their profession and position. This introduction should be done gradually, since many of these platforms may be new to them. It is recommended to implement a digital model of working to increase apprentice autonomy; this can be done either by working inside the company's premises 2 or 3 times a week or completely remotely.
(c) Given that the role of teachers and trainers is essential in helping apprentices develop their digital skills, companies must provide training to their staff so that it can help apprentices develop these skills.
(d) A system should be put in place to allow feedback and evaluation of the digitalisation of an apprenticeship programme by both trainers/mentors and apprentices. Transparency on this issue is required to identify the areas that need further improvement (ILO, 2022);
(e) It is important to close the gap between VET institutions and companies. These two entities should share a closer connection and they should collaborate effectively when conducting the apprenticeships. Goals and learning outcomes for apprentices should be relevant not only to the technical field studied but also to the needs of the current digital era (Directorate-General for Employment, Social Affairs and Inclusion, 2017).

The DigiGo methodology reflects all these needs and offers key elements for creating a framework that supports digitalisation of apprenticeship programmes.

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CHAPTER 8.

The digital office simulation LUCA from the perspective of teachers and learners: first findings of usability analyses

By Sophia Gentner ([63]), Sabrina Ludwig ([64]), Anke Braunstein ([65]), Christian Mayer (23), Viola Deutscher (25), Andreas Rausch (24), Jürgen Seifried (23)

8.1. Introduction

The digitalisation of business processes is changing the world of work and hence the competence requirements in commercial workplaces. Less emphasis is being placed on routine activities, with a shift towards more complex tasks gaining significance (Frey and Osborne, 2017). Problem-solving skills are becoming increasingly important for mastering complex tasks (Funke et al., 2018). To prepare apprentices in the commercial sector for their future workplace, vocational education and training (VET) needs to address not only routines but also problem-solving skills (Rausch et al., 2021). Digitalisation is also changing learning and instruction within VET. There are many options available to teachers and in-company trainers for the design of technology-enhanced instruction. According to Puentedura (2006), the use of technology can involve different levels: substitution, augmentation, modification, and transformation (SAMR model; for a critical discussion of the model see Hamilton et al., 2016). Meta-analyses confirm the potential of digital tools for promoting learning (for elementary education see Chauhan, 2017; for mathematics and science learning see Hillmayr et al., 2020; for effects of simulation-based learning in higher education see Chernikova et al., 2020). However, few studies are available in the field of VET (e.g. Schumann et al., 2022).

One significant approach to designing digital teaching and learning processes for VET is the use of authentic simulations. Such simulations simplify real-world situations and provide a wide range of opportunities to learn (Plass & Schwartz, 2014). Authenticity is defined as the extent to which the characteristics of the simulated learning environment are similar to those of the real-life environment (Gulikers et al., 2004). A high level of authenticity can be beneficial in terms of applying knowledge, skills, and attitudes gained in the simulation to real-life situations (Gulikers et al., 2004). In the business domain, office simulations provide an environment where learners can experiment, learn by doing, receive feedback, and thus acquire relevant skills for their future office workplace (Caruso, 2019). Office-simulations may also provide a means to integrate learners socially into a business environment comprising colleagues, superiors, clients, and suppliers, thus enabling a heightened level of social immersion (Braunstein et al., 2022).

In this chapter we introduce a specific simulation for designing instruction in VET and discuss results regarding its usability. Within the project Problem-solving analytics in office simulations (PSA-Sim) ([66]),

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the office simulation LUCA (in the following LUCA) was developed. LUCA is primarily designed for apprenticeships in the commercial sector, particularly targeting prospective office and industrial clerks. They typically complete a 3-year training course of dual vocational education and training (at European Qualifications Framework, EQF, level 4) in Germany (hereafter referred to as commercial apprenticeships). LUCA aims to support these apprentices in acquiring the domain-specific problem-solving competences necessary for everyday working life. They work on complex tasks (authentic work scenarios) in the office simulation and instructors create these work scenarios themselves. LUCA is suitable for both the school-based and the in-company training segment of apprenticeship (see Section 8.2.2. for the application possibilities), although in this paper we focus on the use of LUCA in the school-based part of the German dual apprenticeship ([67]).

Whether simulation-based learning environments such as LUCA are used in commercial apprenticeships depends on various factors. For instance, the relevance of perceived usefulness and ease of use of technology are important. These factors have been addressed in the context of the Technology acceptance model (TAM) (Davis, 1985, for the educational context see Antonietti et al., 2022; Scherer et al., 2019). The concept of user experience is also an issue. This includes the subjective evaluation of an application, which is related to individual prior knowledge, experience, or preferences (Schrepp et al., 2017a, 2017b). Besides the perception of the software characteristics by end users, other contextual factors are crucial for implementing new products in educational practice. Characteristics of the teaching staff (e.g. expertise, motivation), the individual school or educational institution (e.g. resources), and the environment, as well as implementation support strategies (e.g. planned support) and learner characteristics (e.g. engagement), all affect the implementation process (Century & Cassata, 2016; Schrader et al., 2020).

This paper ([68]) presents findings on the experienced usability of the office simulation LUCA, the experienced authenticity of the content, and factors that facilitate or hinder implementation in teaching practice. In the following, the functionalities of LUCA and possible applications in commercial apprenticeship will be presented (Section 8.2). Subsequently, results on the perception of the software from the learner's (Section 8.3.1) and teacher's perspectives (Section 8.3.2) are reported. The contribution concludes by discussing the findings and limitations (Section 8.4).

8.2. LUCA: simulation-based teaching and learning

LUCA enables simulation-based teaching and learning. It is web-based software that requires users to have a computer or laptop, an internet browser, and internet access. The learning environment is free of charge as an open educational resource (OER). Its functions, and the possible applications in commercial apprenticeship, are described in the following.

8.2.1. **Structure and functions of LUCA**

The development of LUCA is rooted in didactic considerations, particularly drawing from the 4C/ID model (van Merriënboer & Kirschner 2018; for an in-depth exploration of 4C/ID principles within LUCA, see Rausch et al., 2021). The objectives of LUCA include a range of software components and functionalities that act as enabling learners to perform the following tasks.

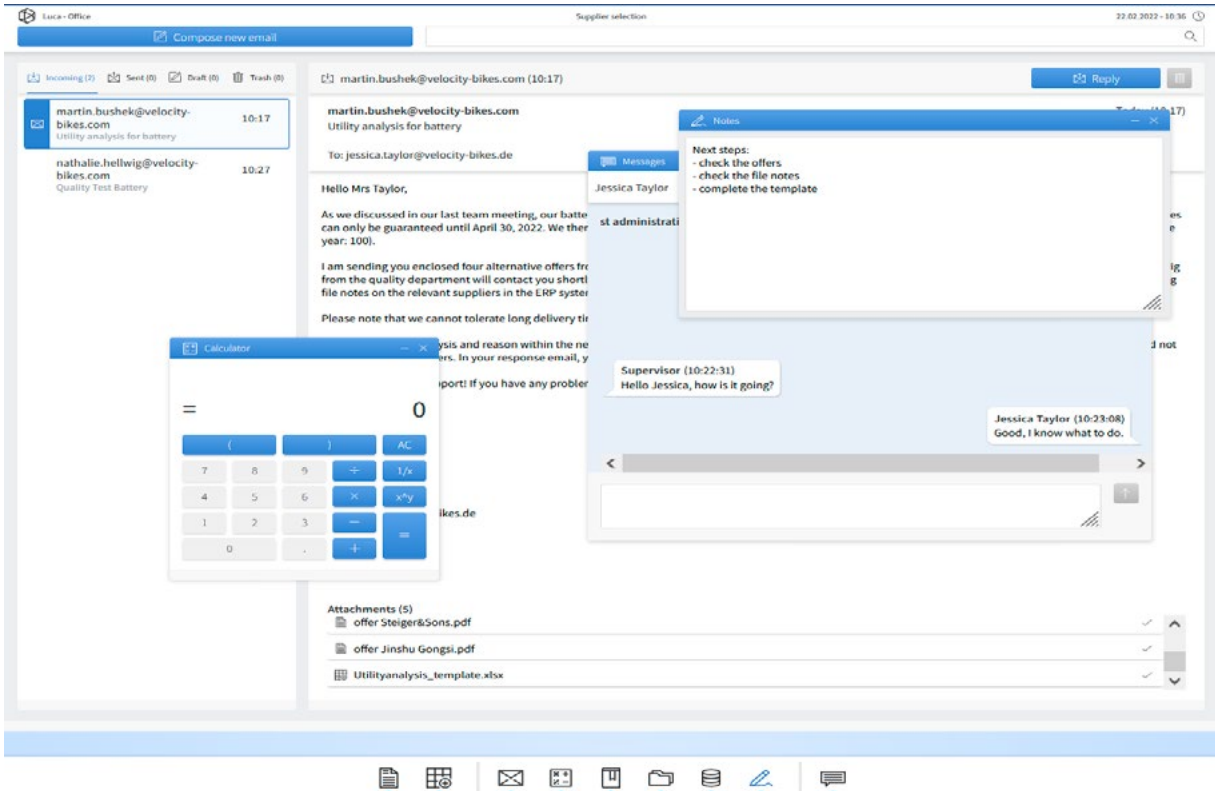
8.2.1.1. *Tackle complex authentic tasks with available supportive information*

LUCA Office offers learners a simulated workplace in a commercial setting (Figure 1), where they work on authentic work scenarios using typical office software tools. These include an email client, a

([67]) Due to the focus on the school-based part of apprenticeship, the terms 'teachers' and 'learners' are used in the following.
([68]) This contribution is based on an article previously published in a German journal (Gentner et al., 2022) and has been extended to include additional findings.

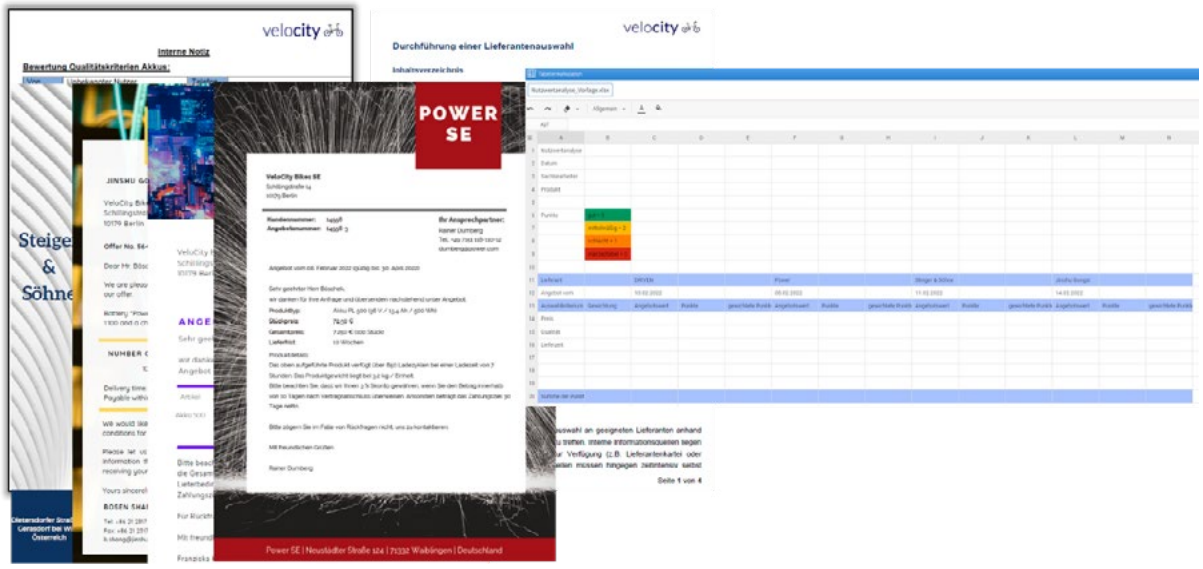
spreadsheet, a calculator and notepad, a file system, a word-processing programme, and enterprise resource planning (ERP) software. The scenarios developed mirror common business processes and commence with a fictional email message from a person, such as the manager of the simulated company where the learners are employed, requesting the execution of a specific task. For instance, in the task 'supplier selection' (developed within the research project, Deutscher et al., 2022) the learners take the role of an employee of the company VeloCity Bikes SE, a fictional German bicycle manufacturer. They receive an email from the head of the purchasing department and are asked to run a utility analysis for bicycle batteries. Scenarios may include additional materials, such as business documents attached to emails, spreadsheet templates, and text documents. In the case of the 'supplier selection', four offers for batteries, a spreadsheet template for the utility analysis and several notes on the requirements for the bicycle batteries are provided as email attachments (Figure 2). Further relevant information is available in the file system as well as in the ERP system. Learners must sort through these materials and select relevant information to complete the utility analysis and choose a supplier. Within the simulated office environment, learners operate in a secure setting that fosters practical engagement in authentic tasks, allowing room for mistakes as a valuable element in the learning process.

Figure 1. **LUCA Office: user interface for learners to process work scenarios (opened tools: email client, calculator, notepad, messenger)**



Source: Screenshot from the LUCA Office.

Figure 2. **Sample documents from the scenario 'supplier selection'**

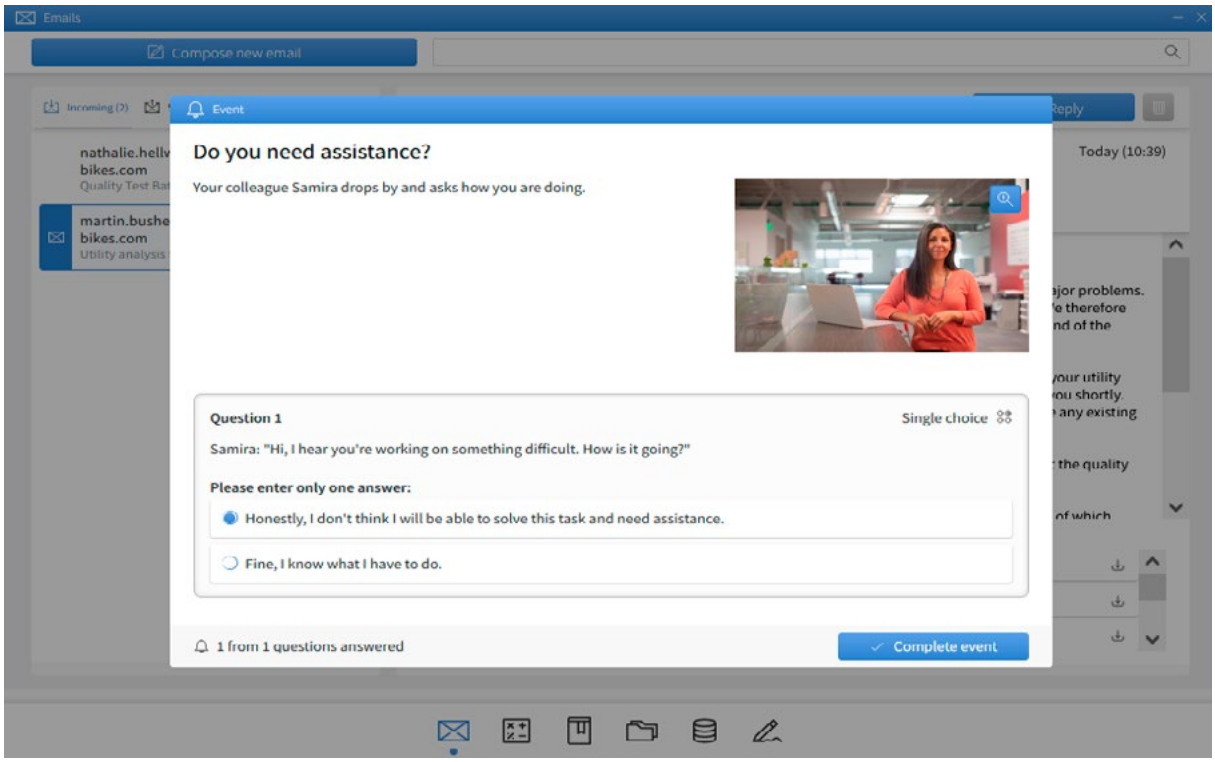


Source: Screenshots of documents developed in the research project.

8.2.1.2. *Benefit from individualised support (prompts or scaffolds) through automated log data analysis*

Various functionalities are available to enable adaptive learning, address learners' different needs and abilities, and effectively support them in their work processes. An integrated log data-based real-time analysis allows the automated delivery of predefined emails (interventions) with additional information if certain trigger conditions are met (e.g. relevant documents were not opened, a specific value is missing in the spreadsheet; for an overview of all individual support options for the task supplier selection see Deutscher et al., 2022). In addition to assistance, the intervention email can also include additional learning suggestions. Events provide further possibilities for interaction and adaptation: events are overlays that appear at predefined times during a scenario and include a heading, a short text and pictures or even a video. They can also include short questionnaires that require a reaction. Events can be used to collect self-report data on mental processes such as emotions and motivation (see embedded experience sampling; Rausch et al., 2019) or to implement learning prompts (Wirth, 2009). Within our scenarios, these events are embedded into the storyline as they simulate typical social interactions in the workplace, such as a colleague who drops by the office and offers support (Figure 3). If a need for support is indicated in response to the event, an intervention email can be linked to this response. Learners can also use an integrated messenger to communicate with the teacher if needed. The scenario ends when the learners respond to the first email after completing the work task.

Figure 3. **Event to request assistance which appears during the procedure of the scenario**

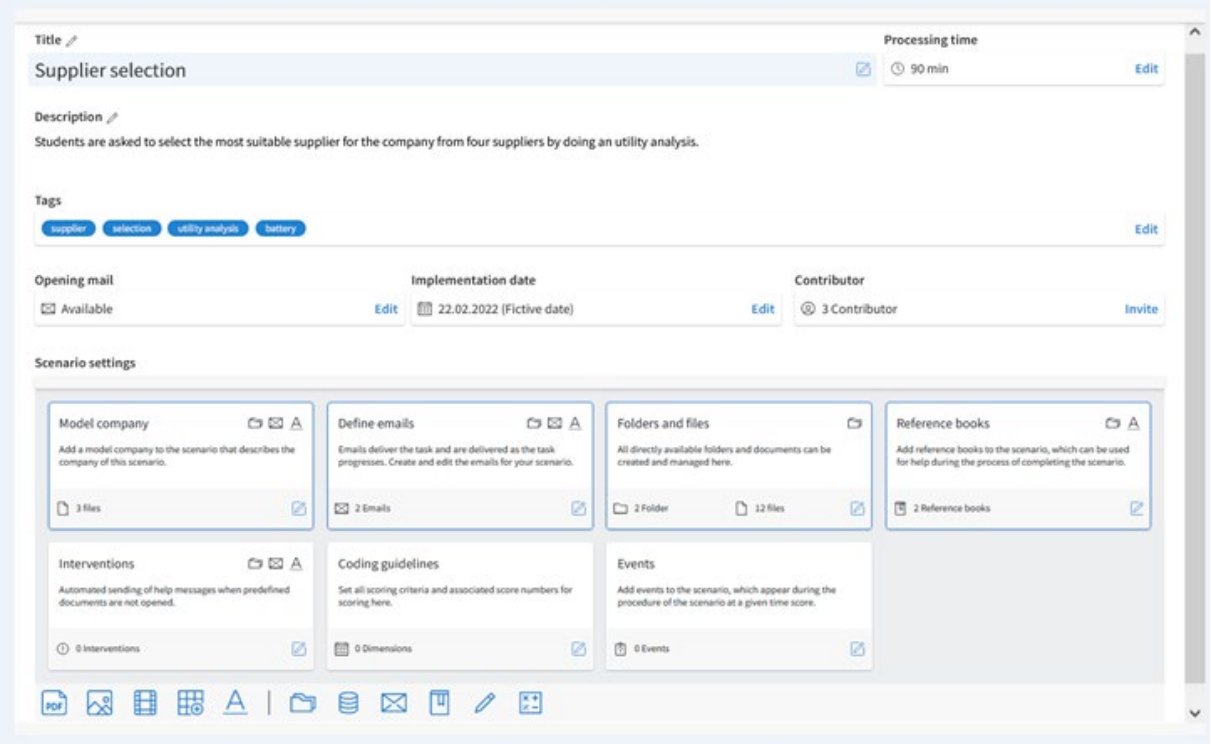


Source: Screenshot from LUCA Office.

8.2.1.3. *Have their learning processes monitored in real-time to facilitate ad hoc assistance by teachers*

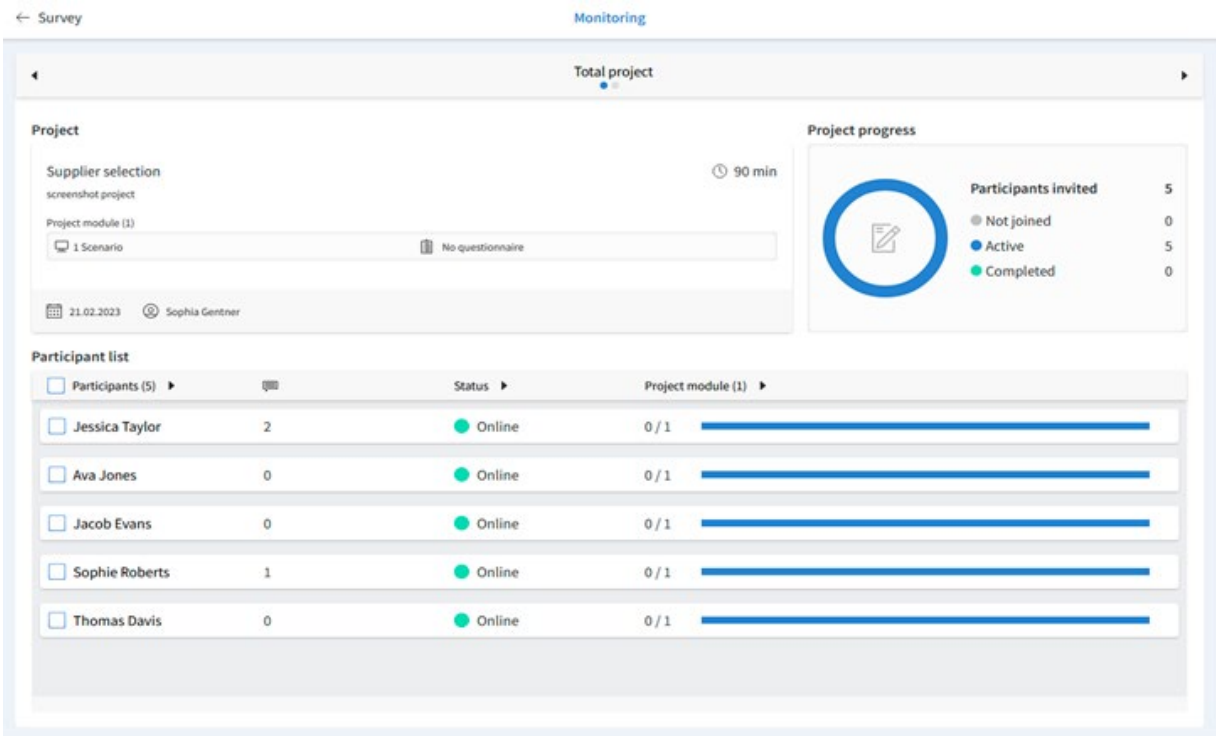
LUCA offers several useful features for teachers. They can either create new work scenarios themselves or customise existing scenarios for their lessons without any programming skills (Figure 4). Subsequently, they can share their self-created scenarios with fellow users, thereby leveraging collaborative synergies in lesson preparation by using the benefits of shared resources. The authoring environment (LUCA Editor) for creating work scenarios offers various design possibilities, such as tailoring the complexity of the task. Teachers can determine the content of emails in learners' inboxes as well as their sending times, allowing them to deliver additional tasks, assistance or realistic distraction during the task processing, and thus simulating an authentic inbox. To enable learners to immerse themselves in an authentic setting, the work scenario can be incorporated into an existing or individually designed virtual company. Teachers can monitor the learners' work processes in real-time in the LUCA monitoring. Different information is available on the group level (e.g. progress in the project; Figure 5) and on the individual level (e.g. individual tool usage; Figure 6). If teachers notice peculiarities (e.g. if someone spends all their time in the email client instead of in the spreadsheet or document viewer), they can provide ad-hoc assistance via a chat tool. Once the project has been completed, teachers can score the learners' solutions using pre-defined scoring rubrics and (partially) automated coding rules, and then provide detailed feedback (Ludwig et al., 2021).

Figure 4. **LUCA Editor: user interface for teachers for editing scenarios**



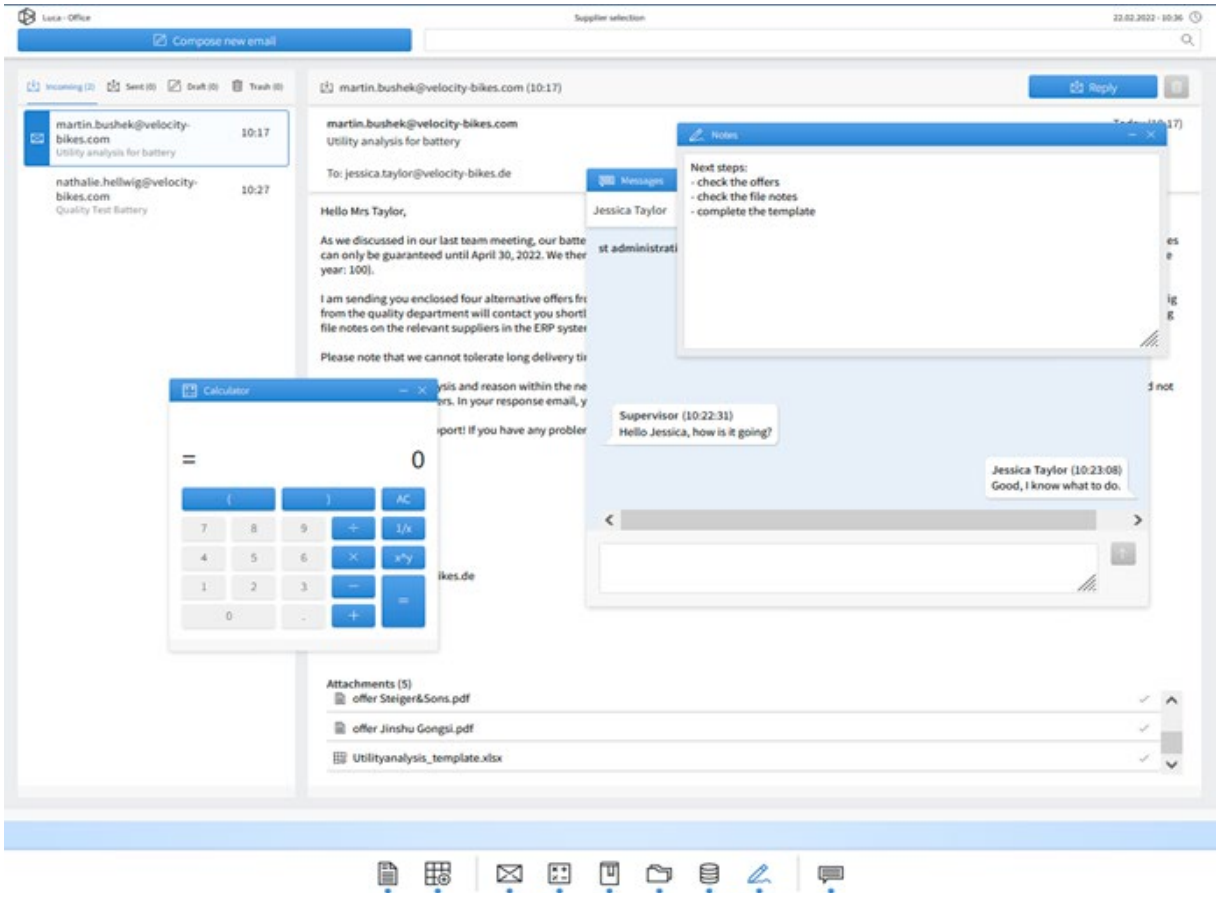
Source: Screenshot from the LUCA Editor.

Figure 5. **LUCA Monitoring: real-time information about the work progress of the participants (group level)**



Source: Screenshot from the LUCA Monitoring.

Figure 6. **LUCA Monitoring: real-time information about the tool usage of one participant (individual level)**



Source: Screenshot from the LUCA Monitoring.

8.2.2. Using LUCA in commercial apprenticeship

LUCA offers various application possibilities. On one side, it finds application within classroom teaching, whether within the school-based component of apprenticeship or during in-company training segments when provided by participating companies. It can be used in both face-to-face settings and synchronous distance learning. On the other side, learners can use the office simulation location-independent and asynchronous as a self-learning environment, supported by predefined assistance.

The appropriate time for using LUCA in the classroom or corporate training setting depends on the design of the scenarios and the desired learning objective. For instance, utilising LUCA may contribute to attaining professional email correspondence skills, honing abilities in cost calculation, or practising sound decision-making in authentic business scenarios (e.g. the selection of a new supplier). The minimum requirement for a scenario is an email that learners receive and respond to. Complexity can be tailored to the desired level by incorporating additional materials and tools. Therefore, scenarios can be created to introduce a new topic and highlight its relevance, to develop new knowledge, or to practice what has already been learned theoretically. More complex scenarios allow learners to go through complete work processes and use previously acquired skills comprehensively.

In addition to its function as a learning environment, LUCA can also serve as an assessment environment. The scoring functions (e.g. automated coding rules, see above) can support the rating of tasks. These features also simplify large-scale assessments, making the office simulation suitable for research purposes.

Various offers are available to facilitate the use of LUCA in commercial apprenticeships and assist

teachers in getting started. Free digital workshops are offered to introduce the simulation-based environment. In the approximately 3-hour workshop, participants first take on the role of learners by exploring the environment through a work scenario. Subsequently, the software functions and the didactic possibilities are presented, and the participants could trial the different functions and create their work scenarios. A comprehensive manual is available, with step-by-step instructions for using the various features, and is supplemented by several video tutorials. Through these materials, independent familiarisation with the office simulation is also possible. The evaluation of the workshops shows that many of the participants are thinking about implementing LUCA in their classrooms. About 87% of the previous workshop participants agree with the statement 'I can very well imagine using LUCA in my classroom in the future' (31% fully agree, 56% somewhat agree).

8.3. Perception of the office simulation in commercial apprenticeship

To gain insight into perceptions of the simulation-based learning environment of stakeholders in commercial apprenticeship, it is important to consider two distinctive perspectives: both the learners' and the teachers' perspectives are of interest. The different approaches used to examine the perceptions of the two groups and the findings obtained are described below.

8.3.1. Learner perspective

Investigating the learners' perception of the platform, their user experience was assessed. For this purpose, a short user experience questionnaire (adapted from Schrepp et al., 2017b) was used with approximately 700 commercial apprentices (in Baden-Wurttemberg, Germany) who had previously worked on the scenario 'supplier selection' in LUCA Office (beta version), as part of their school-based training. The participants were 21.4 years on average, with the majority being female (64%). The questionnaire includes five items (pleasant/unpleasant, interesting/not interesting, understandable/unintelligible, easy/complicated, clear/confusing) rated on a 7-point Likert scale as well as one open-ended question that allows additional feedback on the simulation-based learning environment.

The results on the apprentices' user experience items reveal a predominantly positive picture (Table 1), with the items 'interesting' and 'understandable' receiving the highest ratings. Working with LUCA Office is perceived as pleasant and easy. The perceived clarity received a slightly lower rating.

Table 1. **Items related to the use of the learning environment rated by learners**

Item	Mean	Standard deviation	Min	Max
interesting	5.14	1.44	1	7
understandable	5.09	1.50	1	7
pleasant	5.02	1.44	1	7
easy	4.88	1.53	1	7
clear	4.53	1.71	1	7

NB: 7-point Likert scale (as an example for item 'interesting': 7 = very interesting, 6 = interesting, 5 = somewhat interesting, 4 = neutral, 3 = somewhat not interesting, 2 = uninteresting and 1 = uninteresting; this scheme applies analogously to the other four items)

Source: Authors.

The findings of the qualitative analysis of the open-ended question reinforce this positive picture. In the analysis, a distinction was made between general feedback (n=208) and specific suggestions for improvement (n=280). For the feedback category, it was distinguished between positive, moderate,

and negative feedback, with additional subcategories developed inductively for the positive statements. Most responses conveyed a positive sentiment. For example, both the clear design of the learning environment and the task received positive feedback. Learners found the office simulation interesting and enjoyable. Several learners appreciated the simulation's authenticity and described it as a 'good idea to gain insight into potential processes within a company'. Information on other mentioned aspects is available in Table 2. In addition to these positively connoted responses, eleven statements indicate a moderate sentiment, such as the following: 'All right on the whole, but not for me'. Five responses have negative connotations with learners, for example, rejecting LUCA and preferring previous software tools.

Table 2. **General Feedback**

Category	Number of codings
Positive feedback	**192**
Software/task design	
clear design	23
authenticity	15
ease of use	8
intelligible	5
Didactic possibilities	
varied	8
effective learning and teaching environment	8
exam preparation	1
Further attributions	
interesting	20
enjoyable	15
potential/promising	8
helpful	6
Other (unspecific)	75
Moderate feedback	**11**
Negative feedback	**5**

Source: Authors.

Numerous statements contain concrete suggestions for improvement regarding the software and the scenario; these were also categorised (Table 3). Most of the statements are related to software design, with enabling split screen frequently mentioned. However, this is not intended because it limits the interpretation of the log data for research purposes. For the use of LUCA in commercial apprenticeship, however, the function seems to be reasonable. Some learners also mentioned' technical problems' and 'further desirable functions' within the different office tools.

Concerning the scenario 'supplier selection', several learners mentioned the time constraint (55 minutes) and the desire for more processing time. Some learners criticised the high number of messages and interventions ('The constant interruptions from email were a bit distracting') and suggested reducing them. In addition, a too high level of difficulty was addressed. Additional suggestions can be found in Table 3.

Table 3. **Suggestions for improvement**

Category	Number of codings
Suggestions regarding the software	
Software design	*122*
split screen	92
clear design	20
layout	10
Technical problems	***20***
learning environment	15
school infrastructure	5
Further desirable functions within the tools	***37***
spreadsheet	25
notepad	4
calculator	8
Suggestions regarding the work scenario	
time constraint	37
number of messages and interventions	28
level of difficulty	27
authenticity	8
opportunities for teamwork	1

Source: Authors.

Learners generally perceive LUCA as an interesting, realistic, and enjoyable simulation and have valuable suggestions for improving the learning environment. However, user experience can be highly subjective (Schrepp et al., 2017a).

8.3.2. Teacher perspective

The teachers' perspective on LUCA is presented based on two main themes. First, the focus is on the perceived authenticity of the learning environment and the materials of the 'supplier selection' scenario described above. Second, perceived facilitating factors and barriers to implementing LUCA in commercial apprenticeship in the classroom are addressed.

8.3.2.1. *Authenticity of the simulation-based learning environment*

The objective of developing LUCA and the scenario 'supplier selection' was to represent a commercial workplace and work task authentically. To assess to what extent this objective was accomplished, a survey was conducted among teachers at those commercial schools where learners also evaluated the user experience of LUCA. The sample consists of 30 teachers with an average age of 44.4 years, 16 being female. The participants answered 19 questions about the perceived authenticity of various materials and the learning environment.

The teachers rated all documents of the work scenario as (rather) close to reality (the mean of the individual items ranges from 4.00 to 4.57; Table 4 shows exemplary results for different items). The authenticity of the work scenario is perceived as rather close to reality and LUCA is also perceived as a rather close-to-reality learning environment.

Table 4. **Exemplary items on the authenticity of LUCA rated by teachers**

Item	Mean	Standard deviation	Min	Max
email quality assurance	4.57	0.73	2	5
company brochure	4.50	0.86	2	5
'supplier selection' overall	4.17	0.70	3	5
LUCA environment	4.04	0.94	2	5
spreadsheet template for utility analysis	4.00	0.79	2	5

NB: 5-point Likert scale (5 = very realistic, 1 = very unrealistic).
Source: Authors.

8.3.2.2. *Implementation of the simulation-based learning environment*

To gain insight into the perceived facilitating factors, as well as barriers to the implementation of LUCA in the classroom, additional semi-structured interviews were conducted. A total of 10 workshop attendees were interviewed: they were asked about their intention to implement LUCA in the classroom and perceived influencing factors. The sample consists of teachers from vocational schools (n=10, of which three are trainee teachers) with an average age of 39.3 years and a majority being female (n=6). The interviews were transcribed and analysed using the software MAXQDA and qualitative content analysis. The characteristics of LUCA, characteristics of teaching staff, individual school or educational institution, environment and implementation support strategies, and learner characteristics were used to categorise the perceived facilitating and hindering factors (Section 8.1).

Four interviewees had not yet used LUCA at the time of the interview, while six had already used it in class. The six teachers who have already implemented LUCA in their classes reported positive experiences (10 statements); as example, the possibilities for personalised assistance through interventions were deemed beneficial. The respondents also mentioned positive reactions from students, such as those who enjoyed tackling challenging tasks within a certain timeframe. However, three teachers reported difficulties (four statements), such as technical problems or overstrained learners. Almost all respondents expressed their intention to use LUCA in the future, with just one person who had already used it stating that she no longer intended to use it due to the problems experienced.

When asked about perceived factors that would facilitate the implementation (a total of 120 statements, see Table 5 for all identified facilitating factors), most responses referred to learning environment characteristics. The respondents appreciated LUCA primarily as an effective learning and teaching environment. For instance, this encompasses the perception of LUCA as varied: 'From a student's point of view, I believe it is a variation, something different to break away from the typical classroom learning at the regular student desk' (interview 8, line 38). The opportunity for self-organised learning is also valued: 'The students can easily occupy themselves with it and must figure it out on their own' (interview 8, line 20). Also appreciated is the option 'to build relatively complex learning scenarios, allowing students to learn holistically' (interview 5, line 20).

Teachers appreciated the simulation's authenticity. The authentic progression of scenarios and the practical relevance that can be established through the simulated workplace is particularly valued: 'I really like the setup, starting with an email that lays out the problem, and then the students, just like they would in an office, actually have to look for the documents and sift through the materials. It adds a certain level of realism, I have to say' (interview 3, line 20). The interactive elements within the work process also received approval: 'I like the concept of these events. Being able to essentially interrupt the process, that's quite realistic' (interview 1, line 24).

Ease of use is described as good and user-friendly, to which the browser-based character also contributes. LUCA's intended 'share economy' is also perceived as a conducive factor. This means

that work scenarios are shared and can be reused and adapted, thereby reducing the workload and exploiting synergies.

Teacher motivation is an essential condition for implementing LUCA. In this regard, a genuine interest in utilising new tools and having the willingness to experiment with LUCA is crucial: 'I'm interested in new things. Hence, I believe that my motivation is the primary factor' (interview 12, line 25).

Positive characteristics of the institution for implementing LUCA include peer support: collaborative development within a team and the expressed interest of colleagues in teaching with LUCA are perceived as beneficial. The availability of the necessary infrastructure and technical equipment is also helpful.

Other factors mentioned relate to implementation support strategies. The participants report that the workshop they attended strengthened their intention to use the software. Getting to know the learning environment in the workshop seems to be helpful, motivating and offers suggestions for the use of LUCA: 'it simply gave me a few impulses and a few ideas, how I can now implement my lessons […] and that was important for me' (interviews 11, line 37). Available information materials (e.g. the user manual) are also rated as helpful.

Table 5. **Perceived facilitating factors for the implementation**

Category	Number of codings
Characteristics of LUCA	
effective learning and teaching environment	19
authenticity	18
ease of use	12
share economy	7
developed within a research project	3
possibilities for differentiation	4
other	6
Characteristics of teaching staff	
motivation	14
Characteristics of the school / institution	
peer support	8
infrastructure	6
supervisor support	3
organisational culture	1
Environment and implementation support strategies	
workshop participation	11
information materials	6
time available	2

Source: Authors.

Besides these conducive factors, respondents also perceived impeding factors in the implementation of LUCA (a total of 83 statements, see Table 6 for all identified impeding factors), including characteristics of the software itself. Some respondents criticised the ease of use and described the interface as confusing and not self-explanatory; the limited functionality of office tools is also seen as a barrier and

the integration of Microsoft Office products is desired. The 'share economy' is viewed critically because existing materials with copyrights or internal files cannot be used and because there are concerns about making one's work available to others. A lack of motivation due to frustration or extra work on the part of the (potential) implementers is also addressed.

For the institution, insufficient infrastructure and technical equipment is mentioned as an obstacle to the use of LUCA; for example, the limited availability of computer rooms and an unstable internet connection are criticised. The lack of support from the college or internal coordination processes is perceived as an obstacle and learner prerequisites represent impeding factors for implementation. The lack of digital competences makes it difficult to navigate the learning environment.

Most statements about obstacles to implementing LUCA are related to time resources. A lot of time is mentioned regarding familiarisation with LUCA, as well as the development of own work scenarios. The processing of scenarios in the classroom is also perceived as time-consuming.

Table 6. **Perceived impeding factors for the implementation**

Category	Number of codings
Characteristics of LUCA	
ease of use	14
limited functionality of office tools	10
share economy	2
other	7
Characteristics of teaching staff	
lack of motivation	1
Characteristics of the school / institution	
insufficient infrastructure	6
lack of peer support	4
Environment and implementation support strategies	
time resource	33
lack of cross-school networks	2
Characteristics of learners	
prerequisite skills	4

Source: Authors.

Given that most respondents have stated their intention to use LUCA in the future, it can be assumed that the perceived benefits outweigh any potential obstacles. However, it remains uncertain to what extent LUCA will be regularly implemented in the classroom of the future.

8.4. Conclusion

Office simulations provide the opportunity to integrate the business work environment into the classroom, allowing learners to acquire practical insights through solving real business problems in a secure learning environment (Caruso, 2019). Computer-based simulations offer the benefit of providing immediate feedback (Caruso, 2019), including additional information, corrections, or suggestions for further steps

(Plass & Schwartz, 2014). In this way, problem-solving and decision-making skills can be fostered, preparing learners for tasks in the professional world (Caruso, 2019). However, simulation-based learning also poses certain challenges. These include financial and time resources for the development of the software, the level of complexity, and the amount of time teachers need to familiarise themselves with the simulation before using in the classroom (Caruso, 2019).

Our findings and lessons learned from LUCA align, shedding light on both the potential of simulation-based learning in commercial apprenticeship and the challenges associated with its implementation. Learners perceive working with LUCA as enjoyable, and they also characterise it as a realistic simulation for gaining insights into business processes. Suggestions for improvements in terms of software design or technical functionality also point to perceived limitations of the software and emphasise the ease of use of this tool. Teachers consider the software, in particular, to be an effective teaching and learning environment for their classes, which is crucial for their intention to use LUCA. They also appreciate the simulation's authenticity, as it helps clarify its practical relevance within lessons. Nonetheless, perceived challenges in using the software may hinder its adoption. Besides these software characteristics, other factors can affect implementation (Century, & Cassata, 2016; Schrader et al., 2020). For instance, our findings indicate that teacher motivation, peer support or participation in a workshop for an introduction to the software play an important role in the intention to use the tool. A major challenge seems to be the time required to become familiar with the tool. Insufficient infrastructure also limits its use.

We can derive vital parameters for the utilisation of computer-based simulations in apprenticeships. The perceived effectiveness and authenticity of the tool are pivotal, and ease of use must also be taken into consideration. Ensuring that the tool offers educational value while also allowing for straightforward use by all stakeholders, including learners and teachers, is imperative. To ensure the successful implementation of such tools within the school-based segment of apprenticeships, it is essential to address potential challenges and put in place supportive measures. These include providing comprehensive support, such as workshops, to motivate teachers and equip them with the essential skills for successful tool use within their classes, or ensuring the requisite infrastructure is in place. Allocating dedicated time for teachers to familiarise themselves with the new tool can contribute to unlocking its full potential for apprentice learning experiences.

The study's limitations must be considered when interpreting our findings. To begin, we only examined a specific simulation within the domain of commercial apprenticeship, which restricts the generalisability of the results. The learners' perception of the user experience was captured using only a few self-report items after processing one scenario. Further usability studies, for example, using eye-tracking data (e.g. Gorshid et al., 2022), could provide additional insights. In the case of teachers' perceptions, the small sample size limits the significance of the results. It must be assumed that only teachers with the intention to use LUCA voluntarily participated in the interviews, so it would also be interesting to know why other teachers do not consider using it. Usage intentions and perceived conditions for implementation may vary over time and it remains uncertain to what extent LUCA will be implemented in classrooms regularly. Surveying teachers at multiple points over time may be informative.

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CHAPTER 9.

Looking behind the scenes: being able to master ERP systems as a goal of vocational education and training

By Christian Mayer and Jürgen Seifried ([69])

9.1. Introduction

For some time now, the use of software in the workplace has played a significant role in supporting operational business and decision-making, including in companies operating in retail, banking, insurance (hereafter referred to as 'commercial') ([70]). In this context, employee skills are now strongly linked to the respective computer-based tasks and workplace roles (Billett, 2021). The results of the latest European skills and job survey (Cedefop, 2022) illustrate the long-standing digital transformation in the EU. New digital technologies, computer systems, computing devices, or computer programmes were used in the workplace by 44% of employees in 2020-21 across Europe and Germany. An OECD Economics Department working paper shows robust empirical evidence of the link between digitalisation and productivity in several countries (Gal et al., 2019), with enterprise resource planning (ERP) systems playing an important role.

As ERP systems are now standard in companies, they must be considered in vocational education and training (VET) and apprenticeships. ERP systems store data in a central database and map business processes holistically across different application levels. These systems access operational information for operational work steps in real-time on a horizontal (functional) level and condense it to different aggregation levels on a vertical (informational) level (Wigand et al., 2003). Teaching and learning with ERP systems can be linked to simulation-based learning. ERP systems in VET mimic business processes in authentic environments where users interact with typical software and authentic documents to solve complex tasks. Simulation-based learning generally refers to any 'instructional tools or devices with which the learner physically interacts to mimic real life', and 'the need to interact with authentic objects' is emphasised (Cook et al., 2013, p. 876). Empirical evidence shows that simulation-based learning in higher education promotes the acquisition of complex skills (Chernikova et al., 2020).

For students in dual VET / apprenticeships, ERP systems use at the workplace for education and training purposes is often limited to routine activities, such as retrieving information; improper use by apprentices (or other types of trainees) could severely disrupt operational processes. The focus here is on developing routines, such as data maintenance (Jasperson et al., 2005). On the operational side of a business, ERP systems are implemented for task-specific purposes, considering industry-specific features and mapping operational specifics (in technical jargon: 'customising'). Employees, and especially apprentices, are often assigned limited roles that do not sufficiently allow a more comprehensive insight into work processes.

Although ERP systems can be used in company training to illustrate business processes, the learning potential of dealing with ERP systems often cannot be fully exploited at the company site. In order to

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([70]) This chapter draws on two recently published German papers: Mayer (2022) and Mayer & Seifried (2022).

do justice to a broader professional logic, ERP systems are used in training at vocational schools to illustrate general business processes, irrespective of company or department specifics. Both learning sites, vocational schools and companies, need to complement each other.

Against this background, more learning opportunities based on the use of ERP are needed in vocational schools. The German dual vocational training system, has positive experience with intensive work with ERP systems in the vocational school learning environment. Learning with ERP systems at vocational schools is not just about the acquisition of routines (as those preferred in the workplace use of ERP) but also about looking 'behind the scenes' to promote a deep understanding of the business processes mapped in the ERP system. In schools, mistakes and errors are allowed (and are viewed as a central component of learning processes; Metcalfe, 2017), and processes can be decelerated comprehensibly. Apprentices can better understand cross-departmental business processes through ERP systems (Pongratz et al., 2009) and apprentice employability can be promoted (Zutavern et al., 2022).

Due to the potential of ERP systems as a teaching and learning subject, it is essential to qualify (prospective) teachers and in-company trainers to implement these systems in a didactically meaningful way (Box 1).

Box 1. **Why have ERP systems not fully arrived in schools yet?**

One reason for the scarce integration of software into lessons may be that teachers still lack qualification themselves.

Source: Knigge et al., 2017.

In this paper, the potential of teaching digital work processes to apprentices using ERP systems in vocational schools is discussed. We do this against the background of the situation in the German VET system, considering curricular requirements, didactic possibilities and challenges, and the need for an adequate competence assessment.

We briefly introduce the theoretical underpinnings of teaching and learning with ERP systems. We then summarise our research on teacher empowerment based on previous work (Mayer, 2022; Mayer & Seifried, 2022) and discuss limitations and implications for vocational education, training, and educational policy-makers.

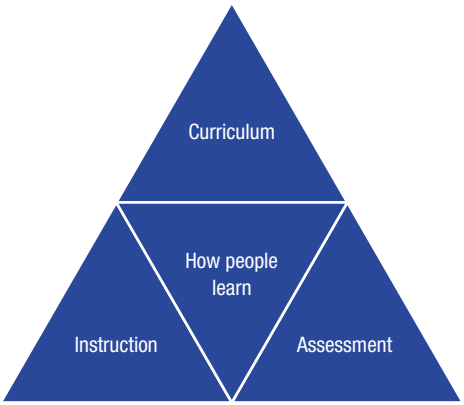
9.2. Theoretical foundation for ERP teaching and learning

9.2.1. Curriculum-instruction-assessment (CIA) triad

To discuss teaching and learning with ERP systems, we rely on the curriculum-instruction-assessment (CIA) triad (Figure 1). We use this approach to address the following:

(a) the knowledge and skills that need to be learned (curriculum perspective);
(b) the learning activities that guide and promote the acquisition of the relevant knowledge and skills (instructional perspective);
(c) the appropriate measurement (assessment perspective) of the acquired knowledge and skills (Pellegrino, 2006; Achtenhagen, 2012).

Figure 1. **Curriculum-instruction-assessment (CIA) triad**



Source: in the style of Pellegrino (2002, 2006; Achtenhagen, 2012).

9.2.1.1. *Curriculum*

Training occupations, and therefore training regulations, must be regularly revised to meet the needs of the workplace. The changes in an increasingly digitalised world of work are perceived accordingly at the institutional level and are also increasingly anchored in dual VET curricula.

For example, the 'guiding questions' of the Federal Institute for Vocational Education and Training's (BIBB) thematic cluster on digitalisation refer to examination of the potential influence of new technologies and the resulting new design options for education and training systems (Zinke, 2019; BIBB, 2021). One of the four recently introduced cross-occupational standards for vocational training (new themes across occupational programmes, 'positions') by BIBB focuses on a 'digitalised world of work' which not only has a recommendatory character for all existing training regulations but is mandatory in all new or updated training regulations that come into force as of August 1, 2021.

Within the framework curricula of the Standing Conference (a consortium of policy-makers responsible for education and schooling, among other things) of the Ministers for Education and Cultural Affairs of the federal states in the Federal Republic of Germany (*Kulturministerkonferenz* – KMK), the use of integrated company software is explicitly listed as content to be taught in some training occupations and learning fields.

From the perspective of vocational schools offering dual VET programmes in Commerce (e.g. in retail, banking, insurance, hereafter referred to as 'commercial' apprentices), examples of this can be found in IT-related training occupations such as an apprenticeship in IT systems management or digitalisation management, where vocational learning is often structured in so-called learning fields/training modules. An example is learning field 12: Carrying out and monitoring sales processes: 'You document the entire sales process with the support of software (integrated company software)' (Kultusministerkonferenz, 2019a, p. 12). Other commercial apprenticeships such as wholesale and foreign trade clerks have also been considering the use of integrated company software. In learning field 2, 'Processing orders in a customer-oriented manner', apprentices create and check invoices and delivery notes while explaining the benefits of integrated business software (Kultusministerkonferenz, 2019b, p. 11).

9.2.1.2. *Instruction*

In the context of business process didactics, functionally operationalised work processes within ERP systems are connected to corresponding domain-specific knowledge based on authentic situations (the situation principle) within a simulated environment (Wilbers, 2014). From a pedagogical perspective, it is essential to make a clear distinction between business process didactics and pure user training. Classic user training, often referred to as 'click training', is insufficient for acquiring comprehensive action competence (Weinert, 2001). Contextual knowledge is also needed for learners to grasp the

corresponding business process.

When progressing the first steps of a sales process (Figure 2), it is not only inquiries, quotations, and incoming orders that are 'worked through' in the ERP system; subject-didactically relevant contents are also taught. For example, while working through the sales process in the ERP system, the agreement of two declarations of intent as the basis of a sales contract can be explained or disruptions to the sales contract can be discussed with consideration of the relevant legal texts. This could help to link procedural knowledge with contextual and factual knowledge.

Figure 2. **Sales process (simplified)**

Source: In the style of SAP4school material ('SAP4school IUS', 2023).

The possible uses of ERP systems are not limited to processing tasks in the school computer rooms but allow for some instructional variation possibilities. Asynchronous and synchronous formats are possible. Wilbers (2009) differentiates between illustrative use, sequential use, use in learning companies, and use in projects/cases/learning situations. Illustrative use is a low-cost and low-threshold variant of presenting ERP systems using screenshots. The sequential application option requires a theoretical concept phase, followed by small step task processing in the ERP system. The most established implementation of ERP systems in learning and teaching at schools in Germany is the use of ERP systems in learning companies (practice firms and junior companies). Teaching and learning in this style go hand in hand with the complex teaching-learning arrangement of (fictitious/real) product, money flows, and (real) suppliers and customers. Using ERP systems in projects, cases and learning situations takes place in addition to teaching and is more likely to be found in a university context. Adapted case studies and more complex cases are worked on (Wilbers, 2009).

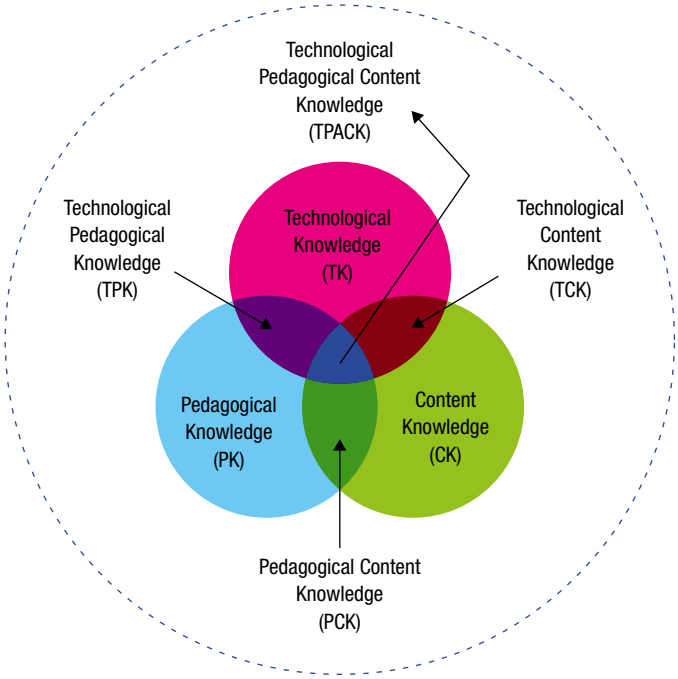
9.2.1.3. *Assessment*

According to Pellegrino (2006), assessment should measure what students are expected to learn according to the curriculum. However, performance-based assessments of skill acquisition are still rare in relation to the use of ERP; most often, a particular learning module must be worked through to see if specific knowledge and skills have been learned. Performance-based measurement based on previously achieved tasks is a prospect for ERP assessments, though the challenges of pedagogical, technical, and individual teacher and student constraints remain a barrier and must be addressed.

9.2.2. **TPACK**

The technological pedagogical content knowledge model (TPACK) encompasses different dimensions of teachers' professional knowledge (Mishra et al., 2006; Koehler et al., 2009; Mishra, 2019). It extends a model for describing teachers' professional knowledge by Shulman (1986) by adding a technological component. The TPACK model distinguishes further between content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK), as well as the intersections of these types of knowledge (Figure 3).

Figure 3. **Technological Pedagogical Content Knowledge (Mishra et al., 2006)**



Source: Available at http://tpack.org (TPACK.org, 2023).

Technological knowledge (TK) includes knowledge about media and technological applications and underlying technological concepts (Mishra et al., 2006). Content knowledge (CK) refers to the knowledge of the respective professions, often certified through government degrees (Shulman, 1986). Pedagogical knowledge (PK), describes knowledge about teaching and learning, considering pedagogical-psychological and didactical approaches such as principles of classroom management or the organisation of lessons (Shulman, 1986).

Pedagogical content knowledge (PCK) combines pedagogical-psychological knowledge and subject knowledge and refers to sub-areas of the underlying professional domains (Schmid et al., 2020 a). Technological content knowledge (TCK), represents the combination of technological and subject knowledge and refers to possibilities of teaching and learning with the inclusion of technology (Schmid et al., 2020 a). Technological pedagogical knowledge (TPK) refers to media-didactic knowledge (Schmid et al., 2020 a).

The core of the model, however, is the technology-related subject didactic knowledge (TPCK), which combines all the previously mentioned areas of knowledge (Schmid et al., 2020 a). In addition, the contextual framework itself (contexts) is also increasingly addressed within the TPACK model, in order to also be able to consider the (technological) conditions of schools, teachers and students (Mishra, 2019).

In the context of ERP systems, TK refers to the knowledge of the structure and functionality of ERP systems and relational databases. The CK component refers to the knowledge surrounding using ERP systems to accomplish professional tasks. PK includes the possibilities of using ERP for instruction conducive to learning and for the practical assessment of learning outcomes. From a PCK perspective, teaching is closely linked to knowledge about typical errors and misconceptions of learners and hurdles during learning and skill acquisition. In the case of using ERP, these include errors in raising an invoice or difficulties in understanding the accounting scheme in the general ledger and sub-ledger of accounts receivable. TCK includes knowledge about using ERP systems to promote domain-specific knowledge, such as the modelling and handling of holistic business processes. TPK also involves the potential of new visualisation and presentation possibilities using ERP systems. TPCK reflects the didactically

meaningful use of ERP systems across all previously mentioned sub-areas for teaching specific subject didactic content. In the context of ERP systems, attention should be drawn to the availability of time, human and material resources (especially software and hardware).

9.3. Methodology

The paper draws evidence from teaching prospective teachers and trainers in VET on the possibilities of using ERP systems in a Master programme in business education offered at the University of Mannheim/Germany. Most of the programme graduates are employed either as teachers of business in dual VET programmes in commerce (wholesale, industry, trade, retail, bank and insurance, and so forth) or as training managers or human resources (HR) staff in companies participating in VET.

We designed a course related to teaching and learning with ERP Systems that deals with the didactic examination of the possibilities of using a specific ERP system in the classroom or instruction in business practice at the workplace.

In the autumn semester of 2021 and spring semester of 2022, 26 students successfully participated in the seminar. Average participant age was 25.6 and they were in their second Master semester. Almost all participants had little to no experience with ERP systems or SAP ERP.

A voluntary pseudonymised entry and exit survey accompanied the seminar. Of the 26 students who took the elective, 20 participants completed both the entry and exit surveys. Data from an anonymised student teaching evaluation, conducted towards the end of the semester, are also available. To capture the TPACK dimensions, the questionnaire of Schmid, Brianza, and Petko (2020b) is used, which comprises 28 items (4 items per TPACK dimension). An example item of the PK dimension is: 'I can adapt my teaching to what learners currently understand and what they do not understand'. The Likert scale ranges from 1 (strongly disagree) to 5 (strongly agree). The reliabilities of the scales can be described as predominantly satisfactory to good (Cronbach's α = .67 to .90). A structured reflection diary was also used, where students reflected on their self-experienced difficulties during processing.

For data analysis, the free statistical software R was used in the R Studio environment with extending packages, particularly *Tidyverse* (Wickham et al., 2019; R Core Team, 2021; R Studio Team, 2021). We resort to non-parametric test procedures for analysing dependent samples, as the prerequisites for applying parametric test procedures are not given in the present case (Döring et al., 2016). The test for normal distribution using Shapiro-Wilk tests shows significant deviations from the standard normal distribution for the data. Therefore, the non-parametric Wilcoxon test (one-sided hypothesis test, i.e. the values of the initial survey should lie above those of the initial survey) was used. The effect sizes were calculated as r-values to classify the results.

9.4. Findings

Insights into the results of the teaching evaluation, in which 15 of the 20 participants took part, show that the students rate the seminar quite well (value range from 1 = fully agree to 5 = disagree at all): Overall, I am very satisfied with the lecturer (M = 1.1); Overall, I am very satisfied with the course (M = 1.5); I have learned a lot in this course (M = 1.6).

A holistic analysis of the self-assessment of one's own skills in dealing with ERP systems (range 1 = no skills at all [novice] to 10 = profound knowledge [expert]) yields the following result. There is a significant increase over the course of the lecture ($M0 = 2.2$ vs $M1 = 6.5$, $V = 210$, $p < .001$, $n = 20$). The effect strength is $r = .88$ and corresponds to a strong effect (according to Cohen, 1992).

To analyse the TPACK dimensions, a mean value was calculated for each subscale, and a pre-post test was conducted. Only the TK dimension showed a significant effect ($V = 114.5$, $p < .05$; Table 1). The

effect size is $r = .41$ (moderate effect). All the other dimensions show no significant changes.

To account for biases in the self-assessment (over- or underestimation), participants were assigned to two groups in a further analysis step. The mean value of the initial survey per participant was formed over all TPACK items and assigned to one of two groups utilising a median split ($Mdn = 3.75$). The students in group 1 ($n = 11$) tended to have lower self-assessment values, while those in the second group ($n = 9$) had higher values for self-assessment. The analysis of the development of competences in the course at group levels shows that the students with lower values at the beginning especially benefit from the course. Significant increases were recorded for the TK dimension ($V = 51$, $p < .01$) and TCK dimension ($V = 44.5$, $p < .05$) (with high effect sizes in each case: TK: $r = .74$; TCK: $r = .51$). For the remaining dimensions, no significant changes can be detected. No significant results were found when comparing the groups (Mayer & Seifried, 2022 for further details). It might be assumed that an initial overestimation of personal abilities was relativised during the course (further information on this aspect can be found in the conclusion section).

The brief insights into the reflection diaries put this result into perspective, indicating that the students often encountered problems when working on the tasks. It becomes clear that they may have overestimated their knowledge and skills at the beginning of the course. Most processing problems encountered, on the other hand, can be traced back to the procedure in the ERP system. Typical procedural processing problems can be further subdivided as follows.

(a) Processing problems in the ERP system due to a lack of essential contents and concepts: 'There is a lack of background knowledge. Deeper understanding of taxes, for example. When is it full taxation or reduced? Or how are list prices calculated. [...]' (problem number / PNr. 116).

(b) Processing problems in the ERP system due to a lack of knowledge of the general functioning and structures of ERP systems, for example: '[...] It was unclear to me that I have to create the offer with reference, I overlooked that or did not think about it. I knew that it was a quotation corresponding to the previously entered request, but I did not know that I could reference it in the system. In the solution notes, it's easy to miss the reference to it because it's right under the process steps.' (PNr. 031). Data referencing is an essential feature. The relational database forms the basis of ERP systems, and the underlying concept should be clear. Referencing not only facilitates preparation of quotations (among other receipts) by taking over data that has already been stored, but key indicators for sales control can only be reliably determined if they are referenced accordingly in the system. Similarly, an offer does not necessarily have to result from an inquiry, so creating an offer with and without a reference is possible (see also Mayer, 2022).

(c) Processing problems in the ERP system due to a lack of skills about the system-specific application of transactions. This includes general skills lacking in using the software: 'In the delivery task, we were supposed to create a substitute document in the logistics category, a single document related to the sales order. When I entered the navigation device, I had to look for it again because I couldn't remember the numbers. When I entered it, I didn't notice the asterisks of Navi* and the corresponding *number, so nothing was shown to me at first' (PNr. 050). In this case, as is common in computer applications, * symbols are used as placeholders (jokers or wildcards) for the search. For learners, this is convenient for searching, while teachers can use wildcards in transactions to check an entire class's progress without monitoring individual student data.

More specific skill deficiencies in dealing with the ERP system also cause problems in processing the tasks, as the following problem descriptions show. It is reported that 'the problem [was] that the material created was saved and therefore some views could not be changed' (PNr. 061). Here, system-side specifics show up, which can only be acquired through appropriate routines. The latter problem could be solved easily by changing the transaction 'create' to 'change' and was solved in the present case by creating another master data entry for the material.

In the end, careless mistakes also present problems in processing tasks, as they will undoubtedly

occur just as frequently in the school context: 'I registered too quickly and without thinking. So, my set language was English' (PNr. 018).

9.5. Conclusions

The paper referred to the benefits of introducing ERP in teaching apprentices, first at vocational schools but also at the workplace. To ensure a high-quality ERP education, (prospective) teachers and corporate trainers need to know the implications of the curriculum, instruction, and assessment dimensions of learning (CIA triad) and how they relate to ERP systems. Therefore, we have designed a master seminar for prospective company trainers and vocational school teachers to promote the teaching and learning with ERP systems among our students.

In this paper we reported the findings of a teaching-learning concept for using ERP systems among business education students and analysed self-assessed knowledge acquisition along the TPACK dimensions in a pre-post design (Mishra & Koehler, 2006). The students reported high satisfaction with the course offered for the first time at the University; positive effects can also be seen concerning the self-assessed change in ERP skills. For the TPACK dimensions, however, the picture is less substantial: only a few significant changes can be detected. Exemplary insights into the students' reflections recorded in a reflection diary show, however, that a misjudgement of their competences in the sense of an overestimation at the beginning of the semester could be at least partly responsible for the lack of more significant effects. The reflection diaries point to clear gaps in the knowledge of some students. An analysis carried out against the background of these considerations, considering the different self-assessment levels, further shows those participants with a tendency towards lower self-assessment in particular benefit from the course. This subgroup shows strong effects on self-assessed knowledge acquisition regarding technological and technological-subject knowledge. However, no significant changes can be found for participants with higher self-assessments, indicating an adjustment of the competence assessment. If a misjudgement of prospective teacher and in-company trainer competences can be corrected within the framework of student reflection, this would have a desirable side-effect from a pedagogical point of view. This is especially true for prospective teachers and in-company instructors, as those who receive specialised pedagogical training in teaching and training with ERP systems will benefit more when assessing the skills of apprentices compared to teachers and in-company trainers without such training.

Typical challenges in processing authentic commercial tasks in the ERP system were also qualitatively evaluated. These are of great importance for designing corresponding lesson plans for vocational education in vocational schools and in-company training with ERP systems, since typical self-reflective problems should be considered in the further design of learning processes. Typical problems in processing can be traced back to a lack of basic subject knowledge of prospective teachers, a lack of knowledge about the general functioning and structure of ERP systems, and a lack of knowledge about the application of processes in the underlying ERP system. The reflection diaries also contain references to aspects which, although they can be described as careless mistakes, are likely to occur in this way in everyday school life and should be avoided as much as possible in the daily work in a value chain of a company.

Given the specific setting and small sample size, the results presented here should be interpreted cautiously. Self-report limitations (especially concerning social desirability bias) suggest that future research should be supplemented by an authentic competence assessment in subsequent studies within authentic VET environments (e.g. assessment of learner skills in in-company training and vocational schools).

For (prospective) teachers and in-company trainers, assessing their own knowledge and skills is a necessary condition for competence development in their professional biography (Ross et al., 2007). We argue that there is an urgent need to educate prospective teachers and in-company trainers fur-

ther and consider the use of ERP in current teacher and trainer programmes in VET to address this problem. Integrating ERP systems into the training phase at university level might solve the problem of prospective teachers lacking workplace skills relevant to technology use and might help to educate the next generation of apprentices appropriately. However, further research is needed to assess the skill acquisition of (prospective) teachers (university / learning-site school) and trainers (learning-site company) and apprentices for teaching and learning with ERP systems (for deeper insights see Mayer, 2002, and Mayer & Seifried, 2022).

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CHAPTER 10.

Extended reality opportunities and challenges for apprenticeships

By Simonas Gaušas, Diana Čop ([71])

10.1. Introduction

This paper originates from the Directorate-General for Communications Networks, Content and Technology (DG CNCT) study Extended reality: Opportunities, success stories and challenges (health, education), led by Visionary Analytics. The study describes the state of the art and provides an assessment of the strengths and weaknesses of the use of extended reality (XR) technologies in the education sector. This paper complements the study with additional insights and examples of the opportunities and challenges of XR, with a particular focus on apprenticeships.

XR in this paper is understood as an umbrella term used to refer to virtual reality (VR), augmented reality (AR), and mixed reality (MR), as well as future realities immersive technologies might create. In recent years, the XR market in Europe, forming around one-third of the global XR market (Report Ocean, 2022), has been experiencing a boom. To illustrate, it is expected to grow between EUR 35 billion and EUR 65 billion by 2025 (Ecorys, 2021).

Given the growing size of the XR market and the potential of XR technologies in all sectors, XR is likely to transform apprenticeships across Europe. However, despite this growth, XR is still a relatively unexplored area and research on the application of XR to apprenticeships is very limited. In order to prepare better for upcoming changes, the potential affordances and challenges related to the XR application in apprenticeships should be investigated in-depth.

To investigate these aspects of XR application in apprenticeships, this paper is based on the data collected for the DG CNCT study, including:

(a) interviews with key stakeholders (including academics and researchers in the field of XR; practitioners and industry representatives; policy-makers/ government officials; and representatives of end users of XR technologies);
(b) 11 case studies of European XR companies across different vertical market segments to illustrate the different types and business models of European players in XR;
(c) an education sector workshop (27 participants). This yielded information and ideas for recommendations on how to address the current barriers and maximise the potential positive impacts of XR.

To complement the data already collected, we also conducted desk research, including for potential XR application examples specifically in apprenticeships and legal regulation.

10.2. Extended reality affordances in apprenticeships

This sub-section describes the potential of XR in apprenticeships, including the application areas and relevant positive effects stemming from XR use. The insights presented in this sub-section are based on

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the data collected in the context of the DG CNCT study, as well as on additional desk research activities, conducted specifically for this article.

10.2.1. XR application areas in the apprenticeship

XR affordances in the context of vocational education and training (VET) and apprenticeships can be grouped into two categories: affordances by objectives; and affordances by instructional approaches. These two groups can also be divided into separate areas, as presented in Table 1 (including specific examples of XR tools applied in those areas).

The XR tools presented are being used in VET programmes, but may also be offered in the form of apprenticeships. For this reason, the tools were picked for occupations that are traditionally offered in the form of apprenticeships.

Table 1. **Affordances of XR technologies in use/identified in apprenticeships**

Affordances of XR	Examples XR tools
XR affordances by objectives	
Procedural training: development of hard skills required for different occupational areas.	**v-CAT** is a VR-based vocational tool for cognitive assessment and training, providing personalised autonomous training options. **EPICSAVE** is a VR simulated environment for emergency simulation training (i.e. paramedic vocational training). **360 video** provide VR-based environment for simulation of different workplace scenarios (e.g. welding). **NXRT** is a train driver simulator as well as rail infrastructure and rail operation training using VR and MR. **SLIM-VRT** is a VR-based training tool applicable to the maritime sector. **TeamViewer xMake** is an innovative AR-based make-by-vision solution for manufacturing processes.
Awareness-raising: raising learners' awareness of environmental issues, development of sustainability	**AVARES** integrates a developed virtual world with a traditional learning management system (LMS), represented by Moodle, for more attractive learning in the challenging field of renewable energy sources (RES).
Creative opportunities in art and design: virtual exploring/ designing of the art works	**VR Painting Simulator** is a VR tool that helps apprentices in vehicle painting improve their skills through a set of learning tasks. **eTryOn** is a VR-based app, which makes it possible to create clothes in 3D and view a high-quality image that reflects the texture of the material used, providing a realistic design experience.
Development of computational thinking skills: development of problem-solving skills	**VR4STEM** assists young people to gain entrepreneurship skill in STEM domain and the related ICT industry in XR settings.
XR affordances by instructional approaches	
Virtual field trips with HMDs, smart glasses, 2D or 3D VR simulators: virtual exploration of the world through both time and space	**Google Expeditions** is a VR app that allows students to explore different locations and subjects, such as science, history, and geography.

Affordances of XR	Examples XR tools
Visualisation of complex processes using AR and/or 3D settings: visualisation of learning material	**World of Physics** uses VR technology to help VET students to study physics. **Spatial figurARs** is an AR-based application that aims to help students improve their spatial understanding when working with 3D shapes and objects. **Virtual table** is a VR learning application, intended to be a generic tool that encapsulates elements such as access to directions at any time, simple interactions, and the ability to display warnings or directions as needed. **VR learning environment** helps participants understand and determine the state of a built structure, with a focus on planning and identifying necessary repairs and finishing work as part of education for construction and plasterwork trades. **Microsoft HoloLens** is a mixed reality headset developed and manufactured by Microsoft. In VET schools, this is used for technical training in engineering, manufacturing, and construction. **ViMeLa** is based on a blended learning method involving theory classes and using VR as an experimentation tool for teaching mechatronics. **Labster** provides students with an opportunity to use advanced lab equipment to investigate different objects and solve real world challenges (e.g. DNA and gene sequencing, chemical reactions, etc.).

Source: Authors.

According to the desk research results, the widest XR application areas are procedural training and visualisation of complex processes (using AR and/or three-dimensional (3D) settings). For these two application areas, XR tools can be used in either of two key learning venues: at the VET school by the trainer; and at the workplace by the employer.

10.2.1.1. *Procedural training*

This area refers to the use of XR technologies for the development of hard skills in apprenticeships. For example, XR tools can be applied to train driver students (e.g. NXRT) ([72]), maritime training (e.g. SLIM-VRT), paramedic vocational training (EPICSAVE), and welding training (e.g. 360 video) (Table 9.1 for more information). In all these cases, the XR tools (e.g. head-mounted displays) are used to simulate a work environment, where apprentices can acquire the skills needed for specific occupations. They can be also applied in real workplaces (e.g. in manufacturing), where XR tools (e.g. smart glasses) assist apprentices and newcomer employees in their daily tasks, providing them with work-related guidelines and recommendations (e.g. TeamViewer xMake, Box 1).

Box 1. **TeamViewer xMake solution for training of newcomers in manufacturing and production sectors**

TeamViewer xMake is an innovative make-by-vision solution that can be used for respective manufacturing and production processes. This solution provides companies with the flexibility to train apprentices or new employees along a production line, displaying different production processes through smart glasses. When wearing the glasses, apprentices or employees always have all relevant information about the production process in their field of view, while both hands remain free for the actual work activity. This feature helps companies to overcome challenges such as seasonal work and employee fluctuations, which require constant training and development of new professionals. This is mainly because apprentices can learn using only smart glasses, even if there are no instructors or mentors around. According to one of xMake use cases, the application of such technologies resulted in significantly improved performance of the assembly and training processes at WS System (an automotive supplier located in Stuhr, Germany).

Source: Authors, based on https://www.teamviewer.com/en-us/frontline/xmake/ and https://www.teamviewer.com/en/success-stories/ws-system/

([72]) The references for specific XR-based tools mentioned in this paper are provided in Table 10.1.

10.2.1.2. *Visualisation of complex processes*
This area offers 3D learning materials that can be especially beneficial in teaching subjects where it is important for apprentices to visualise the subject matter. For example, XR provides an opportunity for apprentices to build their skills while practising in virtual laboratories (Alnagrat et al., 2021). They use special XR-based computer software that visualises 3D models, chemical or physical reactions and provides them with virtual assistants (e.g. *Labster*). This XR feature can be especially useful in such apprenticeships and VET areas as engineering, manufacturing, electrician, welding, constructions (e.g. Microsoft HoloLens and VR learning environment), and mechatronics (e.g. ViMeLa).

10.2.1.3. *Other areas*
Narrower application areas of XR in apprenticeships and VET include awareness-raising (e.g. of occupation-related sustainability implications), the development of creative and computational thinking skills, and the organisation of virtual field trips (see particular examples in Table 1 above). It is important to highlight that these XR affordances should be seen in the context of apprenticeships as supplementary (contributing to the apprentices' general education and skills development) rather than as a direct focus of apprenticeship.

In contrast, no specific examples of XR use in apprenticeships or VET were identified in other education-related XR application areas, although they can be found in general formal education contexts. These areas include:
(a) soft skills development;
(b) collaboration between students in the training process;
(c) physical training;
(d) language learning;
(e) interactive storytelling based on prepared content and user interaction with the story world.

As in the case of other formal education formats (primary, secondary, or higher education), the above XR affordances in apprenticeship can also ensure a more comprehensive education for apprentices, going beyond hard skills development. XR tools can help apprentices to develop their soft skills, teamwork skills, physical skills, and language skills. Below we list a few examples of such XR-based tools, which are applied in other formal educational formats but can be also offered for apprenticeship.
(a) ConVRself is communication and problem-solving software that utilises 3D virtual avatars to facilitate self-reflection and soft skill development by allowing learners to switch roles between talker and counsellor, providing fresh perspectives and fostering transformative thinking in handling challenges.
(b) Laerdal is a health care company that employs Varjo's MR headsets to create a shared simulation in which students work simultaneously in the same immersive patient treatment scenario and build their teamwork skills.
(c) ICAROS integrates fitness and VR to deliver engaging and impactful training by combining full-body workouts with immersive virtual environments, utilising a gyroscopic mechanical device for navigating virtual 3D worlds.
(d) Mondly is an app that takes an innovative approach to foreign language teaching and learning. It is the first app to combine AR, chatbot technology and speech recognition to create an immersive and lifelike language learning environment.

10.2.2. **Positive effects of XR adoption in apprenticeship**
The positive effects of the application of XR technologies in VET and apprenticeships can be divided into two main groups: economic impacts and social impacts. Both groups of impacts are discussed further.

The economic impact of XR application in apprenticeships and in VET is linked to the increased efficiency of the learning process. This brings higher learning outcomes with lower investment. According to the literature review and desk research, these economic impacts are the following.

(a) Lower financial costs: XR technologies allow VET to be organised in VR at much lower cost compared to real-life settings ([73]). Specifically, they reduce transportation costs (when organising training online or in class), and equipment costs (when using simulators rather than specific expensive technologies) (Liu et al., 2018). For example, SLIM-VRT (VR-based simulator) can be used in the maritime sector to simulate the operation of a ship for training purposes (without the use of real inventory). The opportunity to organise training at lower costs is especially important for micro or small companies with limited resources for apprenticeships. XR technologies can contribute to better comparability of experiences among apprentices, particularly between those trained in large and in micro/ small companies.
(b) Lower human resource costs: XR tools also increase the effectiveness of training personnel work by automated monitoring of apprentice learning and providing them with personal feedback, which reduces the workload for teachers/ trainers (Martin-Gutiérrez, 2015). For example, Labster (a VR-based lab) provides virtual support to apprentices (e.g. guidance or feedback).
(c) Lower time costs: XR allows apprentices to achieve better learning outcomes in less time (Checa and Bustillo, 2020, García et al., 2016). This is due to higher engagement in the learning process, more active interaction with a learning object, and learning by doing opportunity (Barteit, 2021, Garzón, Pavón, & Baldiris, 2019, Fracaro, 2022; Ibáñez, & Delgado-Kloos, 2018). For example, EPICSAVE proved its effectiveness in the training (see Box 2)

Box 2. **EPICSAVE project for paramedic vocational training**

EPICSAVE project created an immersive 3D simulation environment for paramedic vocational training. It created a room-scaled, multi-user, and highly engaging training environment, which simulates a virtual emergency scenario of anaphylaxis grade III with shock, swelling of the upper and lower respiratory tract, as well as skin symptoms, in a 5-year-old girl (virtual patient) visiting an indoor family amusement park with her grandfather (virtual agent).
To examine the effectiveness and quality of this virtual scenario training, a cross-sectional, one-group pre-test and post-test design was used. The examination sample included 18 active emergency physicians, who rated the VR simulation training positive in terms of training effectiveness and quality of the training execution. The testing found a substantial and noteworthy correlation (r=.53, P=.01) between perceiving a sense of presence and evaluating the effectiveness of training. This means that XR-based technologies that provide a more realistic (than traditional in-class) learning environment lead to better learning outcomes. However, the positive effects were limited by perceived comfort constraints and relatively high external cognitive load. This opens a window of opportunity for improving XR technology.

Source: Authors, based on Lerner, D., Mohr, S., Schild, J., Göring, M., & Luiz, T. (2020) (image source).

Positive social impact from XR-based looks at apprentice mental health and includes the following effects.

(a) Behavioural effects: XR ensures a safer learning environment for apprentices, as XR-based tools offer various training scenarios that would not really be possible or too dangerous in real-life settings (Bahadoran, 2021, Pottle, 2019). For example, NXRT (train driver simulator) ensures the safety of apprentices, where operating real trains could be too dangerous (especially for inexperienced apprentices) and even result in a crash.
(b) Psychological effects: a VR-based learning environment allows apprentices to get rid of the fear of costly and dangerous consequences, which may occur when training in real-life settings (e.g. wasted materials, damaged appliances) (Rajgopalan, 2018). The XR-based software eTryOn can ensure this opportunity (Box 3).

([73]) Based on interviews carried out for the DG CNCT study (Extended Reality: Opportunities, Success Stories and Challenges (Health, Education))

These positive impacts (economic and social) can lead to higher satisfaction with the learning process. This is possible due to the increased interactivity of the learning process and reduced training-related fear (Theodoror et al., 2018).

Box 3. **eTryOn: virtual try-ons of garments enabling novel human fashion interactions**

The primary objective of eTryOn was to revolutionise the interaction between users and fashion items, by researching and developing technologies that allow virtual try-ons of garments. Under this initiative, the VR-based designer app was developed. Although the app is not directly targeted at apprenticeship, it can be successfully applied in the field of design and sewing. With this, apprentices can develop their vocational skills without fear of making costly mistakes (e.g. damaged fabrics).

Source: Authors, based on https://etryon-h2020.eu/.

10.3. Challenges

The use of XR in apprenticeships provides not only opportunities but also challenges. This section provides a quick glimpse at the negative impacts and barriers to XR adoption in apprenticeships according to the data collected for the DG CNCT study.

10.3.1. **Negative effects of XR adoption in apprenticeship**

The use of XR in apprenticeships can have negative impacts on the training process and on the apprentices themselves. The following XR-related risks (if not properly addressed) can not only reduce the positive effects of XR but also create long-term damage to apprentices.

(a) Content-related risks: apprentices, when using XR technologies, may see realistic catastrophic images (e.g. images of factory disasters, and deaths), which may not be suitable for them. In the long-term perspective, this experience may result in aggravated trauma symptoms (Blum, 2021).
(b) Personal identity risks: a person who frequently uses VR tools and embodies his/her virtual character may lose the sense of reality and perceive himself/herself as a VR character even in real life (Kenwright, 2018; Madary & Metzinger, 2016). This can lead to altering personal identities (Ramirez, 2021).
(c) Ethical risks: the application of XR can increase harmful social interactions such as fraud, harassment, and bullying among apprentices while interacting in a virtual environment (Cortese & Outlaw, 2021).
(d) Privacy risks: XR technologies (if inadequately controlled) can use illegal data tracking and exploitation of personal data, breaching the General Data Protection Regulation (Tromp et al., 2018).
(e) Medical safety risks: the use of XR technologies can cause motion sickness (Chang et al., 2020) and temporary modification of sensorimotor and perceptual capacities after use (e.g. head-mounted displays, smart glasses, VR simulators) (ANSES, 2021).

10.3.2. **Barriers of XR adoption in the apprenticeship**

There are also barriers which slow down the adaptation of XR technologies in VET and apprenticeships.

(a) Lack of familiarisation and trust: a lack of familiarisation, awareness, and trust in XR technologies among stakeholders (trainers and apprentices) may reduce uptake ([74]). One possible reason for this is the limited research on the application of XR in apprenticeships.
(b) Insufficient skills: a lack of digital skills among both trainers and apprentices may also slow down the XR adoption process (Bucea et al., 2020). It should be noted that this challenge is not only relevant

74 () Based on interviews with academics carried out for the DG CNCT study (Extended reality: Opportunities, success stories and challenges (Health, Education))

for the use of XR tools, but also for the whole process of digitising education.

(c) Costly XR adoption: the adoption of XR tools may be too costly for education and training institutions, particularly if they have limited financial resources (Ghobadi et al., 2020) and/or have already acquired traditional learning and training tools. This may lead to path dependency, where institutions continue using and/or updating the acquired infrastructure and equipment instead of adopting new solutions such as XR technologies. Nevertheless, XR customisation and upgrade may be a cheaper solution for training in the long run than the purchase and use of real equipment (especially when considering the costs of wear and repairs due to misuse of equipment). XR technologies are also expected to become cheaper over time, as is usual for innovative technologies, which are typically more expensive at the beginning of their deployment (i.e. in the start-up phase).

(d) Technical limitations: the existing technical limitations of XR (e.g. limited simulation scenarios in some specific occupational areas, or unrealistic or too simplified view) may not always reflect the actual and/or all possible training conditions and circumstances of the use of work equipment (Fertleman et al., 2018). This can lead to insufficient skills acquired by apprentices during training sessions, and thus ineffective apprenticeships. It can also result in a mismatch between skill supply and demand in the labour market.

(e) Uncertain XR adoption: the slow uptake of XR in VET and apprenticeship programmes may also be due to a lack of guidance and policy provisions. There are no guidelines for VET schools or companies on the use of XR technologies by teachers and trainers, providing feedback and assessment, and adapting curricula to include XR ([75]).There is also no establishment of regulations or procedures for penalising cases of harassment within the XR environment ([76]).

To mitigate the existing XR-related challenges and ensure effective XR adoption, it is crucial to encourage intensive cooperation between trainers/ apprentices and XR tools/ content developers. Joint discussions, workshops, or hackathons with VET schools (including apprentices and trainers) and XR software creators may be organised to this end. This approach can ensure the feedback from users (trainers and apprentices) to the developers of the tools, both in terms of the challenges and risks of use and the need for educational content.

10.4. Broader policy-level issues/implications

The DG CNCT study has identified public XR-related initiatives that aim to address some of the above negative effects and barriers to the deployment of XR technologies in apprenticeships. These initiatives are presented in the following sub-section, focusing on the specific cases identified in Belgium, Denmark, and Lithuania. The second sub-section (Section 10.4.2. Policy recommendations) also includes concrete recommendations to public authorities (both at national and EU levels) on how to promote further the use of XR technologies in apprenticeship; these are based on both the DG CNCT study and on the additional desk research specifically conducted for this exercise.

10.4.1. **Who does what?**

While policy frameworks usually lag fast-developing technologies (Ellysse Dick, 2021; Lemley & Volokh, 2018), and particularly behind its adoption in apprenticeships and VET, some concrete examples of public initiatives can be observed.

(a) Belgium: according to the policy-maker interview, the Ministry of Education has allocated EUR 5.5 million for XR technologies under the Flemish initiative. It has also provided government guidelines

([75]) Based on interviews with academics carried out for the DG CNCT study (Extended reality: Opportunities, success stories and challenges (Health, Education))

([76]) Idem.

and recommendations on XR hardware and software. The Ministry launches calls for tenders for applied research on how to implement XR in education (including apprenticeships) and also runs programmes to train teachers to acquire skills to use XR technologies in education (including internships). In cooperation with the education sector, the Ministry plans to launch calls for tenders for the development of XR software tailored to education curricula (including apprenticeships) ([77]).

(b) Denmark: the Danish government's latest digitalisation strategy recognises the importance of VR and AR in VET (which is offered in the form of apprenticeship). The strategy stresses that inclusive technologies strengthen the link between theoretical training in school and practical training in the enterprise (e.g. through realistic visualisation of the working environment). The government has allocated funds to enable schools to purchase relevant equipment (e.g. VR- or AR-based tools, such as smart glasses, health-mounted displays, simulators) by 2023 ([78]).

(c) Lithuania: Lithuania's Next generation Lithuania plan aims to promote economic recovery, resilience, green and digital development. The plan foresees the development and use of XR technologies, including high-performance computing and VR/AR solutions. The Green and digital competences for vocational training initiative prioritises the development of virtual and augmented reality in distance learning to make VET more flexible and accessible. For this purpose, the Lithuanian government plans to invest in development of curricula and human resources for the training of occupations aligned in the Vocational training advancement platform, where training is delivered through distance and blended modes.

Despite these public initiatives to promote the deployment of XR technologies in VET and apprenticeship programmes, there is still a need for additional public attention in this area. The next subsection discusses possible policy recommendations which could lead to a greater uptake of XR in apprenticeships.

10.4.2. **Policy recommendations**

The following recommendations are suggested to boost the adoption of XR in apprenticeship and address existing XR-related challenges. These recommendations are based on the opinions of the authors taking into account the results of the DG CNCT study and of the complementary desk research.

(a) Carry out training for teachers/trainers on the use of XR applications and technologies, to build the required digital skills.

(b) Ensure favourable conditions for VET schools to adopt or experiment with XR technologies. This should include the provision of a clear guidance framework (on the use of XR for apprenticeships) and the creation of national education funds for the purchase/rental of XR software and hardware for VET schools. This may increase the awareness and affordability of XR technologies.

(c) Establish a regulatory policy body (or extend functions of an existing similar body) focusing on emerging technologies such as XR and providing clear guidelines for addressing ethical, legal and data protection issues to increase the transparency of XR adoption.

(d) Fund research projects to evaluate the potential effects of XR (including both positive and negative) to increase the awareness of XR adoption. For example, focus group research (e.g. experiments, contrafactual analysis), investigating the effects of XR on users. The results of such research should form the basis for further action by the regulatory policy authority in relation to XR.

(e) Encourage close collaboration between teachers/apprentices and XR developers (both software and hardware). For example, organise joint discussions, workshops, or hackathons with VET school (including apprenticeship) representatives and XR software creators to understand education needs better (especially, in terms of virtual training content/ scenarios).

(f) Ensure that apprentices' skills are sufficiently developed: the traditional method of training (e.g.

([77]) Flemish Parliament. (2021). *Visienota Van kwetsbaar naar weerbaar*. pp. 6-7.

([78]) *Danmarks digitaliseringsstrategi: sammen om den digitale udvikling*. [Denmark's digitalisation strategy: together for digital development.

physically in-company training) should not be abandoned completely but should be complemented by XR-based training.

10.5. Conclusions

XR technologies are being rapidly introduced into VET schools across the EU and can be offered in apprenticeships. The deployment of these technologies has already demonstrated positive effects on the learning process and its users (including trainers and apprentices). XR technologies have been shown to improve learning results, save resources (financial, time, and human), and increase student engagement.

However, despite these benefits, several challenges associated with the use of XR tools persist. These include the lack of a policy framework governing XR deployment, as well as potential psychological, ethnic, data protection, and medical risks posed to users. There is still a lack of trust in XR technologies, primarily due to insufficient evidence in the research field. There is limited evidence from large-scale longitudinal studies investigating the long-term effects of XR technologies (especially on users' physical and mental health).

Addressing these policy and research gaps, as well as managing existing XR-related risks, is crucial for ensuring faster and smoother uptake of XR technologies in VET schools. It is also essential to ensure favourable financial conditions for VET schools to adopt XR technologies, reducing their dependence on traditional learning approaches based on physical infrastructure and equipment.

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CHAPTER 11.

Virtual reality in apprenticeship training: myths and real opportunities

By Andrzej Wojciech Stępnikowski ([79])

11.1. Introduction

In 1935, Stanley G. Weinbaum published the science fiction novel *Pigmalion's Spectacles* where elements of virtual reality (VR) were described. The novel's hero meets a professor who has invented spectacles enabling the wearer to watch a movie, hear sounds and touch displayed objects. Since then, VR headsets have been deeply explored in many areas, including the field of education as well. In 1956, a simulator called Sensorama was developed (with vibrating chair and sound effects like rain and wind) and in 1968 Ivan Sutherland invented the first head mounted display (HMD) connected to a computer called Sword of Damocles. These headsets depicted simple virtual wireframe shapes, which changed perspective as the user moved his or her head. Since 1979, VR has been used to train professionals: military pilots as McDonnell-Douglas Corporation integrated VR with HMD (creating VITAL helmet) and in 1990 NASA developed its Virtual interface environment workstation (VIEW) to train astronauts.

VR technology is currently spreading across the World and the COVID-19 pandemic strongly accelerated this trend. In 2021 there were nearly 10 million VR headsets deliveries, and this number is still growing as they become more and more affordable. They are used extensively for playing but also for education. It is foreseen that in the next years more than 25 million virtual reality (VR) or augmented reality (AR) devices will be sold annually, though VR training markets in eastern Europe are at the early phase of growth with only a few companies delivering such virtual/augmented reality solutions ([80]).

Companies in European countries have a strong need to offer their apprentices and employees training and upskilling in new technologies, such as VR, AR and other. The need is more evident in the case of apprentices who lost for a period (a few months) equal possibilities with previous cohorts to be trained on the job (and be examined) as COVID-19 struck.

Different approaches are available to companies, like simulators and techno-educational stands, in physical or virtual form. According to Maddox, VR solutions are very effective in education ([81]) and can be used both in the school-based and the workplace component of apprenticeships. But not all approaches and training offers are suitable for developing the skills needed for craft and industry companies. They are sometimes not very flexible and adaptive to rapidly changing needs linked with the emergence of new technologies; only 62% have declared that they have the ICT competences to train apprentices (Stępnikowski, 2020, pp. 171).

The paper presents lessons from the application of virtual reality in the context of three EU funded projects (VR-PLC, COVIR and VR-PLC Train the Trainers), and concludes with messages about the challenges of using VR in apprenticeship programmes and enablers, also revealing myths and the real possibilities of VR use in apprenticeships.

([79]) Łukasiewicz Research Network – Institute for Sustainable Technologies (Łukasiewicz – Instytut Technologii Eksplotacji), Centre for VET Research and Innovation Management.

([80]) Source: IDC: AR/VR headset shipments to surge 54% this year

([81]) Source: The Science of VR/AR/MR Training for Retention: Training is Only Half the Story....and Not Even the Most Important Half [access: 10.6.2023]

11.2. Application of VR in VET and apprenticeship

Although the use of VR in apprenticeship seems promising, there is little evidence from its actual application. However, lessons on the readiness and willingness of teachers, companies and learners can be drawn by studying the use of VR in other VET options, especially since the same employers, and often VET schools, may also be participating apprenticeships.

11.2.1. **Experiences of Polish and Lithuanian companies**

Surveys conducted among Polish and Lithuanian companies active in metal machinery, automotive and electronics show that current offers are not satisfactory in this regard. Training formats for adults and juvenile learners are expensive, inflexible and do not cover industrial requirements (Stępnikowski A. 2022). One such research exercise was conducted among VET learners and companies in October 2022 in Radom and Kaunas, as part of the VR-PLC project (Box 1).

Box 1. **The VR-PLC project**

The survey was undertaken within the project *PLC-Centered VR-Training for Industry 4.0 (VR-PLC)* ([82]) realised by a consortium of the following EIT-Manufacturing ([83]) members: University of Ruhr-Bochum (leader), the Lithuanian Engineering Industry Association (LINPRA) and the Łukasiewicz Research Network – Institute for Sustainable Technologies (Ł-ITEE ([84]).

Participants from 14 Polish and Lithuanian companies from metal machinery, automative and electronics were part of the survey. The project involved constructors, team leaders, VET teachers and higher education lecturers in testing content and possibilities to master the basics of programmable logic controller (PLC) programming (with the support of the course at the SkillsMove.eu and VR learning environment.

Of the 52 participants (40 from Lithuania and 12 from Poland):

(a) 18 were employees – in-company trainers from Polish and Lithuanian industry (constructors, product designers, production line workers: they were in-company trainers) (35%)
(b) 16 students from the robotics and automation bachelor studies at the College of Kaunas (30%)
(c) 15 were executives, like COO or head of production from Lithuanian manufacturing industry (29%),
(d) 3 were VET students from Polish vocational schools (2 electronics, 1 mechanic-apprentice) (6%).

Source: Stępnikowski, 2022.

The survey showed that employees had already engaged in informal on-the-job training (86%) and sector-specific training, often offered by producers (78%) and e-learning (58%, in Poland 77%). Among eight forms of employee engagement in training, the one less mentioned one was training with the use of VR (used only by 16%, in two companies).

The main challenges of the training offer referred to the fact that most trainers are based in theory (71%), the subject of training is not adequate to the needs of the company (71%), and training costs are too high (64%). Managers also state that there are no proper training possibilities (63%), the training offer demands excessive technological requirements (43%) and it takes too much effort to attend the training (28%). Analysis shows that those issues correspond to both areas of vocational education, as in 'soft' and 'hard' competences, and to both parties in the learning process, students/apprentices and teachers/VET instructors.

([82]) Source: PLC-Centered VR-Training for Industry 4.0 [access: 11.3.2023]
([83]) European Institute for Innovation and Technology (EIT) – Manufacturing.
([84]) Source: Intranet EIT Manufacturing [access: 10.03.2023]

11.2.2. **VR used to train learners on PLC (VR-PLC project)**

Following the survey, the VR-PLC project involved training on site, on the physical techno-educational stands with virtualised version strengthened by the course set up on the SkillsMove.eu Platform.

Following the training, participants filled out a short survey on their overall experiences with VR compared to traditional models (like techno-educational stands) with reference to the VR-PLC solutions that were tested.

Figure 1. **VR-PLC Workshop in Radom (October 2022)**

Source: Author's resources.

Comparison of answers was given in a Likert scale (1-5 points). This different background also shows in the learners' self-assessment. Technical understanding and experience are vastly different between all learners: the best answers were given from the group of nine professionals from Polish companies – indication of 4.17 points – while for the whole group it was 2.50. Learners generally had prior knowledge of programmable logic controller (PLC) programming, because this is part of the curriculum at Kaunas College, and constructors were having classes on that as well during studies at universities of technology (although for many this was many years ago). Surprisingly, learners expect their mental effort to be lower in VR (1.40) compared to regular 3D applications, while they expect their physical effort to be higher (2.44). Prior experiences with 3D and VR greatly differ between the individual learners but VR applications (both for learning and gaming) are rarely used (1.71). In both countries VR is not yet popularised: there were not even one person among participants with his/her own VR headset. However, their cost is relatively high and equal to half the average salary.

Nevertheless, when comparing the usage of the 3D interface to the VR interface, both systems are easy to use and understood, without major differences as the user interface was indicated as 'intuitive to use', and the environment 'easy to navigate'. The VR experiences felt quite realistic, although there were some issues with regards to readability of the text that might need to be improved for both the 3D application and the VR application.

Most learners think the 3D on the PC and VR applications improved their understanding of PLC programming a little. The training was successful in showing different PLC programming options. Participants do not generally feel prepared to work on real PLCs, which might be a result of an over-simplification of the virtual learning environment (Wolf & Siewert 2022).

Most participants agreed that they would like to have more VR training in the future (4.06) though

there were also cases of physical complaints such as eye irritation, dizziness and nausea (3.46), and in a few cases skin irritation was also visible after 20 minutes of VR training.

11.2.2.1. *Lessons for the use of VR in apprenticeships*

Some important lessons emerge from the VR-PLC project.

First, for VR to be more effective in preparing apprentices (e.g. in the use of PLC), the learning environment should not be oversimplified and should be a part of a bigger 'educational package', bearing in mind VR technology limitations and comfort of participants.

Other important suggestions refer to the idea given by the consortium and the European Institute for Innovation and Technology (EIT) Manufacturing, of developing attractive ways of learning such as use of gamification and open badges (microcredentials). Gamification gives (feeling of) control to learners, as well as feedback, sense of achieving goals (progress) and collecting badges.

11.2.3. **Developing teacher and trainer communication skills (COVIR project)**

Vocational education is not only about hard skills as it helps develop learner personality (Goethe, Kerschensteiner and other labour pedagogists). Communication skills are considered as a one of the most difficult subjects to be taught online, especially in the VR environment.

To meet this challenge and address the lessons learnt from the VR-PLC project, the Łukasiewicz Research Network, Institute for Sustainable Technologies, launched the COVIR project: Collaborative virtual reality platform for e-learning: teaching communication. The project is financed from the Erasmus+ programme (covir.eu).

The project developed a collaborative VR platform and training materials and tools for a specific course to help trainers (teachers and VET instructors) to offer a communication skills course using VR. Participants are trained in using the VR environment effectively in the training process with the use of multimedia, avatars (and their gestures) and possible interaction (Figure 2). They are called meta VR trainers and include HE lecturers, school teachers and VET instructors (apprentice in-company trainers). Meta VR trainers were certified in four countries (Box 2).

Figure 2. **COVIR VR learning rooms**

Source: COViR partnership.

Box 2. **COVIR: VR platform for teacher and trainer communication skills**

The objectives of the COVIR project are:
(a) to develop a collaborative VR platform that will be able to host online training courses;
(b) to train trainers and certify them in the use of VR and the CoViR platform for online interactive training;
(c) to develop an e-learning platform for training trainers in the use of VR technologies and the CoViR platform especially;
(d) produce a teachers' guide for the sustainability and further use of the platform and accompanying materials.

To achieve those goals, COViR partnership has delivered tailor-made training for candidates (teachers and trainers) that will include professional/substantive preparation and teaching competences, methods and techniques with the adequate use of e-learning and tutoring (that will support individuals' self-learning).
The training of VR teachers consists of nine units including definition of VR, main steps in its history, advantages, limitations and challenges, VR head-mounted devices and main parts of VR headsets, as well as interaction in VR and its use in the education.
Meta VR trainer competences are validated in the way of knowledge test (on VR aspects) and practical demonstration based on the presentation of the communication skills course that is available in the COViR space. These include the performance of 10 indicated tasks such as profiling avatar, writing on the whiteboard, making typical gestures (waving hands, smiling, being angry) and showing presentation.
This project is being realised in Greece, Spain, Cyprus and Poland. 18 Meta VR Trainers have been certified, and 45 trainees/apprentices will be trained.
The communication skills course is used in this paper as a case study, as within the project tools to be used in a VR environment can be used for any other course.

Source: Author.

11.2.3.1. *Lessons for the use of VR in apprenticeships*

The implementation of the project in the four countries (Greece, Spain, Cyprus, Poland) leads to several messages on the use of VR in VET/apprenticeship.

First, VR technology is still rarely explored by education institutions, though it has great potential for social integration and can make group training more appealing when traditional tools are transferred to VR class (like whiteboard, presentation). VR solutions were warmly welcomed by teachers, VET instructors and entrepreneurs, although they will probably not be able to purchase such devices soon. There can be some difficulties in using VR for pupils with disabilities; in some cases it is almost impossible.

Specifically for apprenticeships, teachers and in-company instructors need to master the use of equipment (e.g. headsets) and VR tools such as those developed in the project. Only then they can they start to use VR headsets during the actual apprenticeship training.

VR tools can be used as supplementary educational aids. They are helpful in showing 3D objects and stimulating imagination, or in the context of operation of machines and devices, especially those that are not present/used in the training company.

11.2.4. **Training VR teachers and trainers (VR-PLC Train-the-trainer)**

Dynamic changes, especially those based on new technologies, and widespread access to the internet and smartphones (Spitzer, 2021, p. 18) urge educators to adopt a life-long learning approach and constantly improve the methods they use. Those changes affect teachers' competences in professional (with virtualisation aspects), technical, as well as personal and social spheres of life.

Lukasiewicz Institute, together with German and Lithuanian partners, developed a training programme for VR-PLC trainers, based on the experience from COViR and VR-PLC (2022). The Train-the-trainer module is financed from the EIT Manufacturing (Horizon Europe).

The idea is that it is easier (and cheaper) to train professionals in an innovative way not only by us-

ing real equipment, techno-educational stands and e-learning courses, but also with VR (and later with augmented reality). PLCs are commonly used in many industries, hence their selection for development and virtualisation: other popular applications reflect learning environment in mines and construction sites. The starting point was to virtualise the existing physical techno-educational stand (technological transport for Ladder Diagram programming) and transfer it to the VR environment. The learning space is enriched by adding a visual inspection system and by enabling interaction between learner/apprentice and VET instructor.

The VR-PLC train-the-trainers module was based on COVIR platform functionalities (Figure 3).

Figure 3. **VR-PLC Train the trainer module**

Source: Ruhr Universitaat in Bochum.

The project intends to take into consideration some critical factors of how educators need to be trained to use VR and how it should be incorporated in apprenticeship training.

For learners to form attitudes and skills, there is a need not only to select proper content for the training programme but to also put emphasis on its skilful transmission. Training should motivate learners to think independently, meet their needs and interests. A good educator should understand the importance of communication, have factual knowledge and be creative (especially in VR).

Teacher and trainer communication skills, especially in the context of VR training, are crucial, as these skills and the personality of the teacher/trainer create conditions for participant engagement and stimulation (including apprentices). It is important to keep in mind that as early as 1908, Yerkes and Dodson proved that too low and too high levels of stimulation reduce the efficacy of teaching activities (Kutschenreiter-Praszkiewicz et al., p. 50).

Along with the increased level of stimulation, we limit the capacity of our working memory, where we process more and more information, but in parallel we witness faster and more effective functioning of our cognitive system that is responsible for our reaction to these stimuli.

A VR teacher/trainer should take this into account when planning the training and consider proper forms of activities and presentations. How should that be done to attract the attention of participants? Like Socrates with his maieutic method, try to run discussions with participants in the way that will 'lib-

erate' their knowledge, not simply equip them with information but rather make them start to think (and they will become aware of the knowledge they have). We can achieve better learning retention if we let participants search on their own and confront results during extensive discussion with other attendees. We perform better and more consequently in executive situations where we have a feeling of our own agency and own competence, when we believe in our abilities and that we can do something (Brophy, 2007, p. 65). The more senses are engaged, the better learning retention we will become. Participants will remember the processes and they can be our 'anchor points' helping us, for example, to activate pre-knowledge in future training (Kutschenreiter-Praszkiewicz et al., p. 51).

11.2.4.1. *Lessons for the use of VR in apprenticeships*

Communication skills are crucial for VR teachers as they greatly influence training efficacy. We can say that VR teachers need to use their voice and avatar-gesture in the optimum way to create lasting impression and use a variety of presentation styles selected for specific audiences. The training environment a key element in quality assurance of the delivered workshop. The VR classroom should enable participants to be focused and creative, to be eager to perform and share experiences.

Keeping participants in proper engagement with an appropriate level of arousal and different presentation styles connected with the topic and trainer's personality should help achieve optimal level of concentration. To 'maintain' participant attention and motivation we need to use various methods like work-based learning (as the foundation in the apprenticeships), e-learning and VR/AR solutions.

11.3. Potential of using VR in apprenticeships

VR technology has many advantages as a training tool, enabling deeper exploration of given topics in an attractive way, with immersion and sense of presence, sometimes also with interaction with avatars of other participants. Literature backs up many of the lessons of the projects presented.

VR solutions eliminate many potential obstacles like costs of travel and use of equipment. In real conditions, open and constant access to the machinery and equipment is not possible: in VR simulations it is. VR can be applied in both learning venues (schools and companies) and can give equal access to the same learning environments to all learners. VR can be a very useful tool especially in the context of simulation of dangerous places like mining and construction sites.

VR also helps maintain learning retention at high levels thanks to the easy access and possibility of constant retraining. Tests and targeted retraining sessions stimulate long-term memory storage, enabling us to keep and recall acquired information. Tests and retraining should be repeated so that 'less and less information must be retrained, and forgetting is nearly absent' (Maddox, 2017). Knowledge retention is increasingly highly valued by scientists like T. Maddox, L. Chitarro, and F. Butussi (Wolf & Siewert, 2022).

A 2022 study offered a comparative analysis of the training effects of VR in relation to AR and physical equipment. For this study, 60 male trainees carried out three maintenance tasks at different levels, using three training platforms based on VR, AR, and actual equipment (traditional group). The study showed that, for single-level maintenance tasks, the training effect of the traditional group was significantly better than that of the AR group and the VR group. For multi-level maintenance tasks, the training effect of AR group was significantly better than that of the VR group. With the increasing difficulty of maintenance tasks, the training efficiency of the AR group was more than 10% higher than that of the VR group and traditional group, and the AR group had less cognitive load (Liu et al., 2022).

VR technology makes it possible to transform maintenance training from an actual equipment platform to a 3D virtual platform. Training effectiveness of VR based on monoscopic screens and actual equipment platforms was compared. The results show that VR training platforms can effectively reduce errors in task execution and obtain better training effectiveness (Langley et al., 2016).

A VR environment can bring significant benefits in terms of performance, motivation and engagement, inter alia thanks to gamification. Gamification gives learners (feeling of) control, feedback, sense

of achieving goals (progress) and collecting badges. Studies suggest that learners with access to a combination of VR training and simulation with traditional forms of learning (like work based-learning, apprenticeships, e-learning) outperform students with only traditional training (Merchant et al. 2014).

Some researchers show that emotional factors like presence, motivation, and enjoyment were significantly greater in an immersive VR space compared to using the same environment through a desktop setup. There was no significant difference in perceived learning outcomes compared between the two setups (Makransky & Lilleholt, 2018).

11.4. Challenges and enablers of apprenticeship VR

The methods and VR solutions mentioned in this paper were partly tested on apprentices but evidence comes from VET teachers and employers who are also participating in apprenticeship. Their analysis helps break down myths related to the use of VR in training (Box 3) and offers useful messages on the conditions under which VR can be introduced in apprenticeships.

The introduction of VR does not come without challenges, especially for VET institutions and companies participating in apprenticeships. For example, VR is expensive at the beginning (high start-up costs, such as headsets) and requires significant investment. VET schools and companies participating in apprenticeships vary in terms of readiness, levels of prior experience, and willingness or reluctance to introduce such technologies. Shared investment in infrastructure (e.g. with the contribution of a professional association or a social partner training centre, craft chamber) might lift the burden from single actors and raise reservations on the use of VR tools in apprenticeship training.

Box 3. **Myths about VR**

- VR is not an augmented reality (AR)
- VR cannot be used without limitations. Time limits are suggested by producers. In general, each session should not last for more than 30 minutes; then the learner needs to rest (15-20 minutes optimal) in order not to feel discomfort
- VR devices have limitations (for people with labyrinth disorders, risk of epilepsy and some other disabilities). Sometimes skin rash or dizziness may appear. VR is (not) only for gaming
- When jumping into virtual reality for the first time, some users can get sick (stomach disorder)
- VR can be antisocial, but must not be
- VR usually keeps hands occupied with controllers or gloves with sensors
- VR users need to keep themselves in the safety area
- VR options are still relatively expensive: equipment costs, costs of development of a VR learning environment and costs of training VR trainers
- VR is not just a trend, but a long-term project
- VR is learning by doing but not authentic work-based learning

Source: Author.

Investment is also required to train teachers and trainers on how to use VR solutions. Evidence presented in this paper showed that their role is crucial, as they need to be properly familiarised with the new technologies and to have the right communication skills for VR environments. Therefore, teachers and trainers need to be allowed to pursue their own continuing professional development in this respect, to have sufficient time to learn the tools and test training scenarios/environments and to develop the communication skills needed for VR. Joint teacher and training programmes such as the ones presented in the paper have significant potential.

Although VR is considered as effective as learning by doing, it is not an entirely authentic work-based learning experience. For example, real apprenticeship training helps develop responsibility for issues such as losses on materials.

Some of the disadvantages of using VR are linked with dizziness, VR motion sickness, skin irritation ([85]). All those issues suggest that VR headsets as an ICT tool should be used for 15-30 minutes, followed by a break. Due to the relatively high costs, VR headsets are also quite rarely used in schools and companies.

For these reasons, VR applications are recommended to be used as supplementary tools (educational aids) that would serve as a means of highlighting the importance of enabling storage of an important information in long-term memory.

11.5. Conclusions

VR solutions seem to have great potential to serve as additional training aids for apprenticeship instructors, making apprenticeship more attractive and enabling continuation of the learning process even in difficult times like COVID-19. VR can be a good training tool and useful element of educational packages, complementing other methods, training apprentices in an effective and efficient way thanks to increased engagement, stimulation and elements of gamification.

With further dissemination of appropriate equipment, VR may also serve as a tool for self-education, enabling constant retraining without the usual cost limitations of machinery or travel to work.

Virtual reality 'potentially offers greater personalised and inclusive learning approaches tailored to the needs of individual learners' (Cedefop, 2022, p. 17). But it also has its limitations and should be incorporated into training courses and apprenticeships as an additional, attractive element in education packages.

VR will not replace apprenticeships (the first legal contracts were signed with craft masters 4000 years ago in Hammurabi times) but it can make them more attractive. The technology should be disseminated more among VET instructors and apprentices, enabling realisation in safe and flexible ways of some elements that would require an access to machinery/equipment that this particular employer does not have.

A proposed way forward is to disseminate training VR components for pedagogical courses for VET teachers and trainers by 2030 and encourage employer organisations to invest in VR and AR technologies for the enrichment of educational processes companies. At the same time, employers should remember the myths and limitations of VR technology, as their impact on learners is not yet fully explored.

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CHAPTER 12.

Success factors in apprenticeship delivery in times of digital transformation: facilitating new skills uptake by in-company trainers

By Barbara Ofstad ([86]) ([87])

12.1. Introduction

Today's European economies have two general problems: a shortage of skilled workforce on the one side and the continuous struggle of companies to defend and/or expand their competitive position in innovative technologies on the other. Innovating requires many things, among which are technical and digital skills to respond to the fourth industrial revolution in the shape of the digital transformation (Gong and Ribiere, 2021). Digital transformation may translate to jobs obsolescence but also gives rise to new jobs and redefines tasks.

Vocational education and training (VET) is one lever to counterweight these two issues:

(a) as a pipeline for young skilled workers at the beginning of their working life who are trained via apprenticeships to replace the baby boomers;

(b) for a workforce which may be on-board but not entirely fit to tackle today's digital challenges and who are trained via continuing education programmes, upskilling and reskilling.

For the latter target group, in particular, active learning strategies are part of the skills which are becoming more important (World Economic Forum, 2019). The OECD predicts 15% of all jobs to disappear due to automation, while another 32% on average across the OECD member states will be likely to change (OECD, 2019).

VET, typically offered in the form of apprenticeship, is considered a cornerstone of the German education system and a warranty of 'Made in Germany' standards and a skilled workforce. During a period of 2 to 3.5 years, apprentices (and students of higher-level dual studies) are employed by a company and develop skills in VET schools (or universities) and at the workplace during the practical phase of apprenticeships. As well as the regular workplace (factory floor), bigger companies may set up their own company training centres to organise in-house applied apprenticeship training more efficiently. These training centres are managed by in-house teams and are referred to hereinafter as VET departments. Intra-company or sector training centres also exist but are not the subject of this research.

A corporate VET department in Germany – sometimes the little sister of a corporate learning department – operates at the bottom of the talent building echelon and typically caters for professional secondary and tertiary education. It offers an interesting personnel assembly of VET veterans: people with teaching background and recent additions from the businesses or factory floors, all truly dedicated to learning and teaching, mainly but not exclusively, young adults enrolled in apprenticeship (or higher

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dual VET) programmes.

Recent developments in technical apprenticeships in Germany have rightly added digital competences to the VET school and company apprenticeship training curricula (BIBB, 2018). This is a strong indicator of how relevant transformation and change have become in the VET community. While theoretical skills can be taught in vocational schools, the company-specific skills, products, sometimes trade secrets or mere 'know-how' in the true sense of the term, are taught in the German dual VET system by the so-called *Ausbilder*. These are corporate VET trainers in the training centres, and/or mentors in the departments where the apprentices are working alongside seasoned colleagues in a learning-by-doing style typical for dual VET. The addition of digital competences in curricula requires trainers to develop, in turn, corresponding competences, skills and methods (Esser, 2018).

Along with this, the way of teaching has also changed, as has the didactic underpinnings. The individual learning progress and competences are put at the centre of all pedagogical effort (Hollatz and Ofstad, 2022), while digital skills and virtual and blended learning formats are added to the didactic concepts.

Proliferating these new skills can be done to some extent by trainers learning from each other within an organisation. Often, this translates to overcoming structural, local, and cultural boundaries to get to a new learning culture for trainers (Hollatz and Ofstad, 2022).

Via an explorative case study which is part of the author's doctoral thesis, this article shows how learning methods contribute to the learning and perception of future readiness in the VET department of a German industrial multinational enterprise (MNE). It also illustrates how learning culture and leadership influence the perception of digital transformation of an MNE's VET department. It is based on the specific research question seeking to understand which factors facilitate the uptake of new skills by in-company trainers to support digital transformation in vocational education and training.

12.2. Methodology

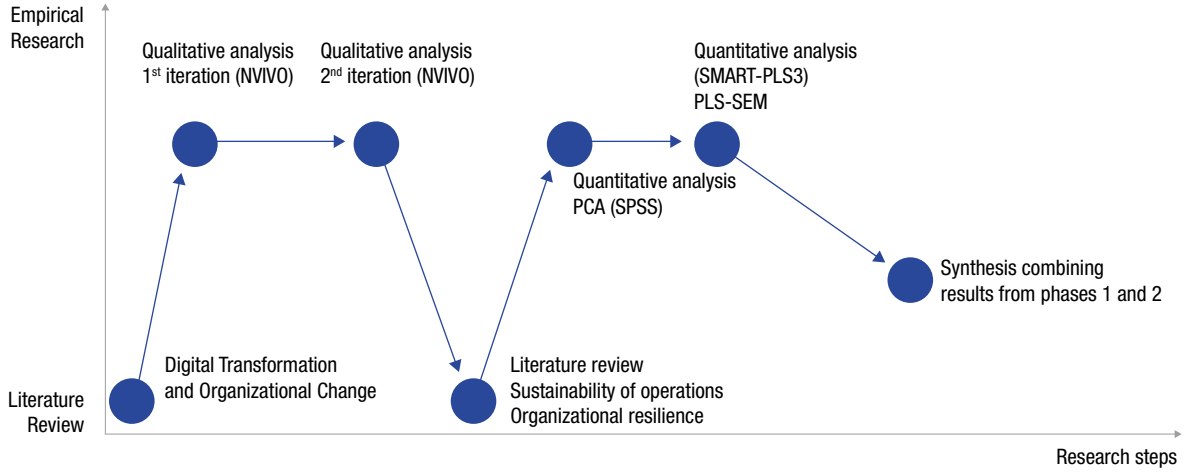
12.2.1. **Research design**

The research uses original data from the author's work environment. First, the topic was explored qualitatively by interviews with 21 people from the German VET department in various roles) and locations. Based on these results, an online survey was conducted with all staff members of the 19 locations of the German high-tech VET department, resulting in 175 answers (representing a 62% response rate) ([88]).

As the researcher has been the manager of the VET department to be explored, an objective – positivist – stance would be hard to attain. Objectivity is given in this exploratory abductive, interpretive approach by 'bringing to light inconsistent and even conflicting findings' (Avenier & Thomas, 2015: 86). The mixed-method research design is chosen to allow for validity and objectivity by a more comprehensive understanding and integration of qualitative and quantitative data to expand reliability and generalisability of the results. The abductive approach allows for accepting the empirical data without consulting too much theory upfront. Rather, theory is enfolded at each step of the exploratory sequential design (Figure 1).

([88]) This exploratory sequential design (Creswell, 2015) is used to seek 'plausible interpretations that fit lived experience' (Avenier and Thomas, 2015: 71). We take an interpretive stance, in the knowledge that rich description is needed to prove to the reader credibility (Avenier and Thomas, 2015) in the conclusions achieved and that generalisations need to be carefully pondered, if not avoided.

Figure 1. **Abductive approach, exploratory sequential design**



Source: Author.

12.2.2. **Data collection and qualitative analysis**

Between January and June 2021, 21 interviews were carried out with the leadership team of the VET department plus various other members in typical roles such as local training centre managers, VET trainers or headquarters staff to explore the topic. Control variables can be seen in Table 1, including age, direct report yes/no of the researcher-manager, regional affiliation, and level of education. The level of education indicated here in the German qualification framework is very similar to the EQF. For data protection reasons, the table does not show which five respondents were female and who identified themselves as one of six head office managers, one of six local training centre managers, one of three trainers and one of six regional managers responsible for several training centres.

Semi-structured interview protocols were used to ensure a systematic and similar procedure to explore attitudes, motivations, observations, and narratives of interviewees around six key topics broadly: challenges, methods, leadership, culture, key people in transformation, and role models ([89]). No special mention was made upfront by the interviewer as to digital transformation or future orientation in the department.

Table 1. **Control variables, qualitative study**

Person No.	Age Group	Researcher's Direct Report	Level of Education	Region
I01	50+	No	6	1
I02	50+	Yes	>6	2
I03	50+	Yes	6	3
I04	50+	Yes	>6	4
I05	40-49	Yes	6	4
I06	40-49	Yes	>6	7
I07	40-49	No	6	6
I08	50+	No	>6	1

([89]) Two rounds of coding using NVivo data analysis software were carried out according to the grounded theory method (Corbin and Strauss, 1990; Gioia, Corley and Hamilton, 2013).

Person No.	Age Group	Researcher's Direct Report	Level of Education	Region
I09	50+	Yes	>6	1
II0	40-49	Yes	6	5
III	30-39	No	>6	4
II2	40-49	No	>6	5
II3	40-49	No	>6	2
II4	20-29	No	>6	2
II5	40-49	No	>6	4
II6	40-49	No	6	4
II7	40-49	No	6	1
II8	40-49	No	6	3
II9	50+	No	>6	2
I20	40-49	No	>6	1
I21	40-49	No	6	7

Source: Author.

To include more people and control the influence of the manager-researcher, a quantitative confirmation of select qualitative findings via MS Forms online survey with all 286 VET staff members, including 190 trainers working in the department, was carried out in November and December 2021. The staff was familiar with handling online surveys. The survey was carried out in German and later translated into English.

Survey participants were asked for their opinion as to learning preferences and effectiveness on a five-point Likert scale. Outcomes from the qualitative findings were developed into questions, again on a five-point Likert scale.

The survey focused on questions about leadership, role models and the confidence of the survey respondents as to whether the department was future-proof, if trust was perceived, and how strongly the participants had experienced culture and change in their VET department in the last 5 years (all five-point Likert scales). Questions regarding learning preference, learning effectiveness, teaching methods and didactics were specifically linked to digitalisation.

Our control variables show that 62% (Figure 2) answered the survey, including 104 trainers. Most of the trainers had worked in only one VET training centre, typically in training centres of 5-15 staff members or >15 staff members.

Figure 2. **Control variables, quantitative study (online survey)**

Age group		Role		Size of training center		Work experience in different training centers	
<30	9	Trainer	104	small (<5 employees)	12	only the current one	119
30-39	52	Staff role	24	medium (5-15 employees)	74	2 altogether	37
40-49	55	Manager	25	big (>15 employees)	89	3 or more altogether	19
50-59	49	Misc.	22				
>59	10						

Source: Author.

12.2.3. **Quantitative data analysis**

The results were gathered in MS Excel and imported first into SPSS; here a principal component analysis with Oblimin rotation was performed to come up with mono-dimensional, empirically grounded factors (i.e. constructs) in the measurement model. The relationships between all these factors were then tested; only the ones showing significance ($p < 0,05$) were retained as arrows in the structural model we established with Smart-PLS3 software inductively, following our analysis.

This way, the following 13 factors (constructs in partial least square structural equation modelling, PLS-SEM), were identified:

(a) positive opinion about new normal teaching/digital learning/hybrid vocational education and training (VET) formats is used as latent variable POSITIVE ABOUT HYBRID VET with a single indicator, anchored in the digital transformation context;
(b) MANAGERIAL ROLE MODELS is also a construct based on a single question related to boundary spanning across training centres aimed at acquiring new skills and new ways of learning and teaching;
(c) MANAGERS SUPPORT is another single-indicator based variable which is special to the new didactic VET concepts;
(d) MANAGER YES/NO is a binary variable reflecting whether the survey respondent has a manager role or not;
(e) METHOD USE CASES, as (conceptional/methodological) aspect relevant for good training, is based on one question as well. The question was not asked specifically on topics relating to digital transformation.

According to the exploratory nature of this research, these latent variables with a single indicator were integrated into the analysis.

The other constructs were reflective. We like the simplistic explanation regarding the reflective character of constructs in the sense that they are indicated/exemplified/reflected by the original variables rather than completely defined/explained/caused (like formative constructs). Hair et al. (2020: 104) describe it as such that the original variables 'are seen as a manifestation of the empirical surrogates (proxy variables) for the latent variable'.

(f) PERCEPTION OF DIGITAL TRANSFORMATION of in-company training means realisation of virtual collaboration, digital learning, and hybrid VET formats;
(g) POSITIVE ABOUT NEW METHODS AND DIDACTICS means a positive attitude towards the new understanding about how apprentices will be taught, including virtual methods;
(h) BLENDED/INDIVIDUALLY PACED LEARNING reflects on both self-led and combined formats. Combination can be hybrid-classroom and/or social-individual learning phases;
(i) FUTURE-PROOF VET OPERATIONS assesses the survey respondents' opinion about the future-proof-ness of departmental operations, i.e. preparedness for future demands from the various in-house businesses on teaching tech skills and capabilities;
(j) VIRTUAL LEARNING PROPENSITY is a reflective construct which describes the survey participants' acknowledged usefulness of virtual training formats (versus in a physical on-site setting), often cross-regional;
(k) culture and leadership: a perceived and appreciated TRUST AND LEADERSHIP CHANGE is noted by the participants. This construct is not specific to digital transformation but evolves around learning culture and the leadership exhibited in general;
(l) MOTIVATION to carry out training for colleagues, because of either a sense of responsibility, sheer passion or with the intent to create and multiply knowledge;
(m) A PEOPLE-ORIENTED SETUP of training activities, where the topic is relevant to the trainee (in this case, a VET trainer) and set up in a network or community of practice of mutual trust.

The 13 constructs were grouped in broader categories. Table 2 shows how the different component

factors are built from the survey items and to which groups they were sorted to.

Table 2. **Principal component factors built from online survey questions**

Group Category	Construct	Survey questions (assessed by interviewees on a 5-point-Likert scale)
New Work Mindset	VIRTUAL LEARNING PROPENSITY	Which learning formats do you consider useful? Train-the-trainer/learning communities technologies
		Which learning formats do you prefer? virtual trainer-led courses
		Which learning formats do you consider useful? Train-the-trainer/methodics-didactics/virtual new normal teaching didactics sessions
		Which learning formats do you consider useful? Train-the-trainer/cross-regional process
	PERCEPTION ON DIGITAL TRANSFORMATION	Perception of culture change: new normal/virtual collaboration
		Perception of culture change: hybrid VET training formats
	POSITIVE ABOUT NEW METHODS AND DIDACTICS	Evaluation of culture change: new normal/virtual collaboration
		Evaluation of culture change: new methods/didactics
	BLENDED/INDIVIDUALLY PACED LEARNING	Which learning formats do you prefer? blended learning
		Which learning formats do you prefer? self-paced learning
	POSITIVE ABOUT HYBRID VET	Evaluation of culture change: hybrid VET training formats
Culture and Leadership	MANAGERS AS ROLE MODELS	My management acts as a role model regarding boundary spanning across training centers.
	MANAGERIAL SUPPORT	I feel well supported by my manager regarding our new VET philosophy.
	TRUST AND LEADERSHIP CHANGE	Perception of culture change: leadership behavior/style
		Perception of culture change: trust within the team
		Evaluation of culture change: leadership behavior/style
		Evaluation of culture change: trust within the team
Training Methods and Activities	METHOD USE CASES	Which (conceptional/methodological) aspects do you consider relevant for a good training? use cases
	PEOPLE-ORIENTED SET-UP	Which (conceptional/methodological) aspects do you consider relevant for a good training: importance of topic for me
		Which (relational/social) aspects do you consider relevant for a good training: networking
		Which (relational/social) aspects do you consider relevant for a good training: mutual trust
Future Orientation	FUTURE-PROOF VET OPERATIONS	What is your assessment about our VET department's sustainability/preparedness for future demands?
Role Manager yes/no	MANAGER YES/NO	I am a manager (regional/local/headquarters).

Group Category	Construct	Survey questions (assessed by interviewees on a 5-point-Likert scale)
Trainer's Motivation	MOTIVATION	What were the reasons that motivated you to carry out a training for colleagues: create knowledge
		What were the reasons that motivated you to carry out a training for colleagues: sense of responsibility
		What were the reasons that motivated you to carry out a training for colleagues: passion

Source: Author.

In a subsequent step of quantitative analysis, we used partial least square structural equation modelling (PLS-SEM) to explore the relationship between the different constructs. This can model complex interdependencies between variables while improving prediction quality compared to linear regression models ([90]).

For all constructs, linear interrelationship assumptions were checked by correlation. Table 3 shows the statistical description of construct characteristics.

Table 3. **Construct characteristics**

	Mean	Median	Min	Max	SD	Excess Kurtosis	Skewness	Number of Observations Used
TRUST AND LEADERSHIP CHANGE	0.000	0.206	-2.941	1.612	1.000	0.591	-0.760	175
POSITIVE ABOUT HYBRID VET	0.000	0.172	-2.793	1.160	1.000	0.223	-0.766	175
MANAGERS AS ROLE MODELS	0.000	0.299	-2.597	1.265	1.000	0.615	-0.848	175
MANAGERIAL SUPPORT	0.000	0.331	-2.254	1.193	1.000	-0.172	-0.685	175
METHOD USE CASES	0.000	0.447	-6.030	0.447	1.000	14.310	-3.256	175
MOTIVATION	0.000	0.000	-6.122	0.981	1.000	12.979	-2.767	175
PEOPLE-ORIENTED SETUP	0.000	0.000	-3.579	1.289	1.000	1.692	-1.054	175
PERCEPTION ON DIGITAL TRANSFORMATION	0.000	0.102	-5.066	0.845	1.000	6.849	-2.034	175
POSITIVE ABOUT NEW METHODS AND DIDACTICS	0.000	0.079	-3.014	1.363	1.000	0.408	-0.767	175
MANAGER YES/NO	0.000	-0.734	-0.734	1.558	1.000	-1.177	0.831	175

([90]) PLS-SEM's conditions for use are not limited by normal distribution of the data under scrutiny. PLS-SEM is also suited for small samples (Hair, Mathews, Mathews and Sarstedt, 2017; Ringle, Sarstedt, Mitchell and Gudergan, 2020). According to Legate et al. (2021), whose methodology we use, PLS-SEM has not made itself a wide reputation in human resources development research. Yet, its advantages such as flexibility regarding data characteristics, suitability for exploratory research and strong prediction quality of sophisticated models, made it the plausible choice for this case.

	Mean	Median	Min	Max	SD	Excess Kurtosis	Skewness	Number of Observations Used
BLENDED/ INDIVIDUALLY PACED LEARNING PREFEENCE	0.000	-0.107	-2.492	1.877	1.000	-0.202	0.019	175
FUTURE PROOF VET OPERATIONS	0.000	0.309	-3.487	1.258	1.000	1.457	-1.222	175
VIRTUAL LEARNING PROPENSITY	0.000	0.152	-2.893	1.746	1.000	0.588	-0.701	175

Source: Author.

Results show that quality criteria (Legate et al., 2021) were globally met.

An assessment of in-sample predictive ability can be carried out via R square of the endogenous variables (Table 4). As moderate predictive quality is indicated by > 0.5 (Legate et al., 2021), we need to state that in-sample predictive model ability remains low, but acceptable for exploratory research.

Table 4. **In-sample predictive model ability**

	R Square
TRUST AND LEADERSHIP CHANGE	0.345
METHOD USE CASES	0.135
PERCEPTION ON DIGITAL TRANSFORMATION	0.366
POSITIVE ABOUT NEW METHODS AND DIDACTICS	0.493
BLENDED/INDIVIDUALLY PACED LEARNING	0.046
FUTURE-PROOF VET OPERATIONS	0.450
VIRTUAL LEARNING PROPENSITY	0.357

Source: Author.

For the model, linear interrelationship assumptions were checked by correlation for all constructs. Empirical measures with low correlation levels between indicators have not been built into the model. Accordingly, paths between constructs (arrows in the model, Figure 3) showing little correlation have not been drawn at all. Table 5 presents the path coefficient and p values.

Table 5. **Path coefficients, standard deviation, t test and p values**

	Path Coeff.	Std. Dev.	t Stat.	p Values
TRUST AND LEADERSHIP CHANGE -> VIRTUAL LEARNING PROPENSITY	0.202	0.072	2.825	0.005
POSITIVE ABOUT HYBRID VET -> PERCEPTION OF DIGITAL TRANSFORMATION	0.381	0.061	6.230	0.000
POSITIVE ABOUT HYBRID VET -> POSITIVE ABOUT NEW METHODS AND DIDACTICS	0.379	0.104	3.636	0.000
POSITIVE ABOUT HYBRID VET -> VIRTUAL LEARNING PROPENSITY	0.368	0.082	4.513	0.000

	Path Coeff.	Std. Dev.	t Stat.	p Values
MANAGERS AS ROLE MODELS -> TRUST AND LEADERSHIP CHANGE	0.457	0.060	7.639	0.000
MANAGERS AS ROLE MODELS -> PERCEPTION OF DIGITAL TRANSFORMATION	0.189	0.086	2.211	0.027
MANAGERS AS ROLE MODELS -> BLENDED/ INDIVIDUALLY PACED LEARNING	0.215	0.075	2.859	0.004
MANAGERS AS ROLE MODELS -> FUTURE-PROOF VET OPERATIONS	0.173	0.071	2.438	0.015
MANAGERIAL SUPPORT -> POSITIVE ABOUT NEW METHODS AND DIDACTICS	0.167	0.071	2.338	0.020
MANAGERIAL SUPPORT -> FUTURE-PROOF VET OPERATIONS	0.314	0.078	4.020	0.000
METHOD USE CASES -> PERCEPTION OF DIGITAL TRANSFORMATION	0.268	0.110	2.436	0.015
MOTIVATION -> METHOD USE CASES	0.368	0.147	2.510	0.012
PEOPLE-ORIENTED SET-UP -> TRUST AND LEADERSHIP CHANGE	0.300	0.063	4.746	0.000
POSITIVE ABOUT NEW METHODS AND DIDACTICS -> FUTURE-PROOF VET OPERATIONS	0.154	0.076	2.040	0.042
MANAGER YES/NO -> POSITIVE ABOUT NEW METHODS AND DIDACTICS	0.222	0.048	4.606	0.000
BLENDED/INDIVIDUALLY PACED LEARNING -> VIRTUAL LEARNING PROPENSITY	0.218	0.071	3.073	0.002
VIRTUAL LEARNING PROPENSITY -> POSITIVE ABOUT NEW METHODS AND DIDACTICS	0.199	0.073	2.727	0.007
VIRTUAL LEARNING PROPENSITY -> FUTURE-PROOF VET OPERATIONS	0.250	0.072	3.450	0.001

Source: Author.

12.3. Findings

According to our exploratory mixed-method sequential design and the chronology of our study, we present first the qualitative, then the quantitative results.

12.3.1. **Qualitative results**

Concepts of the qualitative analysis evolve around challenges, game changers and benefits of digital transformation enabling the update of new skills by VET trainers. The challenges can be described as follows.

Digital transformation, accelerated by the pandemic, has led to accelerated change regarding content and methods of VET used within the company for apprentices. As one interviewee puts it: 'In the dual VET system, we are very strongly ruled by laws and regulations, which may not be appropriate for today's time and speed. Hence, it is a balancing act, there are things from the past which won't change swiftly' (P4). Digitalisation in VET is explained as follows: 'Hardware is one side of this whole topic, didactics, methods are the other side. And the latter are much more important regarding digitalisation' (P03). 'The biggest challenge? To convey the future technology topics' (P13).

The didactic concept of how VET is provided has evolved. The department has officially introduced a new VET framework (competence and project-based education, COPED), which promotes learner-centric methods and individual competence enhancement while allowing more variety and creativity in curricula under the tutoring of the VET trainers. This is referred to by another interviewee: 'The tasks of the VET trainers change tremendously, […], i.e. the trainer is not the conveyer of knowledge any longer, but he is also the coach and the learning progress companion. He does not teach things any longer which he knows by heart and in which he is expert and understands, but he must have a broader standing and accompany the learning process. This constitutes a challenge' (P04).

Trainer motivation to change may vary and is influenced by his or her peers, as described by another manager, dependent on peer group constellation and peer group size: 'Then you also have the type who says: 'I have been in VET for so long, you don't need to tell me that, I already know everything and have my fixed structures and have been doing this for 20 years…' This type exists, of course, and if you have a lot of these types in a group, that it gets difficult to envision something else' (P14).

The game changers in this department evolve around learning culture and leadership in general, but also individuals' mindsets.

'Fundamentally, I can state that managers today strive much more to act at eye level with their staff', states interviewee P07. P18 points out that managers should act as role models: 'Culture has definitely changed. It became more open. […] That is fun. That raises or keeps up motivation. […] I think managers should live this topic.'

Managerial support can look like this example: 'I started with little nuggets, really, did not paint the whole picture […], but rather tried a bit to visualise the dialogue together. What are the next little steps? And then aim at small success stories, say, this is a tool I have learned to master, and it works. In the next step, I will deep-dive into 3D printing, and then I share this. We had such nuggets. One of the team members is really fit in terms of robotics. And then we said 'OK, this one does a 2-hour training in the afternoon', while the apprentices were tied up with [something else]. This time we use, even the team assistant participated, such that really everybody knew what this was about. Then there was another part where we said: 'Ok, and now we do 3D printing.' And not just this 'I got it', but rather this successful feeling of 'I could teach this' (P15).

Training methods and activities are considered as another game changer: a deliberately voluntary participation in people-oriented training set-ups, fuelled by virtual meetings and the pandemic, is aimed for: 'And what really is undergoing change now, is this whole topic of learning communities, sometimes also smaller nuggets, shorter sessions, simple opportunities for exchange. In fact, I perceive this as a clash of generations, it really depends on your normal workday, how well you can integrate this into your VET operations. If you are somebody who does a lot of classroom teaching, can you build it into your sessions or not? Acceptance differs, I think, it still has to become mainstream. This is a change we are currently stuck in' (P14). This is seconded by P11 describing projects: 'But this new, open thinking, to say we discuss this, we allow for solutions out of the ordinary that may fail, but we take select aspects which may bring about a solution, we question those critically […] both sides may benefit from this.' (P18).

Case studies are of particular interest for trainers to learn and teach, giving an applied example of digitalisation technologies and methods and how they work: 'Real use cases, showing how to use it concretely. What concretely is the task? Which real project did I task my learners with, for instance, not on a theoretical level, but in a real-life context, for practical implementation (P16)?'

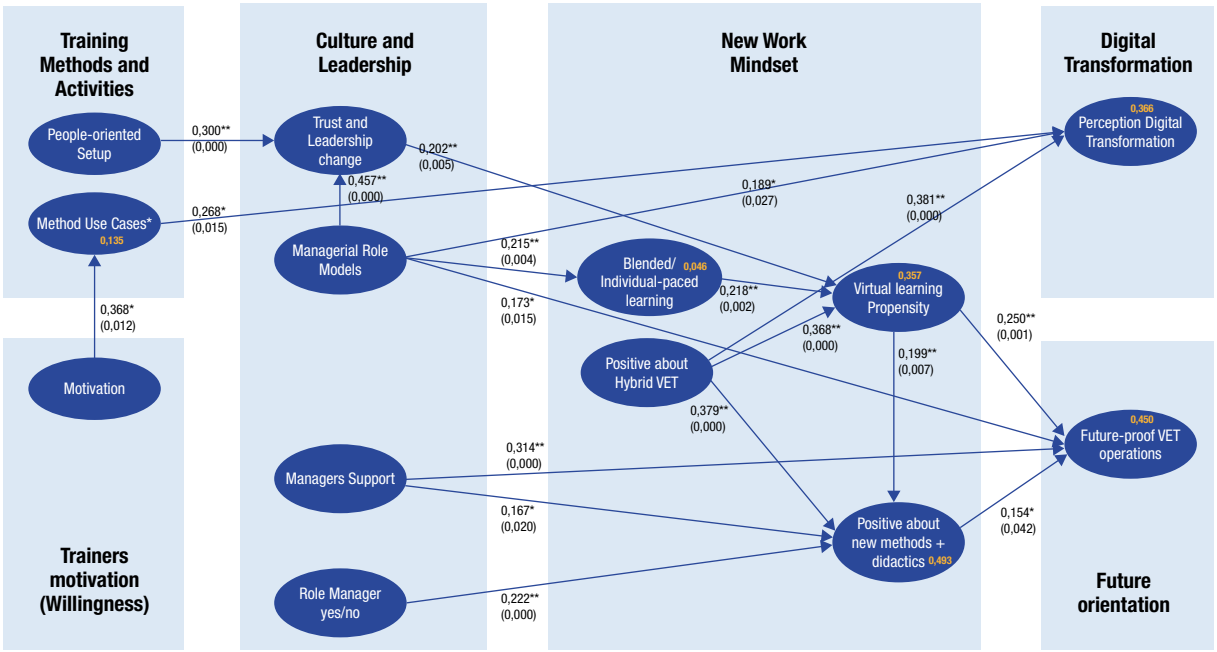
More freedom and variety in learning, more motivated employees and faster implementation of new technologies are among the benefits of digital transformation in this VET case described, 'because they are able to teach themselves the topics, thanks to their basic skills and knowledge' (P08). An original finding is the topic of future-proof VET operations. 'We can only win if we are perceived as customised qualifier (in German: *passgenauer Qualifizierer*]. There is a social context somewhere, as it has made dual VET made in Germany successful, because of this customised qualification towards the business needs. This helped reduce youth unemployment.' (P06). Besides the value-add for the company and

the apprentices, 'we really want to be positioned well here and secure the future of our employees', is pointed out by P17.

12.3.2. **Quantitative results**

Based on both our qualitative analysis and quantitative survey, we can establish a model showing how virtual learning propensity, the perception of future-proof VET operations and of digital transformation are linked in the case of this VET organisation (Figure 3). The figures on the arrows indicate path coefficients and p values. The values in the constructs indicate predictability (R^2); for further detail on robustness please refer to Table 5.

Figure 3. **PLS-SEM based model**



Source: Author.

Constructs that emerge from the quantitative survey have been identified in Section 12.2.3. Some of these constructs have already been discussed as *concepts* in the qualitative results part (Section 12.3.1). The quantitative survey gives a more differentiated and quantifiable view on factors facilitating the uptake of new skills by VET train in the context of a (new work) mindset. In addition to the qualitative concepts discussed previously, a propensity towards blended and or individually paced learning (versus traditional classroom training) for trainers to learn, a positive attitude about hybrid VET settings where apprentices can be taught virtually for certain topics, and a virtual learning propensity of trainers, can be identified as new factors reinforcing the perception of digital transformation and future-proof VET operations, both important aims of trainer upskilling.

In the following, quantitative results are discussed, supported by Figure 3.

The analysis shows that a positive attitude about the new methods and didactics and a perception about future-proof VET operations are of highest in-sample predictive quality. Almost half of the variance can be explained via our model.

The perception of digital transformation is significantly influenced by managers acting as role models in this transition, use cases which exemplify digital technologies and methods, and a positive attitude about hybrid VET. Indirectly, the motivation of trainers to develop and share use cases for digital topics to teach others fuels this perception as well. Trainers' motivation, in our case, is not influenceable by

leadership, thus intrinsic.

The question of how future-proof is the department considered from the point of view of its employees is significantly influenced by the trainers' virtual learning propensity or their individual positive attitude about the new methods and didactics, managerial support, and managerial role models *per se*. A positive attitude about hybrid VET helps indirectly (while it would not suffice stand-alone), because of its effects on virtual learning propensity or attitude about VET methods and didactics.

Trust and leadership change, managerial support and managers who act as role models in this journey towards a digital world, significantly influence individuals' mindsets in general. When it comes to virtual learning propensity specifically, which is one of the constructs belonging to the category of individuals' mindsets, a positive attitude about the new corporate VET methods and didactics, and also about blended or individual learning styles of trainers plus adapted trust and leadership, significantly influence this propensity.

A people-oriented setup of training measures and operations can influence how individuals perceive trust and leadership change.

The most surprising result is that a positive attitude of individual trainers to hybrid VET is not influenced by leadership. Considering that VET trainers consider themselves the subject matter experts, this result is plausible.

This model shows that factors which facilitate the uptake of new skills by VET trainers concern both their individual predispositions and managers' behaviours. Trainers' individual learning styles, propensity and attitudes, in return, influence their perceptions on digital transformation and future orientation of the department; these are both important reasons why trainers learn, to ensure the ability of a VET provider to adapt to changing digital skill demands.

12.4. Discussion

12.4.1. **Trainer attitudes towards virtual learning and hybrid apprenticeships**

This study clearly shows how apprenticeship trainers' propensity to virtual learning is influenced by leaders demonstrating change, trust, and new learning styles; trainers' individual learning styles, in this case their preference for blended and or individual learning; and their positive attitude to hybrid VET in general.

Whether a person training apprentices thinks positively about offering apprenticeships in a (semi-) hybrid mode, as tested during the pandemic and practised in the post-pandemic era or not, is a crucial key factor for his or her own virtual learning propensity.

This positive attitude helps explain individuals' virtual learning propensity and helps them accept the new VET methods and didactics processes in apprenticeship delivery, e.g. self-learning elements and a trainer role more as a mentor than as a teacher.

What we observe here in VET is in line with what classical technological acceptance models (TAM) posit, though it was found exploratively: if we assume that VET trainers with a propensity for virtual learning have experienced its usefulness and ease of use, then we see here that usefulness and ease of use fuel acceptance (Davis 1989; Venkatesh, Davis, Morris, 2007) of the new methods and didactics. Future research routes may want to verify how far TAM models can be abductively used here, similar to what Karaali, Gumussoy and Calisir (2011) did for web-based learning system among blue-collar workers.

Management of training centres or apprenticeship stakeholders striving to facilitate the uptake of new skills by in-company trainers, to support digital transformation in VET, need to pay attention to attitudes. One option would be building teams that believe in learning transformation through digital means (Figure 4). Apprenticeship stakeholders / VET providers could also offer opportunities to apprenticeship teachers/trainers for first-hand experience with virtual learning, so that they are able to develop their own

experience which makes it easier for them to accept new methods and didactics for apprenticeships.

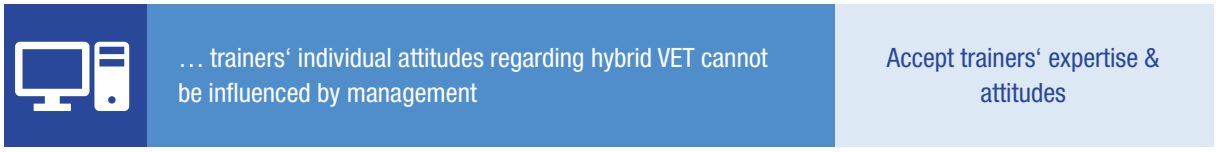
Figure 4. **Lesson 1: Build teams that believe in learning transformation**

Source: Author.

While our research shows how managers acting as role models (indirectly, through their influence on individuals' learning habits) as well trust and leadership changes (directly) have significant effects on individuals' learning propensity, it also becomes unexpectedly clear that management has zero effect on how individuals feel about doing apprenticeship in a hybrid mode. This is a surprising finding. Our careful explanation is that trainers consider themselves learning experts whose own experiences prevail (on this question of apprenticeship training in presence or in virtual mode) over others' opinions, the latter absent from the trenches of apprenticeship training every day. It would take more research to confirm this explanation but, for now, it is advised to accept this expertise and attitude (Figure 5).

Our case shows that apprenticeship trainers views on hybrid options for apprenticeship learning can be critical in how they deal with their own virtual learning. Policy-makers and VET providers should take that into consideration when exploring the opportunity to use hybrid or blended learning modes and whom to choose to champion and promote such new learning formats.

Figure 5. **Lesson 2: Accept trainers' expertise and attitudes (and choose the transformation champions as role models)**

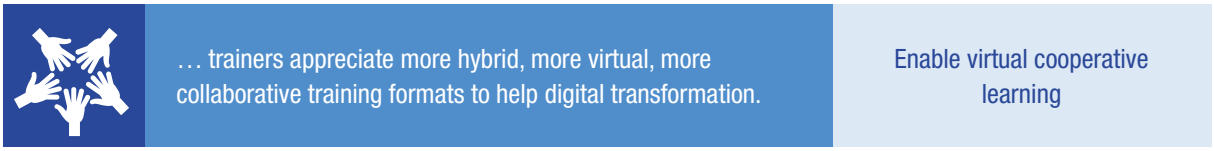


Source: Author.

Generally, both qualitatively and quantitatively, our empiric data support that training methods and activities in times of digital transformation, fostered by the pandemic, have changed to more hybrid, more virtual, more social formats. This reflects what Seufert and Meier (2016) recommend to training providers: collaboration, exchange and learning in networks and communities. For instance, the VET trainer team has access and opportunity to learning from each other via so-called 'learning days' (established monthly), to allow for boundary-spanning learning in virtual learning units in a non-mandatory set-up. The department also offers job shadowing, flipped classroom formats, learning platforms, micro-learning, gamified methods and tandem teaching for topics that have recently been learned by apprenticeship trainers.

Flexible learning strategies are required to allow the organisation to adapt to new requirements and skills. Change is sometimes improvised (Orlikowski & Hofman, 1997) and process continuously improved, from formal training (prior to 2018) to virtual, individual nuggets via digital learning platforms, to new normal great teaching sessions (2020) via trainer-to-trainers, up to learning days and, depending topic and level, deep-dive learning sessions. This reflects on what Morgan (1998) calls an open system, with managers as connecting agents and information processing as source for intelligence and success.

Figure 6. **Lesson 3: Enable virtual cooperative learning**



Source: Author.

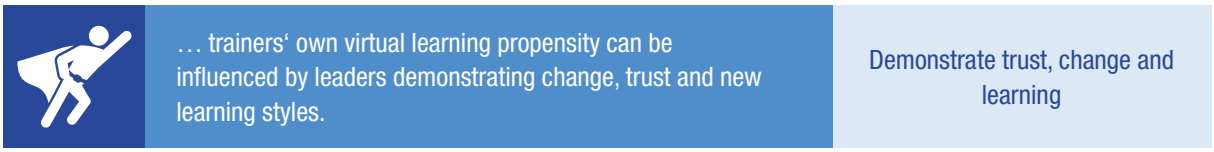
VET providers and apprenticeship stakeholders may want to support virtual communities of practice of groups of teachers and trainers in apprenticeships, as possible catalysts for introducing digital methods and tools in apprenticeship training (Figure 6).

12.4.2. Leadership support to facilitate the uptake of new skills by apprenticeship trainers

A significant factor facilitating trainers' upskilling concerns leadership and trust exhibited by managerial role models. Leaders can contribute to a positive perception of the department's future and of digital transformation through leading, with confidence, learning journeys towards mastering digital technologies and digital methods of teaching apprentices, (Figure 7).

Extant leadership theory can be confirmed: leaders need to adapt their behaviour to suit the new digital era (Kazim, 2021). Leadership and culture play an important role as carriers of messages and of learning towards teams (Gong & Ribiere, 2021; Schwarzmüller et al., 2018). It come as no surprise to see how managerial support and the sheer fact of being in a management position both have a significant positive impact on the new VET methods and didactics. The identification of the various influencing constructs for making an organisation robust for future demands in the management arena (managers support, managerial role models) have also been explored to some extent (Zehir & Narcıkara, 2016). Confirming these within this research as significant contributors leading to the perception of future-proof operations in VET contributes to the research body to understand in theory and managerial practice how to orchestrate resilient organisations (Mallak, 1998) in the corporate learning arena.

Figure 7. **Lesson 4: As a leader, demonstrate trust, change and learning**

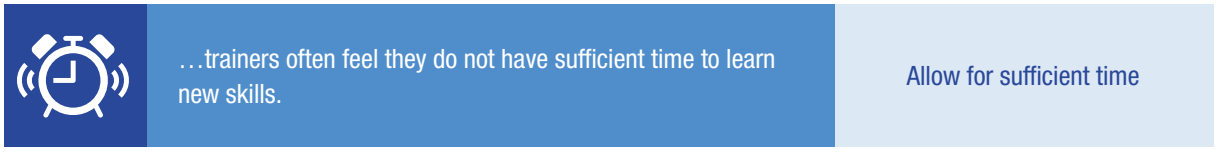


Source: Author.

Apprenticeship stakeholders, and specifically leaders in the VET arena, are advised to act as role models regarding their own learning journeys and to provide genuine support for trainers in the process of upskilling, while nurturing a climate of trust and change. At Siemens this translates to a 'growth mindset' we want our people to adopt and our managers to breathe, rather than preach.

Another issue, often underestimated, relates to the time needed to learn new skills. An honest discussion of productivity versus time-to-learn for trainers with the aim of ambidexterity – 'thoughtful trade-offs between competing demands' (Birkinshaw & Gupta, 2013, p. 290) – of the organisation, is often needed to instil trust and change as a leader (Figure 8).

Figure 8. **Lesson 5: It takes time to learn new skills as a trainer**



Source: Author.

VET providers and apprenticeship stakeholders need to take this into account when designing training programmes for trainers.

12.4.3. **Apprenticeship provider ability to meet future needs and digital transformation**

Trainer perception of digital transformation is influenced by two things: technology brought to life tangibly by use cases and managerial role models. The third factor is their own attitude about hybrid VET, which is not influenceable by any of the factors identified in this study. In starting the journey towards the new metaverse, a manager hiring apprenticeship trainers is advised to look for a positive attitude about hybrid VET venues in future VET trainer candidates. As a policy measure, intensifying contacts among local players in the VET and upskilling market to provide opportunities for learning new skills by trainers, and professional networks, should be useful to advance digital transformation regionally.

A second finding concerns future orientation: if a trainer already exhibits a virtual learning propensity and / or the staff thinks positively about new VET methods and didactics, these individual mindsets contribute to the perception of whether the department is prepared for future challenges. Such preparedness translates to organisational resilience, a new aspect in the discourse about digital transformation of VET. A resilient organisation exhibits positively adaptive behaviour, '[p]erceive[s] change as opportunity, not danger. [It] allow[s] responses to adapt to the needs of the situation, rather than execute ineffective 'programmed' responses' (Mallak, 1998:4). In this setting of a corporate VET department, it is trainers adopting new learning venues, notably a virtual learning propensity, and methods plus managerial support, which ensure the future.

For policy-makers and VET stakeholders, spanning boundaries (companies, social partners, vocational schools, academia, parents) to advocate and scale up local skilling ecosystems via digital/virtual means results in giving shape and depth to local skilling ecosystems with public and private partners, and with academic as well as vocational institutions.

12.5. Conclusion

The learning culture for apprenticeship trainers must change to ensure that apprenticeships meet requirements. Such learning transformation is typical for organisations in transition and represents Gong and Ribiere's (2021, p. 10) 'fundamental change process'. The study illustrates numerous examples of how to make the learning offers more flexible and future-proof.

This single-case study in this specific German high-tech MNE context is limited in validity and objectivity, even though the two-step mixed-method approach in an exploratory sequential design helps to obtain a more comprehensive, more objective understanding and integration (Welch et al., 2011). The outer model check shows loadings and significance of all loadings acceptable for explorative purposes, while the constructs must be handled with care for subsequent studies. Generalisation *per se* is neither possible nor intended in case study research; however, this case gives insights into departmental details otherwise not accessible to the research community.

There are consequences for management regarding apprenticeship training and related contexts such as corporate upskilling and reskilling domains, in technical schools and colleges, possibly in other

cultural – national or professional – contexts. In such environments, similar challenges stemming from digital transformation will bring forth culture change and new forms of learning and upskilling of trainers and teachers. It will be interesting to compare with the current case to further enrich the findings discussed in this study.

Future avenues for research may want to explore more cases in the apprenticeship trainer learning context. We also recommend exploring related contexts such as corporate upskilling and reskilling domains, in technical schools and colleges, possibly in other cultural – national or professional – contexts. Further research endeavours may want to expand on social groups beyond apprenticeship trainers, e.g. skilled and unskilled blue-collar. In such environments, similar challenges stemming from digital transformation will cause culture change and new forms or learning, such as microlearning (Roth et al., 2022), and upskilling to emerge. To understand conditions, motivations and activities of learners is relevant, corresponds with the actual scientific research agenda, and will be interesting to compare with and enrich the findings of the current case.

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CHAPTER 13.

Informing pedagogies for apprenticeship in a complex and modern world

By Tessa Forshaw ([91]), Mary Kate Morley Ryan ([92]), Beca Driscoll ([93]) and Maggie Lorenz ([94]) ([95])

13.1. Introduction

Policy-makers, education institutions, and workforce development providers increasingly promote apprenticeships and other workplace-based learning programmes. Analysis indicates an opportunity to expand this model to new occupations, including many in which employers commonly require a bachelor degree (Fuller & Sigelman, 2017.; Federal Reserve Bank, 2019). This global trend has a stronghold in Europe and a recent policy revival in the US, where the Biden Administration stated that 'Apprenticeships can change lives' (The White House, 2022). Within the US in 2021, nearly 27,000 registered apprenticeship organisations served over 800,000 apprentices. Most identify as white men under age 35 (DOL RAPIDS, 2021).

Less than 1% of apprentices were enrolled in programmes that could be considered as related to digitalisation (DOL RAPIDS, 2021). However, this trend has been shifting, presenting opportunities to reconsider where and how apprenticeships can help organisations achieve talent priorities.

The needs of society's digitalisation and advancements of technology call for the offer of apprenticeship programmes in digital sectors and/or supporting the development of digital skills. At the same time, technology allows for apprenticeship provision to benefit from digital technologies. While promising, apprenticeships are not a one-size fits all solution to this direction. Many focus on narrow skills or recruitment strategies and lack learning design to support the development of digital skills. Instead, they leverage historical models of craft apprenticeships, which are effective for their purpose.

While modern apprenticeship programmes present an opportunity for apprenticeships to adjust to and benefit from the digital transition, contemporary revival needs to take on a different embodiment as a Modern Apprenticeship is more cognitive than craft. Developing the training curriculum is critical to success (Opportunity America et al, 2018., Jones, 2018).

Putting a modern apprenticeship programme in conversation with the learning sciences makes their design a learning problem instead of strictly a labour problem. Such a pivot is essential when considering the broader societal needs that expand past business benefits and oblige us to create inclusive, valuable, research-based and effective learning experiences for those participating in these programmes. A growing body of learning sciences, cognitive sciences, neuroscience, and psychological science literature is providing foundational research into how people learn (Bransford et al, 1999.; National Academies of Sciences, 2018).

Most relevant to the nature of modern apprenticeship programmes is the body of literature focused

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on situated learning (Lave & Wenger, 1991, Brown et al, 1989; Saivyer & Greeno, 2009). Situated learning proponents theorise that, to enact learning, we need to focus on the necessary social engagements and contexts which enable the cognitive processes of learning (Lave, 1991; Suchman, 1987; Hanks, 1991). This means grounding that durable learning happens through processes of participation and not in the heads of learners sitting in a classroom (Hanks, 1991). This body of knowledge also promotes enabling learners to influence their learning and see its relevance to their lives (Lave & Wenger, 1991).

If understood from a learning standpoint and married with insights from the learning sciences such as those above, the dynamic components of apprenticeship models can shed light on the role of social relationships, culture, and motivations for developing new skills in the context of modern work. They can help practitioners and policy-makers design more effective learning experiences. Potential benefits may include:

(a) implications for future study of learning design in work-learn practices;
(b) new tools for supporting workers in pursuing meaningful careers;
(c) techniques for individuals to create conditions and relationships to support dynamic career trajectories;
(d) information to improve a proliferating model for talent acquisition;
(e) insights into meeting the needs of talent within the context of learning;
(f) greater opportunities to expand professional networks and relationships.

This paper draws on empirical research in learning sciences to build a more powerful pedagogy of modern apprenticeship (Morley et al., 2023), a framework for the design of apprenticeships for digital skills and the digital transition.

Leveraging qualitative research methods from semi-structured interviewing, case studies, and portraiture, we use Accenture's North America Apprenticeship Programme and the experiences of five apprentices as a case study. Using these inputs, and a combined etic and emic stance, we propose a new and more powerful vision of modern apprenticeship programmes, centred around five central features. Each builds upon the research of how people learn (Figure 1) and amplifies what is working about traditional apprenticeship models today, while positioning additive and contrasting features necessary for modern apprenticeships.

13.2. Research questions and methods

This study was designed with two specific research questions in mind:

(a) what are the features of a modern apprenticeship programme, and how do they relate to empirical learning sciences research on situated learning?
(b) how do participants in a modern apprenticeship programme describe their experiences, and how do they connect them to what they do today?

Guided by these questions, the study set out to address three specific aims: First, to investigate participants' experience in modern apprenticeship. Second, to identify what features might be powerful in modern apprenticeships. Third, to provide an archetypal study of a modern apprenticeship.

13.2.1. **Participants**

The sample for this study consisted of five individuals who graduated from Accenture's North America Apprenticeship Programme (the programme hereafter) between 2020 and 2022. The programme is a 12-month earn-and-learn employment model. Individuals were recruited by emailing a sign-up of the study to 30 programme graduates who still work at Accenture. The first five to sign up were selected to participate in the study. While not intentional in sampling, each participant was based in a different major United States (US) city and had distinct educational and work experience background (Table 1).

Participants were interviewed by the first author, who is not an employee of Accenture. The names and transcripts of individuals who signed up and participated were de-identified before sharing memo-level insights with the Accenture authors; this enabled confidentiality and trust from participants and ensured no adverse consequences for their participation, as Page et al advised in Reporting Ethnography to Informants (1998).

Table 1. **Study participants' region and background**

Pseudonym	Region	Pathway to programme See section 13.1	Prior college	Prior work experience
Olivia	Mid-West	Technology bootcamp	Did not complete	Moderate
Nelson	Atlantic	Workforce development programme	Did not complete	Extensive
Carlos	South	Workforce development programme	Did not complete	Limited
Pia	Northeast	Via recruiter	Community college	Limited
Hani	West	Via recruiter	None	Moderate

Source: Morley Ryan, Forshaw & Driscoll (2023).

13.2.2. Investigation framework and approach

The investigation started with an emerging theoretical framework about what pedagogical features would improve modern apprenticeships. This framework was based on learning sciences research and a snapshot analysis of the programme, including apprentice data on what is working and retention (Morley et al, 2023). The investigation started with a set of etic or 'theory driven top-down' ideas about what pedagogical features would improve modern apprenticeships and used them to explain what was going on in the cultural setting of the programme (Shaffer, 2017). However, to make full sense of the cultural setting, the framework also needed to make space for an emic or 'participant-driven' understanding of the situation; that is, an understanding of the programme through the perspective and voice of apprentices. These emic findings then both acted as a feedback loop to adjust a revision of the pedagogy of modern apprenticeship, and a mechanism to show the sub-features of each feature as they manifest in the language, actions, perspectives, and voices of the study participants.

Box 1. **Data collection and analysis procedures**

Data collection procedure

Each participant was interviewed once in a semi-structured interview lasting approximately 60 minutes. Each interview was conducted via the Zoom video conferencing platform and audio-recorded and transcribed via the platform. The interview protocol was inspired by the semi-structured approach to interviewing in Robert Weiss's Learning from Strangers (1994) to build a case study of each participant's experiences. Initial questions focused on asking the participants to introduce themselves personally and professionally and build rapport, as Peshkin & Glesen (1992) advised. Subsequent questions focused on asking about a grand tour of their career at Accenture before diving deep into the particulars of the apprenticeship programme, month by month. The final questions focused on prompting participants to reflect on the most impactful parts of the programme and how, if at all, it has influenced what they do today.

As part of gaining background into the history and establishment of the programme, the team responsible for it provided extensive documentation, including public reports, internal presentations, and other materials to inform the overall picture.

Data analysis procedure

This analysis involved thematic data analysis using the software tool atlas.ti, and drew upon both inductive and deductive coding strategies. In this, the analysis allowed for finding new and emergent themes to observe and record aspects of social life (Emerson et al, 2011) while also coding for the five theoretical principles discussed in the Pedagogy of modern apprenticeship (Morley Ryan, Forshaw & Driscoll, 2023). In addition, thematic memos were written for each interview, as was a de-identified case study of each participant's experience.

An essential task in the deductive coding approach was to triangulate data points under each of our central claims to 'cross-check information and conclusions' (Johnson, 1997). This included constructing a negative case for each pedagogical feature to disabuse leading interpretations and strengthen the internal validity of the findings. Specifically, constructing each negative case involved surfacing all the instances in which participants' experiences and insights differed from the theoretical interpretation proposed for each feature (Anfara et al, 2002).

Source: Authors.

13.3. Findings and proposed pedagogical framework

This section presents a synthesis of findings related to our primary research motivation for the study: proposing a more powerful and research-based pedagogy of modern apprenticeship. First, we draw upon background materials and direct participant quotes to describe the programme. Second, we complement the theoretical and conceptual rationale for each of the proposed aspects of the pedagogy with direct quotes from the five participant case studies that are illustrative of the feature.

13.3.1. Accenture's North America Apprentice Programme

In the US, the apprenticeship model is heavily focused on skilled trades. More than half of all registered apprenticeships are in construction and manufacturing, with less than 1% in professional and technical services (US DOL, 2021). Apprenticeships in these modern sectors are relatively nascent and heavily linked to digital-related occupations and skills.

Accenture is a global professional services company that works with businesses, governments, and other organisations on strategy, technology, digital, and business operations. The company has over 730 000 employees and serves over 9 000 clients in more than 120 countries (Accenture.com, 2023). Traditionally, individuals interested in careers at Accenture have had two avenues for joining; first, through 4-year college campus hiring programmes, and second, through experienced hire advertised roles.

Accenture's North America Apprenticeship Programme began in 2016 when it hired its first cohort of five apprentices into its internal information technology department. The initial programme success, coupled with Accenture's established and public goals for inclusion and diversity, fuelled the development of the programme as a pathway primarily for candidates without a 4-year degree. At the time of writing, it has expanded to additional occupations, over 40 cities, and has involved more than 2,000 apprentices (Accenture.com, 2023).

The programme minimum hiring requirement is a high school degree or equivalent, consistent with the US focus on adult apprenticeship. An estimated 60% of apprentices in the US are age 25 and above (US DOL, 2021).

The programme hires from beyond the company's traditional avenues, including non-profit organisations, community colleges, military veteran organisations, technology bootcamps, and direct outreach to engage a broader talent pool. The participants in this study joined the programme via bootcamps, workforce development programmes offered by nonprofits, and after being directly contacted by a recruiter (Accenture.com, 2023).

The programme is a full-time, year-long earn-and-learn employment model, and apprentices are paid with benefits, including paid time off. Many of the participants in this study cited benefits as a major

reason for being able to take advantage of the opportunity.

Consistent with federal apprenticeship guidelines and criteria for apprenticeable occupations, the programme enables progressive attainment of skills and knowledge via the completion of 2 000 hours of on-the-job learning and related instruction; this is an organised and systematic form of instruction designed to provide the apprentice with the knowledge of the theoretical and technical subjects related to the apprentice's occupation, to supplement the on-the-job learning. Related instruction, which may be given in a classroom, through occupational or industrial courses among other means is delivered through Accenture's learning department and external providers. Training includes, on average, 240 hours across technical and professional skills, exceeding the federal recommended minimum of 144 minimum hours for each year of apprenticeship (US Law, 2023).

Paths include application development, programme and project management, data science, customer service, and human resources, with learning tailored to each. All paths focus on digital skills such as collaboration, effective communication, problem solving, data analysis and agile ways of working. Transversal digital skills are also covered: computer literacy and digital collaboration tools. Technology paths add specialised digital skills such as front-end, back-end, or full stack development, test execution and defect triage, DevOps, requirements gathering and analysis.

The programme starts with introduction of apprentices to Accenture, the programme, and both technical and professional skills.

During on-the-job learning, apprentices typically work alongside a cross-geographic team in a hybrid digitally enabled workplace. Participants described working virtually in teams across two to three projects during their programme. For some, this included job shadowing.

The programme has formal and informal mechanisms for apprentices to develop their professional network and help them understand company structure, culture, and values. Apprentices are assigned at least five experienced others among other informal supports: a peer mentor, supervisor responsible for on-the-job instruction, people lead responsible for professional development, apprentice champion mentor, and human resources partner.

Apprentices who complete the programme, as defined through a structured performance feedback process, are offered positions to stay at the company. However, experiences post-conversion differs between participants as they adjust to new roles and expectations.

There is generally high retention of apprentices who stay at the company after programme completion, and all participants in this study describe the programme as helpful and formative.

13.3.2. **Pedagogy of modern apprenticeship**

The proposed pedagogical framework for modern apprenticeship programmes (Morley Ryan et al., 2023) amplifies what is working with traditional apprenticeship models today while positioning additive and contrasting features necessary for more powerful modern apprenticeship programmes. These features were highlighted through etic and emic findings from participant studies and experiences and putting them in conversation with the learning sciences literature about how humans learn.

Figure 1. **Proposed pedagogy of modern apprenticeship (Morley Ryan, Forshaw & Driscoll, 2023)**

Source: Morley Ryan, Forshaw & Driscoll (2023).

This pedagogy acknowledges when learning happens and establishes a shared concept to reflect upon and help modern apprenticeships evolve to support the learner in today's digital economy and the future of work. It has five features that characterise learning in the context of an increasingly digital, global, and rapidly evolving work environment (Figure 1).

(1) Learning in context.
(2) Learning among community.
(3) Learning through development.
(4) Learning towards flexibility.
(5) Learning with agency.

All participants shared examples of experiences during their time in the programme that could be thematically allocated to each of the five pedagogical features (Table 2). The frequency of occurrence of examples of each feature is evenly distributed, suggesting similar levels of significance to the participant (Table 2). However, some findings related to participant experiences in the years since completing their apprenticeship did not fit within the etic framework being used.

Table 2. **Prevalence of pedagogical features based on participant interviews**

Feature of pedagogy	% of Interviews where theme arises	# of mentions across interviews	% of mentions across interviews	Negative case notes
Learning in context	100%	35	23%	One participant provided a negative case example
Learning among community	100%	31	20%	None identified
Learning through development	100%	32	21%	One participant provided a negative case example
Learning towards flexibility	100%	28	18%	None identified
Learning with agency	100%	28	18%	One participant provided a negative case example

Source: Morley Ryan, Forshaw & Driscoll (2023).

13.3.2.1. *Learning in context*

Learning in context refers to the circumstances of an ecosystem that inform when and how an individual engages with digital tools to learn and do work that is global, cross-industry, and adjusts quickly to changing demand and pressures. The circumstances include proximity (digital and physical) to the work, the client-to-consultant relationship, and the operation in a broader organisational culture. Each circumstance is informed by another and collectively drives decisions and purpose for learning.

All participants in this study shared examples highlighting how learning by doing, in the context of real projects at Accenture, was the most helpful. Especially early on when they were able to shadow participate or learn to perform a new and different type of role.

> Hani: *'For the first couple of tasks and roles…we would have our buddies shadow us and then they would see what we would need improvement on and then as the weeks went by, once we got it down, we were able to release the training wheels.'*

> Carlos*: 'We had nine o'clock meetings at least 3 days out of the week to understand what our assignment is, what we completed and what needed to be done next. We used the mural board to keep our notes and information… We were given instructions day by day, week by week as to what needed to be done and how.'*

This finding and essential pedagogical feature is unsurprising when examined through the lens of the learning sciences since a significant body of work highlights how essential it is to situate learning in the context in which it will be applied (Greeno & Engeström, 2014.; Collins & Greeno, 2010). Apprenticeship has been a long-studied way to apply learning in context. However, this is true primarily for trades and crafts.

Learning for professionals in digitalisation is often siloed into college courses, bootcamps, and other instructor-led training contexts where knowing is separated from doing. In these cases, too often the 'learning in context' dimension is less prominent or missing altogether.

When learning in context, an apprentice experiences the consequence and outcomes of their activities in real terms, such as the impact of their work product, project team, client feedback, and timelines with dependencies. Combining what it means to know and do or learn and work also provided participants with opportunities to build self-efficacy.

> Olivia: *'I did see my work actually displayed and I can see myself being a contributor.'*

The company's goal for the programme is to embed apprentice roles directly into project teams doing real work. The Accenture apprentice learns in context with full access to the company's digital tools, working on project teams in which they learn from and contribute work alongside experienced others. Projects that study participants worked on include:

(a) working on talent matching via online database for Accenture consultants to available roles;
(b) conducting market research for a healthcare company;
(c) addressing testing issues during human resources information system implementation;
(d) designing a user acceptance test for an enterprise resource planning software implementation.

In analysing participant stories and transcripts, one participant provided a 'negative case' for this pedagogical feature. Pia described working on a project early in the programme and not feeling as though she was learning very much, although it only lasted for a short while.

Pia: *'I started working… as a data analyst. Things were really slow at that point. I felt like I didn't do much or I didn't learn much during that period... But I started doing testing... and I felt more useful at that point. I felt like I was doing more things. I was getting involved more.*

13.3.2.2. *Learning among community*

Learning among community refers to the relationships between apprentices, their cohort, the support system, and the broader organisation. All participants in this study shared examples of how their wider involvement in the Accenture community was enabled and added value to their development. It is through this process of enculturation into the broader community of practice that apprentices develop the nomenclature, practices, and norms of the profession and find opportunities for legitimate peripheral participation (Brown & Duguid, 1991.; Toulmin, 1999.; Lave & Wenger, 1991.; Perkins, 2008) that enable them to learn and do their work. This can be seen in Nelson's description of learning to do the work with his team.

Nelson: *'My teammates and I, we'd work on all those same tickets together. We'd meet to discuss them, or we'd send messages to each other and screenshots.'*

Apprentices are encouraged to engage beyond the apprentice community with programmes that include non-apprentice employees. The apprentice is invited to participate in organisation-wide supports such as employee resource groups, the Accenture information and knowledge portal, and meetings with executives and other colleagues focused on their location, industry or practice.

Digital collaboration tools such as shared presentation and document editing platforms, cloud file management systems, and online calling and chat tools further drive connection by removing physical barriers and giving access to local, national, and global experiences; these are especially helpful for apprentices working in the process of digitalisation who are often remote or distributed.

Participants shared that the apprenticeship programme intentionally provided opportunities and encouragement to connect with people in the broader organisation.

Carlos: *'Network is one of Accenture's big things as well because Accenture is a huge company. They stress that you build your team, build your network, know who your network is...One of the things that a lot of the employee resource groups do is what they call network bingo...you download a digital bingo board, and your squares would look like, for instance, meeting a managing director that you did not know before, meeting an apprentice that you did not know before, meeting somebody out of your particular practice... Networking is a huge part, and they stress it because it makes a huge difference.'*

For individuals to learn among a community, they need to feel as if they are a member of that community and not on the periphery. This requires moving beyond focusing on apprentice cohort building, giving them access to all normative parts of the organisation, and fostering a culture of inclusion among the other community members. Hani and Olivia's experience highlights this sense of inclusion.

Hani: *'It was almost as if we were a full-time employee.'*

Olivia: *'You can reach out to anyone, literally anyone. If you put it on their calendar, they are open to actually speak it to you. I spoke to managing directors before honestly, just by reaching out to them asking, can I put some time on their calendar? They actually talked to me and talked about their journey, their challenges that they faced going into the company as well and how they got to the position that they are at today.... They don't do this at every company.'*

13.3.2.3. *Learning through development*

Learning through development refers to the actions taken by experienced others intending to develop the apprentice, as well as the programme's emphasis on preparing the experienced others to do so. In these deliberately developmental relationships, (Kegan & Lahey, 2016) the more experienced others support the learner to transition from novice to expert in specific skills (Vygotsky, 1978; Bronfenbrenner, 1979; Collins, 2005). All the participants in this study provided examples that can be classified as a development relationship with an experienced other.

Nelson: *'Three of us [were] working on this ticket... One of them is a manager. He was teaching us how to resol0ve problems so that the next time, say he's busy or he can't help, then we'd be able to figure it out on our own. [He got on] a Teams call, walked us through the steps, showed us how to resolve his query.'*

Hani: *'We would get on a meeting, and then once he sees where he needs to step in, would step in and provide clarity and the bigger picture of why we do it this way and then from there, would give me the floor for any Q&A.'*

As we can see from the participant examples, in a modern apprenticeship the developmental relationship is not limited to the traditional 'master' structure. Instead, multiple people can play this role: a mentor, supervisor, business lead or buddy.

This is essential in the current era of digitalisation, where apprentices must learn formally and informally from a wide variety of experts to ensure they are able to do dynamic and multi-faceted work, and work in collaborative contexts.

Programme participants often report having multiple people providing this kind of development, some are formally provided, and others informally formed.

Olivia: *'I would say about six or seven people who are still with me today, helping me throughout Accenture. Now I could always increase because they always say you should network as well. So, I have several other people, but I got my main seven people with me throughout pretty much my time here at Accenture.'*

Deep expertise is not the main requirement for an experienced other, but rather the ability to guide and coach the apprentice through a task that they can complete, with the guided assistance of someone else, but not yet alone (Vygotsky, 1978).

Carlos: *'[If] you don't know how to navigate it, they will put you with somebody that will quickly teach you to navigate those tools. With that particular project, I'm like, I do not know how to do testing and it was: 'It's okay, we will teach you.' I realised once it was explained to me... it's step-by-step instructions...going through the system. I was like, huh, I can do that... once they explain it to you, sometimes you realise, oh, I do know how to do that. I just didn't realise it.'*

Due to the essential function that multiple experienced others play in the development of a modern apprenticeship, it is vital that they are provided training on the mechanisms of the programme, expec-

tations of their role in the apprentice experience, coaching skills, and a structure for working with each apprentice.

In analysing participant stories and transcripts, one participant provided a 'negative case' for this pedagogical feature. Nelson describes in the first quote a one-off instance where he had a boss who did not help with a task. This was an exception to the other experiences Nelson describes. He then followed up on this experience with a request for opportunities to shadow an experienced other available to more apprentices.

> Nelson: *'The boss, I guess she was working on all the tickets because she didn't help us'*

> Nelson: *'What I would change is job shadowing; making it more available to more of the apprentices'*

While this is a negative case example in the sense that it is an example that goes against the feature of the pedagogy, Nelson's subsequent desire for more shadowing reinforces the importance of this pedagogical feature and the importance of having many experienced others from whom to learn.

13.3.2.4. *Learning towards flexibility*

Learning towards flexibility refers to the awareness of the diverse use of skills and knowledge across contexts or to novel problems. When apprentices learn expansively and are motivated, they can transfer knowledge learned in one project and apply it to another (Engle et al., 2012; Lobato, 2012). This ability is essential in Accenture's project-based consulting dynamic and, more broadly, in digitalisation, where companies increasingly need adaptive and resilient workers, who can adapt to changing technologies.

Study participant Carlos described in detail being surprised to learn how his skills from being an equipment technician in a past career transferred into his new roles at Accenture.

> Carlos: *'I had a teammate first tell me you're really good at speaking to people and then I had another teammate tell me the same thing. He's like, you really speak up about a lot of things and you ask questions for clarity and to make sure that everybody's on the same page. And that made me think.'*

> Carlos: *'I had to be able to tell them specific details minute to minute… And so, asking questions and clarifying what was being done in order for me to do my job was very important. Asking details, asking questions to make sure that the next step was the appropriate step was just a skill that I didn't realise was gonna be a transferable skill and that was transferring unknowingly to my job at Accenture.'*

Nelson, also had a similar realisation.

> Nelson: *'I used to work with my mom at her company, which is totally different from this. My Excel skills and PowerPoint skills were used there, so I guess it does overlap… Now that I'm thinking about it, I guess some of my skills did transfer and I just didn't notice. Like Microsoft skills and researching skills.'*

Learning towards flexibility also means that apprentices are learning skills and knowledge relevant to the future and not the jobs of the past. Several of the study participants shared examples of being encouraged to learn emerging skills and technologies.

Olivia: *'I actually opened my eyes to so many different technologies that I didn't even know existed prior to the start.'*

Hani: '*We had technology quotients, and you learn about all the different types of technologies that Accenture works with, and I was really appreciative of that because in some of my discussions now, I'm able to understand the different type of skills that are required for certain technologies for certain projects.'*

Reflection and other metacognitive practices are known ways to foster this kind of flexibility in learning; a modern apprenticeship includes opportunities for apprentices to reflect. These reflections can be formal and indirect activities – like becoming a buddy themselves – that prompt apprentices to be reflective.

Carlos: *'Now that I'm out of the programme, I have a couple of mentees. And that gives me time to reflect and be transparent with them, to let them know from my experience, what is important.'*

In analysing participant stories and transcripts, one participant provided a 'negative case' for this pedagogical feature. Pia describes being placed on a track that did not initially align with her ideal choice. In the end, Pia navigated changing tracks in a supported way but this participant example highlights the importance of that feeling of control to Pia.

Pia: *'I wish I could do programming from the beginning… I was told it was bad luck that the account I was a staff on, they weren't doing any programming. I think that if I would have gone to a project where I had to learn a programming language and work with programming, I wouldn't have any complaints. I feel it would have been perfect.'*

13.3.2.5. *Learning with agency*

Learning with agency refers to the combined role of the learning environment, experienced others, and the apprentice to prioritise agentic behaviour from motivated and self-efficacious learners (Nolen et al, 2015., Bandura, 1994). A modern apprenticeship programme understands that the individual apprentice exhibiting desired agentic behaviours is enabled by combining these three factors: the learning environment, the experienced others, and the apprentice (Grotzer et al, 2021).

Learners with agency are invited by the learning environment and experienced others to determine what they need to learn. As a result, they are empowered to develop their own skills and knowledge and express individual choices over the direction of their development (Grotzer et al, 2021).

In this era of digitalisation, empowering apprentices to be agentic is essential to supporting them to build habits of being proactive and taking the initiative on what to learn, where to learn it, and how to keep their skills relevant. Participants provided several examples of feeling agency over the direction of their learning.

Olivia: *'I like the fact that we can always tap into different types of learning to actually increase our knowledge in these different platforms and software…They provide you with training, provide you with support to help you get to where you want to be. You take your career into your own hands, to do what you want to do.'*

Nelson: *'I do want to learn UX/UI [User experience/User interface] design, to eventually move to that side of the company, which I'm doing on my own right now.'*

Pia: *'I was being trained on project management. But I really didn't like project management. I wanted to do something related to technology. Doing that maybe three weeks, maybe a month and a half. And then my people lead...I told him that I wanted to do technology. I started working for him as a data analyst.'*

Learning environments and experienced others also have to work hard to establish feelings of safety and control to enable agentic behaviours. The Accenture programme provides participants with a salary, benefits, and paid time off, which allows them to step into a place of control by providing a secure livelihood. Participants provided examples of feeling in control of their careers.

Carlos: *'I tell people all the time, there's no reason why you cannot succeed, and you don't succeed. If you don't, then that just simply means you did not want it and you did not put in the time and the effort because everything is provided for you. It's just a matter of navigating your resources and your tools and being very, very organised.'*

Olivia: *'You take your career into your own hands, to do what you want to do.'*

For the learning environment and experienced others to enable agentic behaviours in apprentices, safety and risk-tolerance must be supported by establishing clear guidelines for escalating issues with the apprentice and experienced others, normalising asking for help, and seeking regular feedback. Agency must be modelled by others and facilitated by ways of working, workplace cultural norms, and processes.

13.4. Perspectives on wider application

The five pedagogical features of modern apprenticeships have applicability across sectors and occupations that interact with digitalisation, as well as across programmes embedded in training organisations or employer-driven.

The features, evident in the Accenture case, are rooted in the learning sciences and so have implications for how they might be realised and incorporated in a variety of programme conditions; the conditions themselves would inform the approach or enable learning.

Learning in context, while enabled by project team participation within Accenture's model, is applicable in any setting in which an apprentice is able to work on activities where colleagues are dependent upon the quality of their work, and the consequence of their work is felt beyond the work's delivery. It can also be enabled by blending related technical instruction with applied learning and on-the-job experiences.

Learning in community in alternate settings is achieved where boundaries between the apprentice and the full employee experience are minimised and the support mechanisms for apprentices mirror the full employee experience and build relationships with community beyond their immediate cohort.

The value of learning through development is realised by having programme expectations and development plans for individuals that touch the apprentice through the tenure of the programme.

Learning towards flexibility allows apprentices to have multiple and varied on-the-job experiences such that the work they are doing is not only situational. This can look like planned rotations and tools to support reflections on the skills used across work products and digital experiences.

Learning with agency requires the environment to be designed for agency. For example, removing burdensome structures and overly prescriptive activities and intrinsically rewarding choice, learning from failure, and self-advocacy of needs.

The above perspectives are examples of how the features within the pedagogy could be reflected

into other apprenticeship programmes where digitalisation is having a significant impact, roles are more skill-based than job-based, and on-the-job learning is an integral part of talent development. As we continue to study this model, we anticipate these applications will evolve.

13.5. Conclusion

Apprenticeship programmes can enable a workforce to address the most pressing economic demands, e.g. climate change, cybersecurity, or evolving geopolitical landscapes. As Accenture's North America Apprentice Programme has shown, new modern apprenticeships offer a platform for apprenticeships to address the continuing needs stemming from the digital transition, while benefitting from digital technologies.

However, without adopting an understood pedagogy, expanding the apprenticeship model to new industries and occupations will fall short of maximising the model in the modern context.

The pedagogy outlined above supports an understanding and implementing practices that meet our obligation to current and future workers. It provides a framework for tapping into the workforce's diverse strengths, appreciating humans' vital role in a technology-enabled global work environment, and preparing people for the work of today and tomorrow. Designers of apprenticeship programmes will benefit from reflecting on and adopting practices that align with knowledge of how people learn best and the social and emotional factors that enable learners to acquire and apply new skills. Designers can evaluate their programmes against the five pedagogical features provided and adjust programme practices.

This pedagogy was developed and shared to inform future research on learning models for workers in digitalisation of on-the-job learning experiences, and to establish a standard vision for reflecting upon and improving them.

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Acronyms

3D	three-dimensional
AI	artificial Intelligence
AFPOLS	Association for Continuing Professional Training of Social Housing Organisations (France)
ANFA	National Association for Automotive Training (France)
AR	augmented reality
AWL	alternation of working and learning (China)
BiBB	Federal Institute for Vocational Education and Training (Germany)
BTP	Construction and public works (Bâtiment et Travaux Publics, France)
CAD	computer-aided design
CAM	computer-aided manufacturing
CFA	apprenticeship training centre (France)
CIA	Curriculum-Instruction-Assessment
CCCA-BTP	National committee for Building and Public Works (France)
CK	content knowledge (see TPACK model)
CNC	computer numerical control
DG CNTC	Directorate-General for Communications Networks, Content and Technology
DigComp	Digital Competence Framework
e-CF	e-Competence Framework
EQF	European Qualifications Framework
ERP	enterprise resource planning
ET	education and training
EU	European Union
FOAD	open distance training (La formation ouverte à distance, France)
HMD	head-mounted display
ICT	information and communication technologies
ICTC	Information and Communications Technology Council (Canada)
ILO	International Labour Organization
ISCED	International standard classification of education
ISCO	International standard classification of occupations
IT	information technologies
KMK	Standing Conference of the Ministers for Education and Cultural Affairs (Germany)
LMS	learning management system
MNE	multinational enterprise

MR	mixed reality
OdAs	Intermediary VET Organisations (Organisation der Arbeitswelt, Switzerland)
OECD	Organisation for Economic Co-operation and Development
OER	open educational resource
OPCOs	skill operators (Les opérateurs de compétences, France)
PCK	pedagogical content knowledge (see TPACK model)
PHP	Hypertext Preprocessor
PK	pedagogical knowledge (see TPACK model)
PLC	programming logic controllers
RNCP	National registry of professional qualifications (Répertoire national des certifications professionnelles, France)
SQL	Structured Query Language
SME	small and medium-sized enterprises
SWPP	Student work placement programme (Canada)
TPACK	technological pedagogical content knowledge
TCK	technological content knowledge (see TPACK model)
TK	technological knowledge (see TPACK model)
TPK	technological pedagogical knowledge (see TPACK model)
UK	United Kingdom
US	United States
VET	vocational education and training
VR	virtual reality
WIL	work-integrated learning (Canada)
XR	extended reality

EN

Apprenticeships and the digital transition

Modernising apprenticeships to meet digital skill needs

Digital technologies are increasingly being adopted in a variety of occupations and sectors, meaning that workers need a solid set of digital skills. Ensuring that young people and adults have opportunities to develop the right digital skills is crucial in avoiding skills shortages and fostering productivity. Apprenticeship can help develop the right skills for the digital transition and can also benefit from the introduction of digital technologies in its delivery.

This publication draws from practice and research that explore how skill needs are changing due to the digital transition, how this impacts apprenticeship systems, how apprenticeships can support and promote the transition, and how they can benefit for from effective technology adoption and use in their delivery in the school-based and workplace components.

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