5 Innovation in vocational education and training

This chapter looks at the use of digital technologies in vocational education and training (VET) and associated pedagogical approaches. The chapter first discusses the use of technologies in VET and their potential benefits. It then describes policies and practices that promote successful implementation of technologies in VET. Finally, it provides an overview of appropriate pedagogical approaches to make the most of technology in VET teaching and learning.

Introduction

The relevance of technology in VET

Digital technologies revolutionised workplace practices by allowing tasks performed repetitively to be automated.[1] At a comparable cost, machines and computers can successfully complete more routine tasks than human beings - leading over time to replacement of labour by machines in jobs with a high share of repetitive tasks. Jobs which typically involved many repetitive tasks and have largely been automated include for example bank teller, switchboard operator and assembly line operator. In education and training the scope for automation is more limited as the core task of teaching at the current state of knowledge cannot by easily divided into replicated sequences. Student populations are highly heterogenous and teachers have to adapt their teaching approaches to students' needs. Out of 38 occupations (based on 2-digit ISCO-08) the teaching profession is estimated to have the lowest risk of automation, as it involves a high degree of social interaction, creativity, problem-solving and caring for others (Nedelkoska and Quintini, 2018[1]). However, digital technologies can complement and make the work of teachers more effective and beneficial to students, since technologies applied to teaching and training change the way in which knowledge is transmitted and skills are developed. For example, technologies can adjust the paste of learning to individual students' needs. Some aspects of education and training not directly related to teaching, such as management and administration, examinations and assessment, and data collection, are more appropriate for automation and in these areas introduction of technologies can generate efficiency gains (OECD, 2021[2]).

Many technologies used in VET are not unique to the VET sector and are also used in other parts of the education system. For example, software that helps to manage a school system can be applied in any school independently of the type of programmes provided. Similarly, tools or programmes assisting students with development of mathematical skills could help all students regardless of the programme they follow. However, some technologies used in VET are unique to VET, reflecting the fact that VET sits at the intersection of the world of education and work and involves more practice-oriented learning. They may refer to the following:

- Non-VET specific technologies that are adjusted to suit VET needs. For example, data analytics may be applied to monitor students' academic performance but also changing skill requirements in the labour market and labour market performance of VET graduates to match the provision of VET programmes to labour market requirements.
- Digital solutions that help students develop vocational skills, e.g. simulators on which VET students can safely learn how to operate tools, machinery or vehicles.
- Technologies that are applied in the occupations that students are preparing for, as students should master these technologies to be able to enter working life after completing their education and training. For example, a car mechanic should be familiar with specialised equipment to work on electric-car batteries as compared to traditional low-voltage auto electronics. In this case, technology refers to technologies applied in jobs and the digital skills necessary to use these technologies, rather than tools supporting the learning process.

The frontier between the three categories is often not clear cut, as the use of digital tools supporting learning can also lead to the development of digital skills that are required in workplaces. For example, a simulator imitating work situations is used for training and at the same time develop work-related skills. Recognising this overlap, this section focuses on the first two types of technology, which are understood as digital tools and devices proper to VET and facilitating its provision. It also looks at technologies that are applicable to the whole education system without being VET specific, such as digital school management system. However, it does not discuss the issue of how well VET programmes match the technological requirements from employers.

In recent years, the education technology (EdTech) market has grown, and many EdTech companies have started producing applications tailored to the needs of vocational teachers, trainers and learners, including apprenticeship management systems, simulators, and virtual reality (VR) and augmented reality (AR). Estimates suggest that between 2019 and 2025, the global investment in education technologies will grow on average by 16.3% each year, multiplying by 2.5 in a 6-year period (HolonIQ, 2019[3]). A lot of the recent growth in EdTech was driven by investment in online learning tools and platforms – in particular during the COVID-19 pandemic-, but investment in advanced technologies in the education industry, such as VR and AR, is likely to expand in the coming years, with projections showing that this market is expected to grow sevenfold between 2018 and 2025 (HolonIQ, 2019[3]). VET teachers, trainers and industry experts can be involved in the design of new applications, to develop materials that are relevant and easy to use in vocational training (OECD, 2021[4]). Several countries encourage such collaborations by establishing formal partnerships between the VET sector, industry, EdTech companies and research and development institutions to foster innovation and the use of technology in VET.

The COVID-19 pandemic demonstrated that digital tools, such as online learning, can be usefully applied to deliver education and training to students. During the pandemic, VET providers made ample use of distance-learning solutions, as did schools in general education. All OECD countries made use of online platforms in upper-secondary VET in 2020 and/or 2021, and between 70% and 80% of countries used take-home packages, television and mobile phones for teaching and learning during the pandemic. At the same time the rapidly growing reliance on technologies in education and training revealed its limitations and pointed to challenges when these solutions are applied on a massive scale. Lack of skills required for the successful use of technologies among teachers and students and unequal access to technology contributed to variation in the use of technologies and their outcomes. The experience during the pandemic also showed that while these solutions can work effectively for the theoretical or academic components of VET, online provision is often less suited for more practice-oriented components. To address this issue many countries applied hybrid models in VET, offering in-person classes for practice-oriented components of the curricula and remote education for the remaining parts.

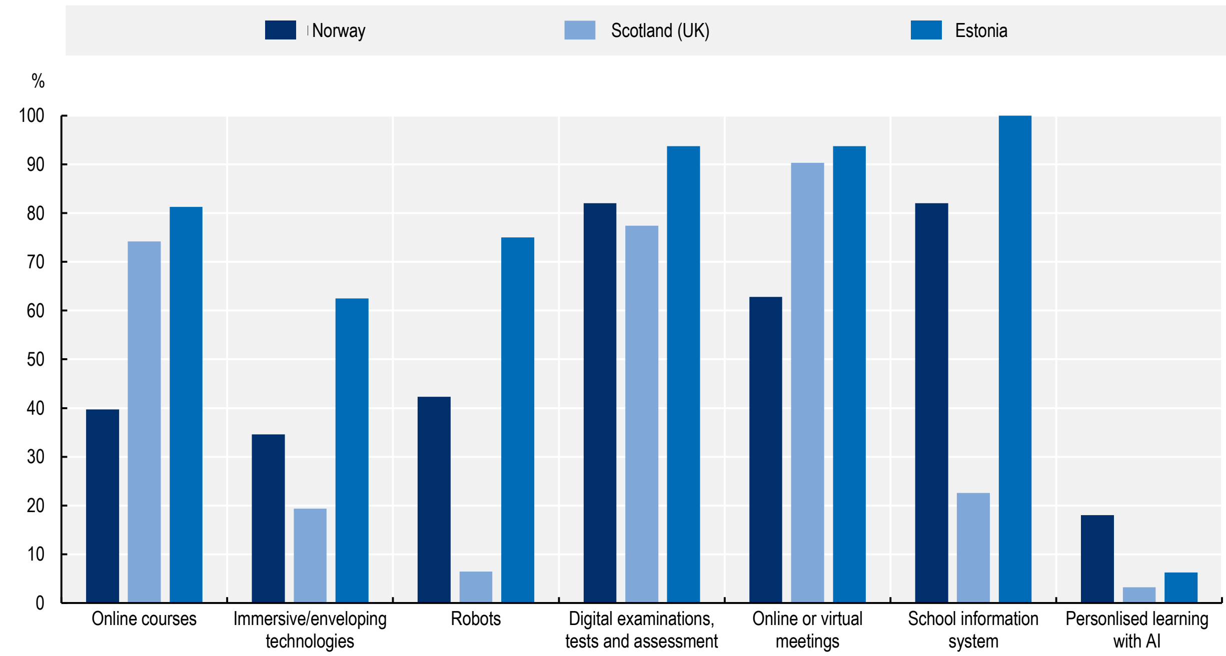
The intensity of technology use in VET

Information on the use of different technologies in VET is scarce. To shed more light on these issues the OECD piloted a survey on the use of technology in VET institutions in selected countries: Estonia, Norway and Scotland (United Kingdom) (Box 5.1). The survey aims to produce new insights on the use of different types of technologies in VET and to identify factors that enable their successful introduction.

The results show that the use of technologies in VET institutions varies across countries, reflecting differences in the structure of VET systems and in polices targeting the use of technologies in VET. Respondents in Estonia are most likely to use digital technologies, while respondents from Scotland (UK) are least likely (Figure 5.1). As described in Box 5.1, results from Scotland need to be interpreted with caution. Digital examinations, tests and assessment, and online or virtual meetings are among the most used technologies across all three countries. School information systems are very common in Norway and Estonia, but not so much in Scotland. The use of robots and simulators also seems more widespread in Norway and Estonia than in Scotland. On the other hand, online courses are common in Estonia and Scotland, but less so in Norway - which may be related to the lower share of the VET institutions catering to adult learners in Norway than in the two other countries. Personalised learning with AI does not seem widespread in any of the three countries.

Figure 5.1. Use of technologies in VET institutions in Estonia, Norway and Scotland (United Kingdom)

Share of respondents reporting using the specific technology



Note: Number of observations by country: Norway – 77 responses from 51 VET institutions, Scotland (UK) – 31 responses from 29 VET institutions, Estonia – 16 responses from 15 VET institutions. Results need to be interpreted with caution due to small sample sizes.
Source: OECD Survey on the use technologies in VET.

Box 5.1. OECD Survey on the use of technologies in VET

The OECD survey on digital technologies in vocational education and training (VET) was sent to institutions providing upper secondary VET programmes in Norway and Estonia, and upper secondary and post-secondary VET programmes in Scotland (Scottish qualifications level 5-9). The data were collected between May and September 2022. In Estonia and Norway, the survey was mainly answered by teachers and headmasters. In Scotland, respondents also included a range of other professionals involved in the provision of VET, such as exam coordinators, managers, CEOs, vocational qualification assessors.

77 answers from 51 VET institutions were received from Norway (out of 315 VET schools); and 16 answers representing 15 VET schools in Estonia (out of 31 VET schools). For Scotland, 31 answers representing 29 VET providers were received, representing only a very small fraction of the more than a thousand VET providers. Scottish results are therefore excluded for most of the analysis in this chapter due to the low response rate.

For simplicity, the Survey divided technologies into seven categories:

- Online course is a form of education carried out through a connection to the internet. With an online course, a teacher may deliver training in a range of formats, using tools like live video streaming, recorded videos, eBooks and webinars. Online courses are usually accessible to a wide range of students, regardless of their location. Some are available for free, whereas others have a price tag.
- Immersive/enveloping technologies include technologies such as 3D videos; virtual, augmented and mixed reality (through computers and simulations the person interacts with an artificial 3D visual and sensory environment, real world elements are enriched and mixed with digital elements); and games and gamification (taking elements from game-design, the general principles and theories which drive gameplay, and applying them to other nongame contexts).
- Robots and simulators can assist with a wide range of teaching and learning tasks. Simulators allow students to develop their ability to confront real-life challenging scenarios. For example, vocational teachers use welding robots to introduce students to automatic welding. They show how welding robotic arms can be programmed using specialised software. In the logistics and transportation sector for example, learners use simulators to learn how to drive a truck or operate a loader vehicle facing real-life issues.
- Personalised learning with artificial intelligence (AI): AI can give teachers a sense of how different students learn and how they advance in learning. It can help them read the classroom better, adjust the speed of teaching, and stimulate students with different techniques such as pop quiz questions. For example, AI can also help integrating real-time data and feedback in assessment and identify students at risk of dropping out or those who may benefit from accelerated learning.
- Digital examinations, tests and assessments refer to assessments, tests, surveys, and other measures that are delivered via digital devices such as computers, tablets, and mobile phones. They may lead to the delivery of digital credentials/qualifications.
- Online or virtual meetings are a form of communication that enables people in different physical locations to use their mobile or internet connected devices to meet in the same virtual room. Online meetings may be used by VET teachers, learners, parents, employers and other actors to exchange information.
- School Information System (SIS) is a web-based platform that helps schools take student and teacher data online for easier management and better clarity. The SIS is able to collect school-wide data online (e.g. student information, grades, records of tests, attendance, appraisal performance, teacher absence) that can be easily accessed by teachers, parents, students, and administrators. SIS can also facilitate teacher collaboration and support teachers in their teaching tasks. For example, teachers can share and use lessons and teaching material that are stored in a centralised location in a database or on a serve.

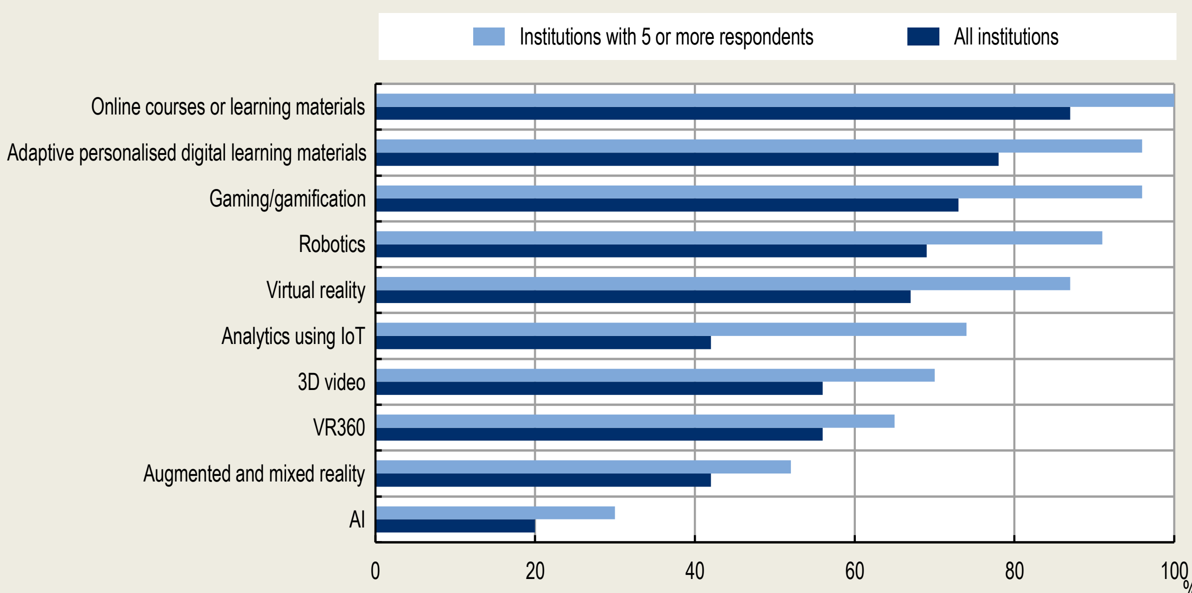
A similar survey on the use of technologies in VET institutions was carried out in the Netherlands. While the results are not fully comparable to the outcomes of the OECD survey because of methodological differences, they provide information on the intensity and type of technologies used by the Dutch VET institutions (Box 5.2). They point to an extensive use of technologies in VET, including virtual reality, gamifications and robotics, although the results also show that some of these more specialised digital technologies are used only in a limited subset of VET programmes.

Box 5.2. Findings from the 2019 Dutch survey of digital technologies in VET

In the Netherlands, the use of digital tools and innovative technologies for teaching is widespread among VET institutions according to a 2019 survey of teachers, leaders and other staff from Dutch VET institutions. The survey found that the most commonly used digital tools are online courses or learning materials. Other commonly used tools and technologies include gamification, adaptive personalised digital learning materials, robotics and virtual reality. In contrast, few institutions are using AI. The survey also found that not all of those tools and technologies are used widely within the programmes provided by the institution. For example, gamification and VR are generally only used in a few programmes or by a few teachers, whereas online courses or learning materials, and adaptive personalised digital learning materials are used in around half of the programmes.

Figure 5.2. Use of technologies in VET in the Netherlands

Share of institutions reporting using a specific technology

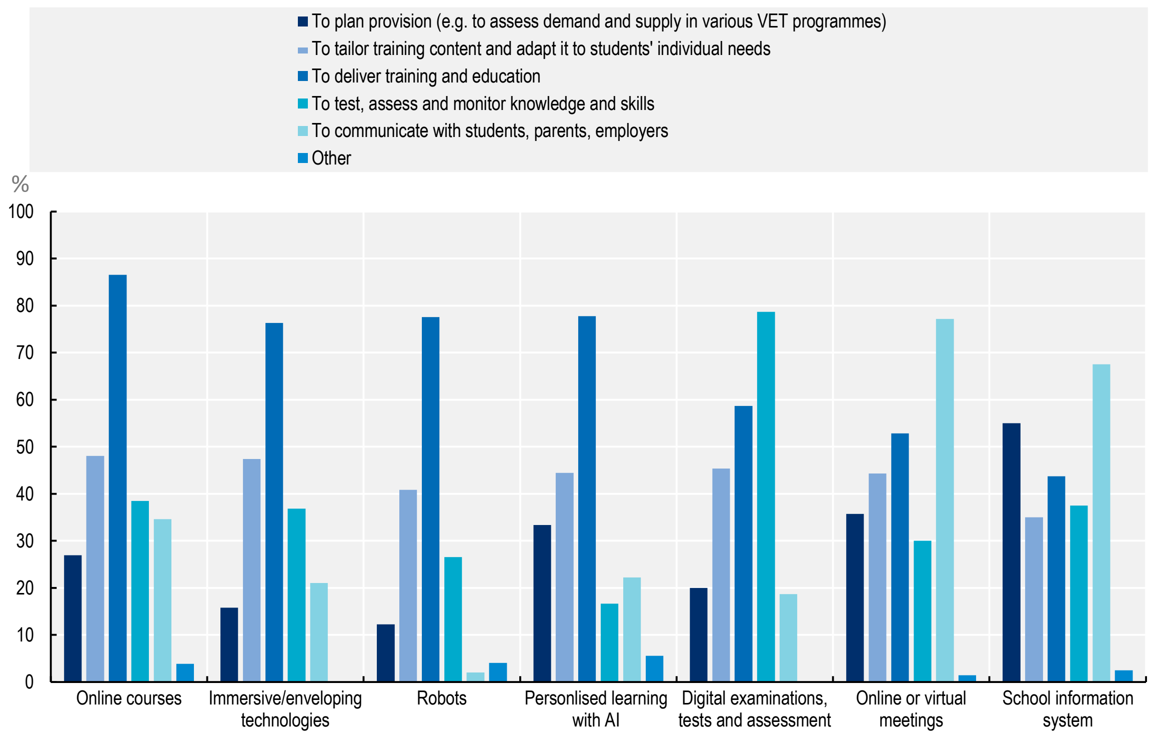


Note: All institutions" refers to the 53 participating VET institutions (i.e. 83% of all Dutch VET institutions). Restricting the sample to those institutions that have at least 5 respondents in the survey reduces the number of institutions covered to 23. VR refers to virtual reality, AI to artificial intelligence, IoT to Internet of things. The survey covers additional technologies not included in this figure, see ECBO (2019[5]).
Source: ECBO (2019[5]) Onderwijsinnovaties met moderne ICT in het mbo, https://ecbo.nl/wp-content/uploads/sites/3/RapportOnderwijsinnovaties-met-moderne-ICT.pdf.

The survey results for Estonia and Norway show that technologies serve different purposes and are used in different settings. Digital solutions such as online courses, immersive learning, robotics and simulators, and personalised learning are mainly used to deliver education and training to students (Figure 5.3). School information systems and online meetings are important for communication with students, parents and other stakeholders involved in VET. At the same time, the school information system in Norway and Estonia also plays other roles, such as helping with planning the provision and with the delivery of education and training.

Figure 5.3. The different purposes of technology use in VET institutions in Norway and Estonia

Share of respondents in Norway and Estonia using a specific technology by its purpose

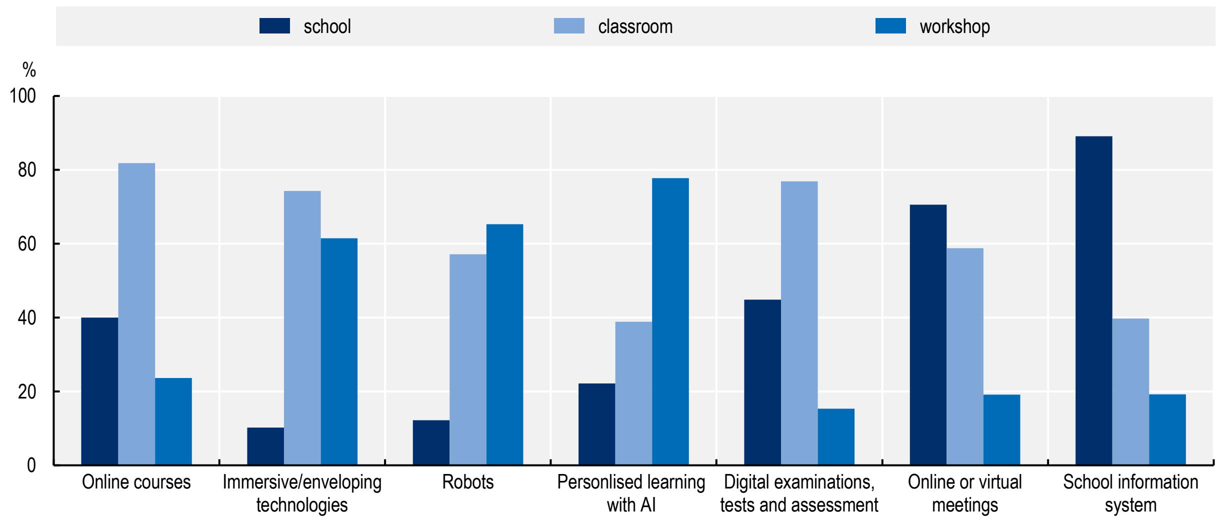


Note: The number of responses by technologies reflects to the number of respondents who use the specific technology: 52 respondents provided answer regarding online courses, 38 on immersive technologies, 49 on robotics and simulators, 18 on personalised tools, 75 on digital examination, 70 on online meetings and 80 on school information. How to read the chart: 68% of respondents using school information system use it to communicate with students, parents and employers, 55% to plan the provision, 44% to deliver education and training, and around one in three uses it in assessment and to tailor training content to individual needs. One technology can be used for more than one purpose.
Results need to be interpreted with caution due to small sample sizes.
Source: OECD Survey on the use technologies in VET.

Depending on their purpose, technologies are applied in different settings Figure 5.4. Survey results for Estonia and Norway show that technologies such as school information system and online or virtual meetings are used at the school level. These technologies facilitate school management and services, meaning that they are relevant to all students and available to all teachers and (some) other staff categories. However, school information systems and online meetings are not purely limited to school matters as they can also be applied in classrooms and workshops. In the two countries, more advanced technologies such as robotics and simulators and to some extent immersive learning with AI are less widespread than other digital tools. Interestingly, when these technologies are applied, they are often used for student training delivered in workshops. These technologies may thus have a particular relevance to VET. The Norwegian results show that teachers of mechanics, IT, industry technology and electronics are the most likely to report the use of robotics and simulators (i.e. the robots category in the survey). Some VET programmes may therefore particularly benefit from the use of these digital solutions. For example, they can be helpful in areas where expensive equipment is required and when errors are costly and may put students' safety at risk.

Figure 5.4. Settings where digital technologies are used in VET institutions, in Estonia and Norway

Share of respondents using technologies, by setting of use and type of technology



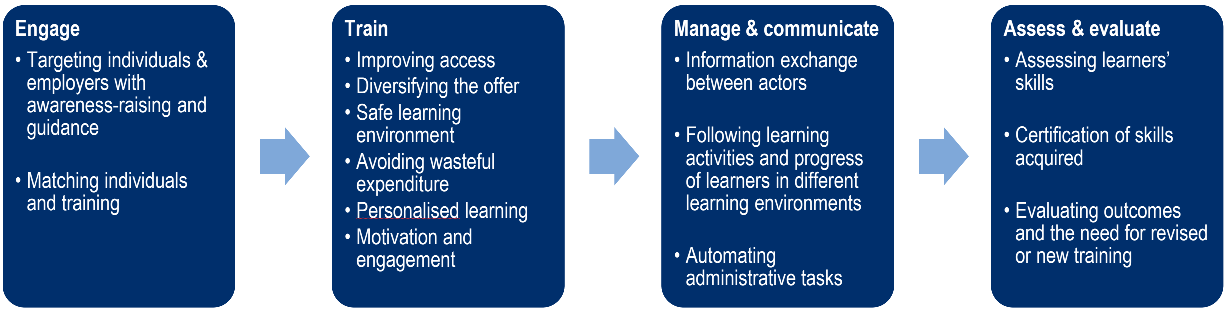
Note: 82% of respondents use online courses in the classroom, 40% apply it to activities relevant to the whole institution and 40% use online courses in the workshop. One technology can be used in more than one setting. The number of responses by technologies reflects to the number of respondents who use the specific technology: 52 respondents provided answer regarding online courses, 38 on immersive technologies, 49 on robotics and simulators, 18 on personalised tools, 75 on digital examination, 70 on online meetings and 80 on school information. Results need to be interpreted with caution due to small sample sizes.
Source: OECD Survey on the use of technologies in VET.

This chapter first discusses potential benefits arising from the use of technologies in VET bearing in mind that digital technologies in VET are still a relatively new and growing phenomenon. While there are many potential benefits that could be associated with their more systematic use, more research is required to fully evaluate the impact of technologies on students' outcomes. It then discusses policies that promote successful implementation of technologies in VET. Finally, it provides an overview of innovative pedagogical approaches in VET.

What are the potential benefits of digital technologies in VET?

Introduction of technologies in VET can potentially lead to many benefits (Figure 5.5) for an overview of potential areas of use). Technology can be integrated in various aspects of VET provision and contribute to making the system more accessible, attractive, relevant, transparent, effective and efficient. The different aspects in which technology is used can be broadly classified as: engage, train, manage and communicate, and assess and evaluate. Technology can be used by the schools/training providers (teachers and leaders) and the employers that provide work-based learning, but also at the higher-level to influence the overall VET system.

Figure 5.5. Potential types of technology use in VET



How to use technology to engage VET actors?

With more detailed data collection and analytics on students and VET graduates, as well as VET institutions (schools) and employers, profiling models could be used to identify individuals who could benefit from VET programmes, including early school leavers and job seekers. Likewise, on the employer side, data on employees' skills and employers' training systems can show which enterprises could benefit from offering training and/or need support to engage in training provision.

Moreover, technology can be used to better match learners, institutions and employers. Technology can help connect them, by profiling individuals' skills and aspirations, employers' skill needs, and VET institution offers, and finding the best matches between them. This can help reduce searching and matching costs and increase the effectiveness of matching skill needs and training. Innovative profiling and matching models are likely to become more prominent as big data become widely available. Flanders (Belgium), for example, uses a deep learning model based on real-time labour market data and job seekers' skills data to support people in taking up vocational training or finding jobs (Box 5.3). Scotland (UK) has set up a comprehensive online apprenticeship portal called *apprenticeships.scot*. Among its many functions, the portal offers services to connect apprentices and employers, and provides information on apprenticeship jobs and funding opportunities, and general guidance and advice on apprenticeships. It complements other online guidance portals, as described in Chapter 4. In Norway, a new online portal for apprenticeships was launched in 2023 (www.finnlarebedrift.no). The portal gives an overview of approved apprenticeship enterprises and available apprenticeships by region and training field. The portal builds on daily updated data from different public registers. The portal is part of the national online portal for information about education and occupation in Norway (www.utdanning.no).

Box 5.3. Flanders (Belgium): Using AI to better match learners and training opportunities

The Flemish Employment and Vocational Training Service (VDAB) helps residents of Flanders find jobs and take vocational training, by using machine learning (ML). VDAB recently partnered with Radix.ai, a Belgian ML start-up, to make the matching process more effective and efficient. This initiative uses the VDAB data contained in CVs and job postings and applies ML to provide better-targeted matches for VDAB users. Deep learning, a subset of ML, enables machines to mimic human behaviour, and in order to train the deep learning model, VDAB regularly uploads new vacancies and CVs to their storage engine. With each new dataset, the engine learns how the job market evolves, noting changes in job demand and how trends shift over time.

The deep learning model also learns how jobs are spoken of and what the changing interplay of words means. For example, "data scientist" is a relatively new job, related to the roles of machine learning engineer, data analyst and even AI architect. The model allows machines to learn the meaning of words and continue to improve matching quality. Based on word relationships and the interests and behaviour of the users, job matches are more closely aligned to the aptitudes, talents and preferences of job seekers.

Source: Amazon Web Services (2021[6]), AWS Partner Story: VDAB & Radix.ai, https://aws.amazon.com/partners/success/vdab-radix-ai/ , DeTijd (2023[7]), AI-bedrijf Radix helpt VDAB jobs op maat aan te bieden, www.tijd.be/de-tijd-vooruit/tech/ai-bedrijf-radix-helpt-vdab-jobs-op-maat-aan-te-bieden/10313389.html.

How can technology facilitate teaching, training and learning in VET?

Technology can help increase the accessibility of VET programmes. Online and virtual learning can improve access for learners in remote areas by providing remote connections to VET institutions and employers – as long as internet connectivity is up to standard. Other types of technology can also make VET more accessible to students with special needs that may have prevented them from following certain pathways in the past. For example, artificial intelligence (AI) systems can help students overcome obstacles, such as through text-to-speech or speech-to-text applications or wearables to help visually impaired students read books (OECD, 2021[2]). With well-known applications such as speech-to-text, text-to-speech, and auto-captioning, etc., AI allows blind, visually impaired, deaf and hard-of-hearing students to participate in traditional educational settings and practices. Some smart technologies facilitate the diagnosis and remediation of some special needs (e.g. dysgraphia) and support the socio-emotional learning of students with autism so they can more easily participate in mainstream education (OECD, 2021[2]).

Technology can also increase the flexibility of provision. This may be particularly important for adults who combine work and learning. In Canada, for example, the Flexibility and Innovation in Apprenticeship Technical Training (FIATT) project experimented with alternative delivery approaches such as a combination of online learning with classroom learning, mobile training units, instructor support or simulators. FIATT apprentices were more likely to agree their training was flexible. They missed fewer hours of work and reported fewer lost earnings (Government of Canada, 2022[8]). In the United States (city of Dallas) high school students can carry out paid virtual internships. Typical virtual internship lasts 120 hours spread over 4 weeks in the summer, though semester-length internships can also be arranged. Students also have on option of carrying out hybrid internships, whereby they alternate work in the company and work from home. During their internships students take on short-term projects that address challenges of the company. A toolkit developed by the city of Dallas provides practical advice to employers who wish to offer virtual or hybrid internships (Dallas ISD's CTE Department, 2021[9]).

More advanced technology can help to diversify training options, by overcoming material shortages that might otherwise limit what governments and learning providers can offer to students and how students can progress. For example, virtual or augmented reality (VR/AR) and simulators, can enable students to develop vocational skills by performing specific tasks like operating heavy machinery, learning how to repair a car engine, or testing chemical products in a laboratory (OECD, 2021[2]). In such cases, it may be cheaper and safer to use simulators or VR/AR than traditional laboratories that are expensive to set up, maintain and update. VR and simulators could also reduce wasteful expenditures in those occupations that make intensive use of materials or supplies, representing a greener cost-effective alternative. They also show important advantages in terms of economies of scale, allowing for their use in many different institutions. Moreover, the use of VR and AR has numerous benefits for employers providing training, as these technologies can shorten the amount of time that new trainees need to spend on real equipment, which reduces the cost of training and therefore provides a cost-effective complement to traditional work-based learning.

According to a World Bank study, VR training is more effective on average than traditional training in developing technical, practical and socio-emotional skills; it is particularly promising in fields of health and safety, engineering and technical education. Students who had VR training used inputs and time more efficiently and/or were better at avoiding performance errors than students receiving traditional training. For each additional hour of VR training, students scored 3% higher in technical learning assessments than those exposed to the same content delivered through traditional methods (Angel-Urdinola, Castillo Castro and Hoyos, 2021[10]). However, the World Bank analysis found that the effectiveness of VR training differs across sectors and subjects.

Moreover, the use of digital technologies has been associated with increased student motivation and engagement, leading to higher student retention rates in VET programmes and therefore contributing to equity in education (Khan, Ahmad and Malik, 2017[11]). Unlike training in workplaces, classroom teaching is often more theoretical and can be less appealing to students who dislike classroom settings and academic learning. One of the aims of VET pedagogy is thus to show to VET students that what they learn in the classroom can be directly applied in workplaces. In Switzerland, a dedicated 'Leading House' has been set up to research technologies for vocational training. Leading Houses contribute to the sustainable development of VET research in Switzerland and are coordinated by one or more Swiss university chairs. Each Leading House serves as a competence network and conducts research under the terms of a service level agreement with The Swiss State Secretariat for Education, Research and Innovation (SERI) (SERI, n.d.[12]). The Leading House dedicated to the topic of technologies for vocational training (i.e. the DUAL-T Leading House) has as purpose to determine how learning activities may be designed so as to close the gap between classroom instruction at VET schools and work-based training at host companies. The Leading House also seeks to optimise coordination between various VET learning locations (SERI, n.d.[13]). For example, in logistics programmes, the Leading House developed an intervention that consists of using a small-scale model of a warehouse in the classroom as a basis for problem-solving exercises close to workplace practice. By using technologies students and their teachers can run simulations on top of their warehouse layouts (EPFL, 2022[14]).

Another potential benefit of technology is that it can be used to provide personalised support to learners and teachers. Personalisation of learning did not start with computerised technology – in a sense, it has been available since the first use of one-on-one tutoring, thousands of years ago (if not earlier). However, with the increase in systematised, standardised schooling and teaching over a hundred years ago, awareness increased that many students' learning needs were being poorly met by one-size-fits-all curriculum. Classroom approaches such as mastery learning (each student works on material until mastery and only then moves on to the next topic) were developed but proved difficult to scale due to the demands on the teacher. Educational technologies provided a ready solution to this problem – the computer could manage some of the demands of personalising learning, identifying each individual student's degree of mastery and providing them with learning activities relevant to their current position within the curriculum (OECD, 2021[2]). Over time educational technologies became more effective at personalised learning. Modern educational technologies in many cases could recognise when students are using ineffective or inefficient strategies, and to provide them recommendations or nudges to get back onto a more effective trajectory (OECD, 2021[2]). Currently, researchers aim to adjust the learning process not only to students' ability but also to their engagement, motivation and emotion. There are now several examples of educational technologies – particularly intelligent tutoring systems and games – which have been able to identify a student who is bored, frustrated, or gaming the system (trying to find strategies to complete materials without needing to learn) and re-engage them productively (OECD, 2021[2]).

Learner tracking systems, where teachers and trainers have detailed information on learners, can improve the quality of training provision, similar to the player-level analytics available to a professional sports coaching staff. Such systems can provide teachers and trainers with information that they may have neglected during lessons due to their workload or other systemic, technical, or institutional issues. Data analytics and statistical profiling models can be used to identify students at risk of dropping out, using the administrative micro-data that are increasingly being collected by education systems and organisations. While identifying a good set of early warning indicators remains difficult, a few systems have shown a high level of accuracy and enriched thinking about the reasons students drop out (OECD, 2021[2]). These techniques may help prevent students dropping out, detect potential problems, and provide opportunities to intervene earlier. For example, in the United Kingdom, predictive analytics tools can be used to identify high-risk programmes and learners by measuring trends in learner engagement and motivation (OECD, 2021[2]). In Switzerland, the DUAL-T Leading House that examines the use of technologies in VET, developed tools to help students to succeed, explore behavioural patterns and predict students' performance. For pre-class activities, this design often makes use of videos and digital content published in online platforms. The students' engagement in pre-class activities prepares students for effective participation in face-to-face sessions. While the pre-class scheme was developed primarily to increases students' success rates during classroom teaching it also contributed to development of a model predicting students' performance. The model draws on digital traces left by students during their online interactions with pre-class activities. The widespread use of the scheme allowed researchers to investigate these interactions and, on this basis, predict students' performance. These early predictions enable effective content personalisation and adaptive teaching interventions (EPFL, 2022[15]). Technology can thus help to personalise learning and adapt its speed and content to individual needs. This may be particularly important in VET, as in many countries VET programmes cater to students with lower academic performance facing a higher risk of dropping out from school.

How can technology help to better manage and communicate in VET?

Technology can be used to reduce administrative and repetitive tasks involved in VET management, such as managing admissions and school allocations, assessment reports, proctoring systems, and resource allocation and planning (OECD, 2021[2]). Initially, schools used technology to facilitate office and clerical tasks, mainly to store student and personnel data. Over time, the use of technology in educational management expanded. Computers now assist institutions not only in storage but also in manipulation and production of data and information. These processes related to the use of technologies in school management are sometimes referred to as School Information Systems (Visscher, 2001[16]). School information Systems serve different purposes. They support the registration of data, facilitate access of students to web resources by creating one entry point, support school management by providing relevant information such as information on student progress, teacher absence and teacher training. Evaluations of School Information Systems show that they can improve access to information and school resources and result in a more efficient administration. They may also contribute to a lower workload among school staff who use ICT technology with confidence (Shah, 2014[17]).

Estonia provides an example of how School Information System contributes to the production of data and how this information then feeds back to schools to support their management and learning practices (Box 5.4). The Estonian government has cooperated with the private sector to deliver several educational programmes and provide educational institutions ICT services to support learning and teaching. Currently, 95% of schools in Estonia use one of the two major school management tools: eKool or Stuudium (e-Estonia, 2023[18]).

Box 5.4. Education Information System in Estonia

Since 2004, Estonia has been managing data on students, schools, study materials, examinations, curricula and teaching staff through the Estonian Education Information System (EHIS), managed by the Ministry of Education and Research. Schools are required to enter the relevant data, such as on students' grades and successfully completed certificates, directly into the system. The Estonian Education Information System is a personal-identity-based database, which means that each person is registered with an individual identification number and the data from different sources are connected. Schools can access their school-specific data to monitor their performance and to integrate this information into their management and learning approaches. Aggregated EHIS data are available to the public on an online platform called Educational Eye (*HaridusSilm* in Estonian) and can be used for example to guide students in their educational choices.

Source: OECD (2020[19]), Strengthening the Governance of Skills Systems: Lessons from Six OECD Countries, https://doi.org/10.1787/3a4bb6ea-en.

School Information systems may also store information on student's progress and more broadly on individuals' credentials and education and training milestones. Mobile logbooks allow students to record and demonstrate their learning and training progress, including details such as hours worked, tasks performed, and equipment used. Collection and production of data is not limited to VET schools only. In apprenticeships, information systems can be developed and used by employers and employer organisations working with apprentices, as in Norway (Box 5.5). This can facilitate the communication between the learning venues and allow for a better monitoring of learning activities and progress.

Box 5.5. Information system in apprenticeship: Norway OLKWEB - an e-platform

In Norway, apprentices are able to complete their training requirements, provide documents and access government assistance through specialised e-platforms. One popular system known as OLKWEB has been optimised for use by training offices (employer organisation assisting individual employers with the provision of apprenticeship training), who are able to follow up on their apprentices and generate reports that document the apprentice's activities and outputs. Learning providers are able to perform several key functions, including:

- Access the contacts and details of member companies
- Analyse and monitor the apprentice's progress through curriculum goals provided through traditional means or by films, images and mobile apps
- Access details of grants and general accounting.

Apprentices are also able to interact with each other through the system and can use the interface to record meetings and receive information. The employer is also able to monitor the apprentice's progress in off-the-job training. In the extremely rural area of Nordland, the customised apprentice interface allows apprentices to fulfil their training requirements without travelling vast distances. E-platforms also remove administrative burdens and allows young people to complete their apprenticeship requirements flexibly.

Source: OECD (2022[20]), *Strengthening Apprenticeship in Scotland, United Kingdom*, https://doi.org/10.1787/2db395dd-en.

How can technology be used to assess VET students' skills and evaluate VET outcomes?

Technology creates innovative, cost-effective, and predictable ways to assess and certify skills and collect the necessary evidence. Digital and smart technology is increasingly being used in the assessment of education and training outcomes, including in apprenticeships, and in compiling e-portfolios of skills. Online exam tools or online assessment platforms can reduce the work of assessors by creating exam questions to test competence-oriented tasks and compile them into an overall exam. Smart technologies and smart data analysis techniques enable assessments to be broadened to take in skills that cannot be easily measured by conventional tests. For example, game-based tests can measure higher-order skills (e.g. creativity) or emotional and behavioural skills (e.g. collaboration, behavioural strategy), and analyse eye-tracking data and audio recordings, and process natural language and information such as time-on-task (OECD, 2021[2]).

Blockchain technology can open new avenues for credentialing in VET as a form of "verification infrastructure". It enables claims about an individual or institution, including their characteristics and qualifications, to be verified instantly and with a very high level of certainty. This helps eliminate diploma and other record fraud; facilitates the movement of learners and workers between training institutions, workplaces and jurisdictions; and empowers individuals by giving them increased control over their own data. Many blockchain initiatives are underway across the world, which may transform how VET and apprenticeship systems – as well as entire skills systems – manage degrees and qualifications (OECD, 2021[2]).

However, caution is needed when expanding these kinds of innovative approaches in assessment and certification. Close collaboration between employers, teachers, trainers and assessors – as well as strategic support from government – is a fundamental step prior to making any decision about implementing technology solutions for assessment. It is important to be transparent about how accurate technological systems are at measuring or assessing competencies as compared to other methods, and to ensure that those using these tools have the knowledge and skills required to use it.

Moreover, technology can improve the monitoring of quality and outcomes in the VET system, by providing more accurate, timely and detailed information on the labour market outcomes of learners and employers' skill needs. Monitoring can be more rigorously and effectively conducted using advanced analytical approaches and technologies that facilitate data collection and analysis. Big data provides many opportunities and these data are increasingly being used, but also need to be used with caution (see Chapter 2). Nowadays, most job vacancies are being posted online in developed countries, replacing traditional hiring methods such as ads in newspapers (Cedefop, 2018[21]). This migration, combined with a growth in computer processing power has provided new opportunities for collecting and analysing large, naturally occurring online job vacancy datasets. Consequently, evidence on employers' demands for skills has been growing over time. The volume and the level of detail in online job vacancy data allow for a granular analysis of employer's demand, across firms, within a specific occupation, and by region. When combined with more traditional data sources such a Labour Force Surveys these data represent a powerful tool to examine changing demand for skills on the labour market. This information can help to (re-)define the offer and content of VET programmes. The models can use the data to improve their predictive power and target results more precisely, ideally in conjunction with a continuous dialogue between data analysts, policy makers and practitioners. This can help reduce searching and matching costs and increase the effectiveness of matching skill needs and training.

How can digital technologies be used more effectively in VET?

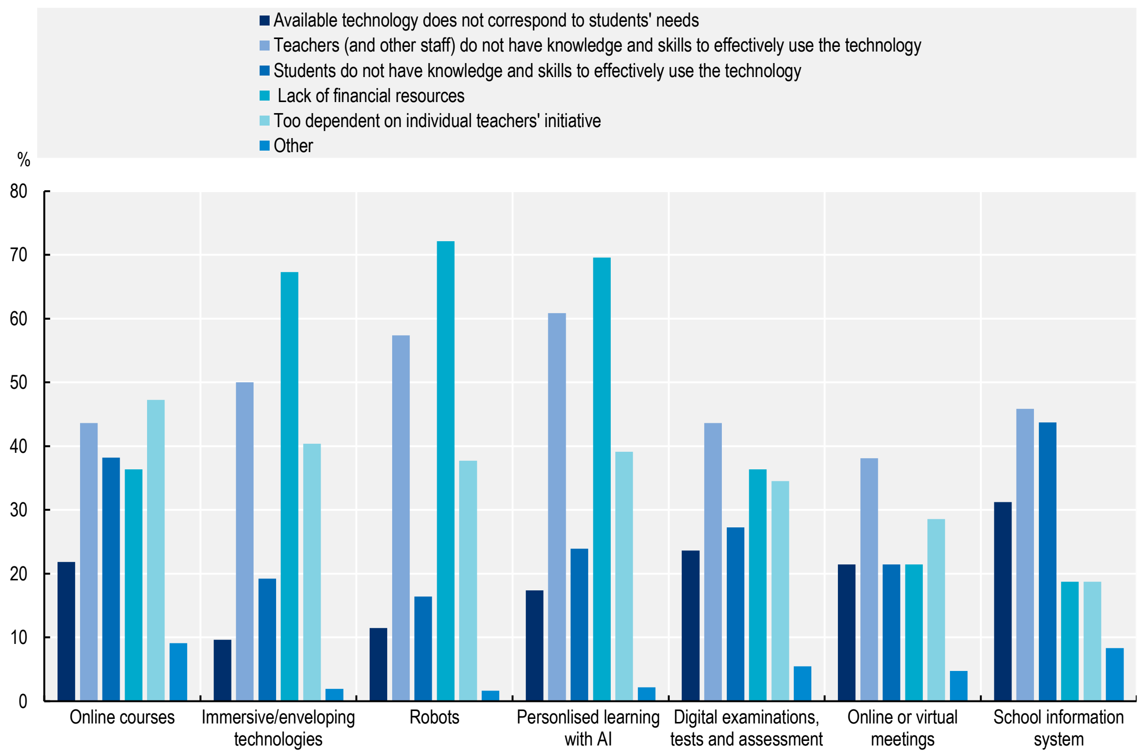
The OECD Survey on the use of technologies in VET (Box 5.1) in Estonia and Norway highlighted that the majority of respondents are most of the time satisfied with the identified technologies. 90% or more of respondents strongly or somewhat agreed that the technologies such as online courses, online or virtual meetings, robots, school information system and immersive/enveloping technologies were successful in meeting its objectives. Using the same measure, around 80% of the participants rated positively digital examinations, tests and assessments and personalised learning with AI.

Nonetheless, various barriers hinder the adoption and effective use of technology in VET. The cost of the purchase and maintenance of technologies, insufficient information about available digital tools, and lack of digital skills among teachers and other stakeholders involved in VET delivery are some of the barriers to a more effective use of digital tools by VET institutions. When reflecting on factors that prevent technologies from being adopted and used more effectively, the survey respondents in Estonia and Norway point to a high cost of some advanced digital solutions supporting delivery of training and education, such as robotics and simulators, immersive solutions and personalised learning and AI (Figure 5.6). Another commonly reported obstacle is teachers not having the right knowledge and skill. A relatively large share of respondents also note that the use of a certain technology is too dependent on individual teachers' initiative, potentially pointing to a need for more institutional guidance and support. The survey on technology use in VET institutions in the Netherland identified similar obstacles (ECBO, 2019[5]): The main barriers to the use of innovative technology in Dutch VET institutions were teachers' lack of ICT skills, time and ownership, and institutions' lack of vision and objectives.

VET institutions and other users of technologies may thus benefit from policies that address the high cost of digital tools, improve knowledge about existing VET technologies, stimulate development of new tools and improvement of existing ones, and help teachers develop the relevant skills. These policy measures are complementary and for those reasons they should be introduced simultaneously. For example, for a new digital tool to be introduced in VET institutions and used by VET teachers it should be evaluated and compared to existing tools; concerned stakeholders should be aware of its existence and its benefits; and teachers may need some training to learn how to use it. Moreover, unless there are specific measures in place, some VET institutions with lower financial capacity may not be able to afford it. Such a holistic approach makes the adoption of technologies more effective: improve the match between digital technologies and teachers and students' needs and prevent users incurring financial losses by investing in ineffective technologies. In Norway, the government launched a "Strategy for digital competence and infrastructure in kindergartens and schools" in 2023. The main purpose of the strategy is to enable schools, their owners and employees to take action on digitalisation, and to receive sufficient support. It should provide a clearer direction for how challenges, including on aspects related to privacy, choice, procurement and use of teaching aids and schools' and teachers' digital competence, can be solved today and in the future in an efficient and sustainable way (Ministry of Education, 2023[22]).

Figure 5.6. Obstacles to technology adoption and use in VET institutions in Estonia and Norway

Share of respondents by reasons preventing them from using a specific technology more effectively



Note: 72% of the participants reported that lack of financial resources prevents them from using robots more effectively. More than one obstacle can prevent effective use the technology. The number of responses by technologies reflects to the number of respondents who use the specific technology: 52 respondents provided answer regarding online courses, 38 on immersive technologies, 49 on robotics and simulators, 18 on personalised tools, 75 on digital examination, 70 on online meetings and 80 on school information. Results need to be interpreted with caution due to small sample sizes.
Source: OECD Survey on the use of technologies in VET.

How to tackle the high cost of technologies?

Introduction and use of technologies can be costly. It requires an upfront investment related to the purchase of equipment and software and upskilling of teachers. It also involves a cost of maintenance and possibly also licencing. The cost of technologies may vary considerably between types of technologies.

For example, Norway divides technologies used in schools into two categories: i) generic technologies such as virtual meeting applications and online resources that were not primarily developed to fit VET programmes and that often are available for free; and ii) teaching technologies developed to match school needs and support teaching and training in VET programmes (Oslo Economics, 2022[23]). Presumably, teaching technologies are more expensive than generic ones. Their initial cost may be higher as they target smaller markets - they are developed to match learning objectives of education and training systems, which means that the producer cannot offset the cost of the technology development by selling more products. Teaching technologies also are more expensive as VET institutions typically have to periodically renew a licence to be able to use the technology over time. While teaching technologies are typically more costly than generic ones they may lead to better outcomes. The fact that teaching technologies are developed for the education sector and that users may be able to provide feedback on the technology they are using to the supplier allows to evaluate the technologies and adjust if necessary. Teaching technologies are fit for learning purpose and are less reliant on teacher's capacity to identify and adapt relevant online resources. Their quality varies less than the quality of free generic technologies and they pose less confidentiality risks (Oslo Economics, 2022[23]).

The OECD Survey on the use of technologies in VET shows that school information systems, robots and simulators and immersive technologies are more widespread in Estonia and Norway than in Scotland (UK). On the other hand, online meetings and courses are commonly found in VET providers in Scotland (based on the information provided by a small subset of Scottish providers). Drawing on the Norwegian classification, Scotland thus is more likely to use generic technologies, whereas teaching technologies are more common in Estonia and Norway. Differences in the design of VET systems and VET policies may explain variation across countries in the technologies used. In Norway and Estonia, public authorities own and run most VET institutions. This is very different from the fragmented Scottish landscape with many VET institution owners, a relatively low number of students per owner, and VET providers competing for students (which may discourage them from collaborating) (Kuczera and Jeon, 2019[24]). The introduction of technologies, and those requiring a large upfront investment such as school information systems and robotics, may be more difficult in fragmented VET systems with a low level of collaboration. School owners with larger populations typically have more funding and bargaining power with suppliers than smaller ones. They can introduce the same services across all their institutions, benefiting from economies of scale. Smaller vocational education institutions may have financial constraints that limit their access to expensive technologies.

Some countries opt for common measures and solutions to ensure universal access to some technologies and to compensate for financial differences across VET institutions and their capacity in invest in technologies. To facilitate access to technologies and digitalisation of schools, Norway developed a national solution for secure login and data sharing in education called Feide. It gives schools access to over 1 500 different services, learning materials and products. In 2019, the last county municipalities were connected to Feide. As of 7 December 2020, there have been 210 million registered logins on Feide, a significant increase from under 180 million in 2019 (Utdanningsdirektoratet, 2020[25]).

Transparency is important for VET providers to make informed decision of which technologies to invest in. Individual institutions may have limited information on technologies that are available on the market and their learning benefits and may therefore find it hard to identify and select the technology that could be most suited to their needs. As available technologies and applications are growing quickly, it may be hard for providers to separate the wheat from the chaff. Transparent markets thus facilitate access and use of technologies. To support and steer institutions in the choice of digital tools, grants for the purchase of technologies in Norway can only be spent on tools developed by suppliers in line with the Norwegian Education Act (Oslo Economics, 2022[23]). Evidence from Norway shows that setting up common standards and objectives for technological tools is beneficial to suppliers and VET system. For the suppliers, stricter requirements may increase the costs in the short term but decrease the future cost related to the development of new tools. The cost of developing tools according to defined standards will be lower compared to when producers have to adapt to a different system of regulations. Common standards would also facilitate access to technology for school owners and school managers. Standardisation will help to simplify the acquisition and administration of digital tools, which are seen by many users as very demanding (Oslo Economics, 2022[23]). However, government interventions to reduce costs may have a cost in themselves and risk injecting extraneous criteria into the choices of producers and consumers.

Also in Norway, to improve the access to and use of digital learning resources in upper-secondary education and increase the use and the variety of such resources, the Norwegian government allocated NOK 50 million to the development of digital teaching resources for subjects in upper-secondary education, including in VET. The national grant funded the Norwegian Digital Learning Arena (NDLA), key body in educational technologies built around the co-operation of counties (owners of the majority of upper-secondary VET institutions). Box 5.6 provides more detail on this initiative.

Box 5.6. Norwegian Digital Learning Arena

Norwegian Digital Learning Arena (NDLA) was established as a joint project by all counties except Oslo to develop digital solutions for all their upper-secondary schools, including VET programmes. It is a collaborative not-for profit organisation with the participating counties providing the funding and managing the scheme. NDLA offers freely available open digital learning resources for upper-secondary education. It provides a range of learning resources that are available with an open license that gives teachers, students and everyone else the right to use them. Open licenses provide the opportunity to share, use, create, modify and re-distribute learning resources (NDLA, 2023[26]). Among others, NDLA purchases goods and services on external markets through public procurement. The responsibility for the editorial work, organising, meta-tagging, and putting together the material in the respective subject areas lies with competent editing groups recruited from upper secondary schools in the counties. In 2021 NDLA bought goods and services from 98 suppliers (NDLA, 2021[27]). When the demand is not met by the supply, the editing groups will produce their own material.

NDLA is by far the largest provider of open learning resources in Norway, and the NDLA offer has expanded over time. Currently it provides learning resources in around 150 subject areas, as compared to 30 in 2009-2010. In VET, NDLA has learning materials for all education programs in year 1, as well as in selected subjects in year 2 (Oslo Economics, 2022[23]) (in Norway the first two years of a VET programmes are typically provided in schools and the last two in companies). The number of visits to the digital resources increased nine folds between 2010 and 2019 according to Google Analytics (NDLA, 2023[28]). NDLA is an important market player and there is some criticism that this situation can endanger competition in education and training technology market (Oslo Economics, 2022[23]). However, thanks to its position and available resources NDLA is able to develop digital resources in 'niche' VET subjects (Oslo Economics, 2022[23]). These subject areas may have been otherwise neglected by the technology suppliers as they are not profitable due to a limited number of potential consumers.

To ensure the proposed digital material meets the quality standards, the content of each site is quality controlled by researchers and specialists in that field. NDLA also sets up collaborations with several pilot schools where students and teachers try out and evaluate the teaching aids before they are put into use (NDLA, 2023[26]).

A survey carried out among Dutch VET institutions on the use of technologies confirms that collaborative approaches, knowledge sharing and a common vision would support VET institutions in a more effective use of technologies. For example, it may involve ensuring that available technologies correspond to learning goals, monitoring the quality of available tools, sharing best practices and a better overview of existing technologies. Dutch VET institutions also reported that they would welcome funding incentives to stimulate innovative practices and experimentation (ECBO, 2019[5]).

How to stimulate technological innovation and excellence?

Policy initiatives can also act on the supplier side and promote development of appropriate digital tools. This can involve investment in research and innovation, and development of digital tools in VET areas that would otherwise not be covered by technology, for example because of a small number of potential users.

In Norway, the government provides grants to suppliers for the development of specific technologies. Other country examples show that, policy makers establish partnerships with the private sector, or stimulate the production of new learning resources through innovation funds for specific industries. For instance, the US Department for Education established the Small Business Innovation Research programme, to give small enterprises access to funding to produce education technology (EdTech) applications that could be later commercialised. The fund promotes the use of education technology to improve teaching practices and student learning outcomes (Small Business Innovation Research, 2020[29]). In England (UK), an EdTech Innovation Fund was established by the Nesta Foundation and the Department for Education. The Fund supports EdTech organisations in England aiming to improve their products, carry out research about the impact that the use of their tools has, and grow their reach to more schools and colleges in England (Nesta, 2019[30]). A first round of funding has already benefitted more than a dozen EdTech companies.

The Estonian experience demonstrates that technological excellence in education requires a consistent policy. After regaining independence in 1991 Estonia thoroughly reformed its education system using information technology. Estonia developed schools' local Internet connections, purchased devices for teachers, supported the creation of digital learning materials and advancement of teachers' digital skills. By 2001 all schools were equipped with computers and connected to the Internet and thousands of teachers took computer basic training course. The priority was given to the preparation of trainers working with teachers and to bringing the training close to the participants (e-Estonia, 2023[18]). Building on these achievements Estonia has kept innovating and developing its technological capacity in education. For example, the IT Academy Programme is a co-operation programme between the Estonian state, universities, vocational schools and information and communication technology (ICT) companies. It aims to increase the quality of ICT-related education, develop research in the field and ensure the necessary labour resources. In vocational education the IT Academy contributes to the quality of IT formal education in vocational schools, so that VET in IT areas is seen as attractive and prepares well for high-quality employment and further education (Haridus - Ja Noorteamet, 2023[31]).

How to improve digital skills of VET teachers?

The extent to which VET teachers will effectively integrate new technology into their activities depends strongly on their digital skills. Digital skills of VET teachers refer to technical skills in using technologies, knowledge of available technologies and their advantages and limitations. Data on actual digital skills of teachers is hard to come by, and the available evidence is mostly based on self-reported skills and abilities (which especially make cross-country comparisons difficult to interpret). Evidence from OECD countries shows that some VET teachers report not feeling fully confident to use digital technologies for teaching (Figure 5.7). Similarly, data from the SELFIE[2] tool developed by the European Commission shows that around one in four VET teachers in OECD countries (for which data are available) feel unprepared to use digital technologies in classroom teaching, and this share is higher among older VET teachers than young ones (Figure 5.8). A study looking at VET teachers in Switzerland confirms that their digital skills decrease with age[3]. The study also finds that technological skills of VET teachers differ by gender. Men have stronger digital competencies, are more confident in choosing digital tools and applying them to teaching and learning, and in assessing students' progress and competences. Women on the other hand are more likely to apply technology to personalise and differentiate learning following students' individual needs (Cattaneo, Antonietti and Rauseo, 2022[32]). However, the observed differences by gender may reflect overrepresentation of women in subjects that are less reliant on technologies.

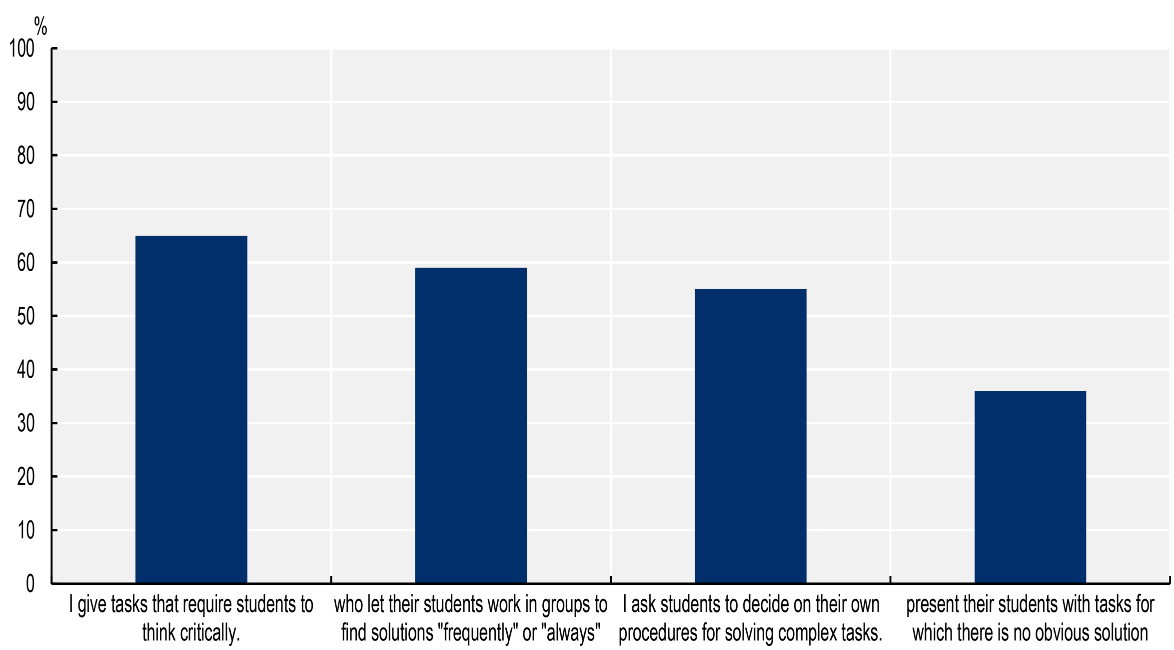
Likewise, the OECD Survey on the use of technologies in VET revealed that insufficient knowledge of technologies among teachers is a major barrier to more effective use of technologies in Estonia and Norway (Figure 5.8). Moreover, the survey shows that the choice and use of technologies is often up to the teacher, which represents a challenge, as technology savvy teachers have a better knowledge of existing tools, their advantages and limitation, and can use them with more confidence in their work. Independently of teachers' digital skills, motivation to use digital technologies may vary, which means that relying on teacher initiative would likely lead to important differences in the use of technologies. A survey carried out in the Netherlands points to similar conclusions (ECBO, 2019[5]). Variation in teacher digital skills may thus result in unequal access to technologies by students.

Successful introduction of technologies in VET institutions and equal access of students to digital tools hinges on VET teachers' digital skills and knowledge and the institutional support they receive. Cattaneo, Antonietti and Rauseo (2022[32]) provide insights on the institutional factors that are associated with technological preparedness of VET teachers. The study finds that classroom equipment and network infrastructure are not linked to digital competencies of VET teachers. In contrast, VET teachers from institutions that actively support professional development of the staff and with an institutional culture that values and foster adoption of technologies report better digital competencies (Cattaneo, Antonietti and Rauseo, 2022[32]). These findings show that students in VET institutions with the best technological equipment will not take advantage of it unless their teachers are acquainted with digital tools and can integrate them confidently in their work. Therefore, VET institutions with clear goals and strategy towards adoption and use of technologies can be expected to make the best use of digital solutions. Development and updating of teacher digital skills as well as guidance on how to integrate digital tools into curriculum should be part of this strategy. Countries provide policy tools to support VET institutions in reaching this goal. Some institutions may struggle with accessing technologies and without this additional support and guidance they would not able to provide technological tools to their students.

To improve teachers' technological ability countries have developed various tools that support VET teachers with the use of technologies (OECD, 2021[4]). For example, England (UK) has developed a competence framework supporting VET teachers and trainers in the use of technology in their classroom and training activities. Unlike the English approach that involves self-learning, Denmark set up physical infrastructure – knowledge centres, to support VET institutions and VET teachers and trainers with the use of technology. See Box 5.7 for more detail on these initiatives.

Figure 5.7. VET teachers struggling with the use of technology in teaching, 2018

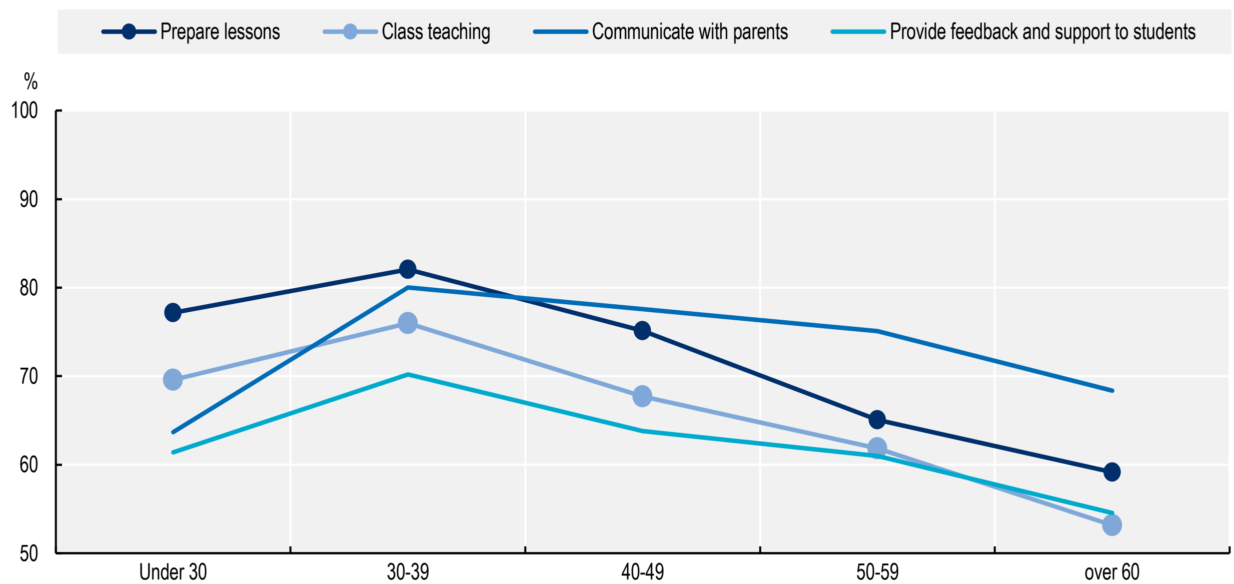
Percentage of upper-secondary VET teachers with limited ability to support their students learning through the use of digital technology.



Note: VET teachers are those who reported in the Teaching and Learning International Survey (TALIS) that they were teaching practical and vocational skills in the survey year in upper secondary programmes (ISCED 3), regardless of the type of school where they teach. The reported average corresponds to the unweighted average for the six OECD member countries/regions in the sample. Teachers with limited ability include teachers who reported 'not being at all able' or 'being able to some extent' to support their students learning with digital technologies.
Source: Elaboration based on OECD (2019[33]), TALIS 2018 database, www.oecd.org/education/talis/talis-2018-data.htm; OECD (2021[4]), *Teachers and Leaders in Vocational Education and Training*, https://doi.org/10.1787/59d4fbb1-en.

Figure 5.8. Confidence in the use of technologies among VET teachers

Proportion of upper secondary VET teachers in OECD countries who are (very) confident using digital technologies, by age



Note: All percentages refer to the share of high responses (i.e. 4 and 5 on a 5-point-scale). Participation in SELFIE is anonymous and voluntary, thus the data are not representative. Not all OECD countries are available and included in the dataset.
Disclaimer: This aggregated and anonymised data is extracted by the European Commission from SELFIE and does not necessarily reflect an official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this document. Neither the Commission nor any person acting on the Commission's behalf may be held responsible for the use which may be made of the information contained therein.
Source: SELFIE database (extraction October 2018-December 2020); Hippe, R., Pokropek, A. and P. Costa (forthcoming[34]), Cross-country validation of the SELFIE tool for digital capacity building of vocational education and training schools; OECD (2021[4]), *Teachers and Leaders in Vocational Education and Training*, https://doi.org/10.1787/59d4fbb1-en.

Box 5.7. How do countries develop digital skills in VET teachers?

The Digital Teaching Professional Framework in England (UK)

The *Digital Teaching Professional Framework* is a competence framework for teaching and training practitioners in the further education and training sector. The framework has been developed in 2019 by the Education and Training Foundation in collaboration with the not-for-profit company Jisc. It has been designed to focus on the benefits of good pedagogy supported by technology to enhance learning.

The framework lists seven key elements of teaching using digital technologies: (1) planning your teaching; (2) approaches to teaching; (3) supporting learners to develop employability skills; (4) subject-specific and industry-specific teaching; (5) assessment; (6) accessibility and inclusion; and (7) self-development. Each of these elements contains a group of up to four key activities (components). For each key activity the framework includes a group of observable practices and standards.

The framework sets out three stages of competence for each of the activities. These three levels are defined as:

- Stage 1: Exploring: practitioners assimilate new information and develop basic digital practices.
- Stage 2: Adopting: practitioners apply their digital practices and expand them further.
- Stage 3: Leading: practitioners pass on their knowledge, critique existing practice and develop new practices.

Each element of the framework details the associated activities and digital competences practitioners would need to achieve in order to successfully progress through the three stages of personal development mapped out above.

The framework is accompanied by free, online, bite-size training modules with certification. Used alongside the Jisc Discovery Tool, a self-assessment tool that teaching staff can use to assess their digital capabilities, it enables practitioners to identify their training needs in order to help develop their teaching practice. For example, some of the modules are specifically designed to help teachers organise activities involving the use of technology that aim to develop soft skills of students.

Knowledge Centre for IT in teaching in Denmark

The Knowledge Centre for IT in Teaching promotes the use of advanced digital technology in VET. It focuses on supporting teachers in the use of IT for teaching across all subjects with a special focus on the pedagogical aspects of teaching practice making use of innovative technology. The centre provides professional development opportunities on IT issues for teachers in VET. Their PD courses include both theoretical and practical elements to support teaching and learning. The centre has also established a network of pedagogical staff and a network of leaders to facilitate the exchange of ideas and share their practical and technical knowledge, creating new solutions to common challenges.

Knowledge Centres for Automation and Robot Technology in Denmark

In parallel, the Danish Government created two Knowledge Centres for Automation and Robot Technology (north and south). These promote innovation in education and industry, supporting the work of VET schools making use of advanced technology such as universal robots, collaborative robots or VR applications for VET teaching. Each centre works with more than a dozen VET schools within their geographical area. They provide VET teachers with teaching material, such as teaching tutorials or short courses in Industry 4.0, VR equipment and robots. Additionally, their specialised facilities provide demonstrations to teachers and students on how robots can be used in the workplace.

The centres lend VR headsets and/or robots to VET teachers, providing them with training materials and face-to-face technical support, so they can operate these technologies and incorporate them into their teaching practice independently. VET teachers receive continuous support until they are fully able to set up and operate the new equipment. The centres provide these technological resources for VET programmes in the areas of industrial automation, mechanics, electronics, welding, data and communication, and education.

Source: OECD (2021[4]) Teachers and Leaders in Vocational Education and Training, https://doi.org/10.1787/59d4fbb1-en; Education and Training Foundation (2018[35]), *Taking Learning to the Next Level: Digital Teaching Professional Framework*, www.et-foundation.co.uk/wp-content/uploads/2018/11/181101-RGB-Spreads-ETF-Digital-Teaching-Professional-Framework-Full-v2.pdf.

Informal learning can also be a key strategy to develop teachers' skills in the area of digital technologies. Teacher networks for professional support are an increasingly important way to foster information sharing and informal learning in VET. They are an important asset for all teachers, but they are especially valuable to those looking to acquire pedagogical knowledge and skills making use of digital technology. For example, collaboration between various stakeholders and exchange of experience are at a heart of a Flemish initiative targeting more effective use of technologies in VET (Box 5.8).

Box 5.8. Upgrading VET teacher technological skills through collaboration: The InnoVET project in Flanders (Belgium)

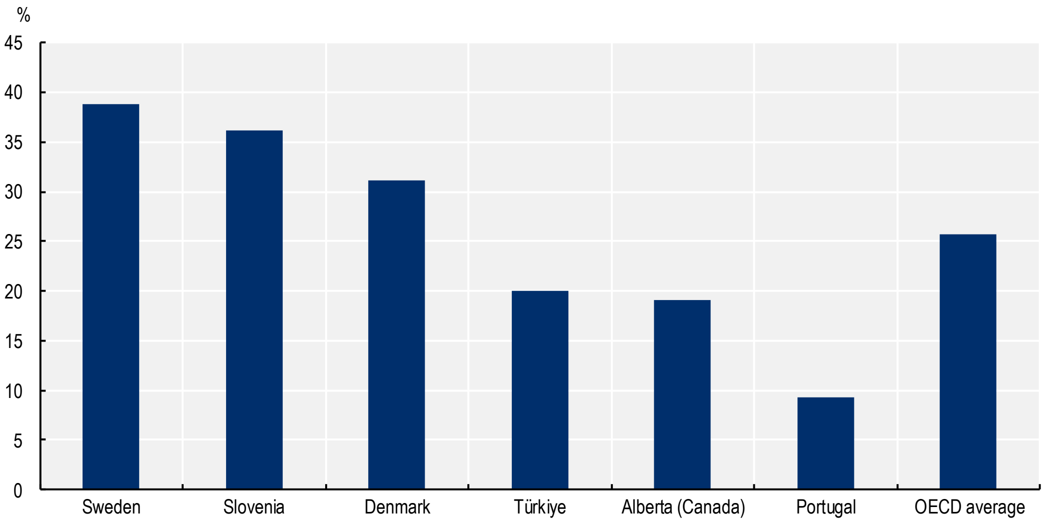
the Flemish government launched the InnoVET project to encourages VET providers to develop and use innovative technologies and pedagogies. VET schools are encouraged to develop and test innovative materials and methodologies through projects, with the intention of spreading this information to all VET programmes in Flanders. For example, it aims to support teachers in Flanders with the choice and use of technologies in classrooms. Schools participate by submitting projects. All projects should include an element of professional development for teachers, and need to be co-designed and co-funded by labour market actors. Materials and lessons learnt are shared across the VET sector. VET schools and teachers thus have the opportunity to share their experience using digital technologies. Between 2019-2022, 29 projects were selected (Vlaanderen Onderwijs en Vorming, 2023[36]).

How can VET adopt innovative pedagogical approaches?

The successful adoption of digital technologies in VET teaching do not only hinge on the digital skills of VET teachers, but also on their ability to use the appropriate pedagogical approaches to make the most of technology in their teaching activities. Moreover, as soft skills, such as complex problem-solving, creative thinking, and collaboration, become increasingly important in the labour market (as discussed in Chapter 4), teachers need to be able to develop them among their students which again calls for innovative pedagogical approaches.

Approaches such as inquiry-based, project-based and collaborative learning can help develop fundamental soft skills such as critical thinking, creativity, teamwork and communication. These pedagogical approaches can incorporate innovative elements such as gamification, blended learning and experiential learning. The use of innovative technology such as robots, virtual reality (VR), augmented reality (AR) and simulators allows teachers to develop students' vocational skills while also fostering their digital and soft skills. However, TALIS data show that innovative pedagogical approaches are only used by some VET teachers (Figure 5.9).

Figure 5.9. Use of learner-centred techniques by VET teachers



Note: VET teachers are those who reported in TALIS that they were teaching practical and vocational skills in the survey year in upper secondary programmes (ISCED 3), regardless of the type of school where they teach. These data are reported by teachers and refer to a randomly chosen class they currently teach from their weekly timetable. Unweighted average of six OECD countries/regions with ISCED 3 programmes (i.e., Alberta (Canada), Denmark, Portugal, Slovenia, Sweden and Türkiye).
Source: OECD (2019[33]), TALIS 2018 database, www.oecd.org/education/talis/talis-2018-data.htm.

Choosing appropriate pedagogical approaches

Until recently, teaching practices in VET mainly involved traditional face-to face lectures and tutorials, with a strong emphasis on vocational practice. Today, there is a need for pedagogical approaches to be learner centred, workplace oriented and inquiry based (see Box 5.9 for examples of some of these approaches). To foster soft skills development, pedagogy should emphasise active and experiential learning and collaborative learning, often using ICT as a key facilitator (Dumont, Istance and Benavides, 2010[37]; Paniagua and Istance, 2018[38]; Järvelä, 2006[39]). For instance, experiential and collaborative learning can be easily implemented through the use of digital technology (Järvelä, 2006[39]).

To effectively foster soft, digital and vocational skills development, VET teachers must choose the correct pedagogical approaches. For instance, inquiry-based learning, embodied learning and experiential learning approaches have been shown to foster the development of soft skills (Dumont, Istance and Benavides, 2010[37]; Paniagua and Istance, 2018[38]; Celio, Durlak and Dymnicki, 2011[40]). Collaborative learning models, such as inquiry-based or problem-based approaches, foster productive task-related interactions and enhance student motivation in general (Järvelä, 2006[39]). In other circumstances, vocational skills might be better developed using experiential learning. For digital skills, pedagogical approaches such as gamification and computational thinking have been shown to be effective (Paniagua and Istance, 2018[38]; Abdul Jabbar and Felicia, 2015[41]; Bower et al., 2017[42]).

To apply these pedagogical approaches effectively, teachers need to be familiar with the theoretical foundations underpinning them, as well as proficient in the use of ICT and specific teaching techniques. In-service formal training can provide the fundamental concepts, as well as ways to incorporate them into teaching practice. For instance, one common practice in teacher training to develop such pedagogical skills is to present groups of teachers with a complex technical problem, making available to them elements that can be used to solve it (tools, components, digital devices, access to the Internet, etc.). By experiencing problem solving themselves, teachers are able to understand how elements of collaborative learning and experiential learning can be used to teach vocational skills. By reflecting on their own practice and sharing their views with others, teachers see how they can make use of new technology to teach vocational subjects while developing students' soft skills.

Box 5.9. Emerging pedagogical approaches in VET

Although there are many pedagogical approaches to VET teaching available (Lucas, Spencer and Claxton, 2012[43]), some of them have particular importance today, as they allow the development of soft skills and digital skills. Three pedagogical approaches that have been successfully used for this purpose are:

- **Collaborative learning** is one of the most meaningful ways to support individual learning mechanisms. Through high-quality interactions this approach allows students to arrive at complex and conceptual understanding rather than simple answers. Technology can be designed to enhance personalised learning environments in ways that increase the possibility that those rich interactions occur (Järvelä, 2006[39]).
- **Inquiry-based learning** is an educational approach that focuses on investigation and problem solving. It prioritises problems that require critical and creative thinking so students can develop their ability to ask questions, design investigations, interpret evidence, form explanations and arguments, and communicate findings. Inquiry-based learning is different from traditional teaching approaches because it reverses the order of learning. Instead of presenting information, or "the answer", up front, teachers start with a range of scenarios, questions and problems for students to navigate. In inquiry-based learning, time and activities are organised around inquiry using different modalities such as world reading, individual research, projects and workshops (Paniagua and Istance, 2018[38]).
- **Active learning** is generally defined as any instructional method that engages students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they are doing. The core elements of active learning are student activity and engagement in the learning process. Active learning is often contrasted to the traditional lecture where students passively receive information from the instructor.

According to Paniagua and Instance (2018[38]) there are six clusters of innovative pedagogies that can complement – or be integrated into – these traditional approaches:

- **Embodied learning** refers to pedagogical approaches that focus on the non-mental factors involved in learning, and that signal the importance of the body and feelings, such as the physical, emotional and social aspect (Paniagua and Istance, 2018[38]).
- **Computational thinking** intersects with mathematics, sciences and digital literacy to offer a unified framework to develop a wide range of transversal skills through ICT. It is about using problem-solving skills and computer-based techniques to tackle problems (Paniagua and Istance, 2018[38]).
- **Experiential learning** is defined as approaches where learners are brought directly in contact with the realities being studied. It is based on the idea that human experience is a central source of learning, and therefore the design of learning environments should make use of human experience as part of the learning process (Paniagua and Istance, 2018[38]; Celio, Durlak and Dymnicki, 2011[40]).
- **Gamification** refers to the introduction of game design elements and game-like experiences in the design of learning processes. It has been adopted to support learning in a variety of subject areas integrating exploratory approaches to learning, and strengthening student creativity and retention. This is supported by the belief that incorporating game mechanics into the design of a learning process means learners will engage in a productive learning experience (Dichev and Dicheva, 2017[44]).

- **Blended learning** seeks to use the potential of new technology to offer more individualised teaching and direct instruction. The main goal of blended learning is to maximise the benefits of technology and digital resources, to improve the differentiation of instruction according to students' needs, as well as fostering classroom interaction. This approach assumes that the active involvement of students can best be achieved through group dynamics and intense face-to-face interactions. Computer technology then can offer direct instruction through individual, highly planned and structured sequences of skills. When computers provide the relevant information, teachers can then be free to spend more time on concept application, using more interactive and complex classroom activities or providing one-to-one instruction (Paniagua and Istance, 2018[38]).
- **Multi-literacies and discussion-based teaching** focus on students' active engagement and the availability of a multiplicity of texts, narratives and sources of information. Discussion-based teaching allows students to share, discuss and give sense to the implicit power relations and become aware of and value multiple modes of literacy. This is particularly relevant given how the Internet shapes the way people become informed and make sense of the world. Discussion-based teaching works as a pedagogical lever to teach rational thinking, affective judgements, and higher-order thinking skills (Paniagua and Istance, 2018[38]).

Some of these approaches are becoming increasingly important, as they use digital technology and allow students to develop soft skills, digital skills and other skills in high demand in the workplace.

Supporting VET teachers in innovating their pedagogy

VET teachers need access to professional development opportunities to develop their skills in new pedagogies, as also discussed in Chapter 2. This will allow them to make informed choices about which teaching strategies to choose. These training opportunities are particularly important, as OECD (2021[4]) analysis shows that VET teachers often lack pedagogical preparedness to adapt their teaching to new requirements. This might be especially the case for industry professionals entering the teaching profession with limited pedagogical training. Moreover, as pedagogical strategies evolve, teachers need to remain up to date with these new methods. The new technology currently available for VET teaching increases the variety of teaching approaches that can be used in VET to develop students' soft skills, and professional development opportunities should therefore also support VET teachers in the use of technology, while strengthening their digital skills. The English Enhance Digital Teaching platform provides training modules that support teachers in using digital technologies and innovating their pedagogical approaches (OECD, 2021[4]).

One of the key barriers to the systemic development of a more innovative approach to VET teaching is the lack of an agenda for policy change in this area in many countries. Changes in policy will only be implemented if there is a shared belief among VET stakeholders (especially teachers) about the importance of developing soft skills and digital skills and adopting new technology in VET, in response to digitalisation and automation in the workplace. Even in general programmes, soft skills still have a secondary place on the skills agenda: according to a survey in five countries (World Economic Forum, 2016[45]) parents and teachers in the general education sector do not assign the same priority to soft skills as to other skills, such as foundational skills. This has had implications on curricula and teachers' practice. A similar situation is found in the VET sector.

Box 5.10. Online training to support teachers' use of technology: Enhance Digital Teaching Platform (England, UK)

The Enhance Digital Teaching Platform – developed by the Education and Training Foundation in 2019 and funded by the Department for Education – supports teachers in England to use technology in their classrooms across the further education and training sector. The platform hosts free, bite-size, certified online self-learning training modules that support innovation in teaching and training to improve learners' outcomes.

Some of the modules are specifically designed to help teachers organise activities aimed at developing student soft skills making use of technology:

- Promoting collaboration and communication between learners incorporating learning activities which require learners to use digital technologies for collaborative processes, and for co-construction and co-creation of resources and knowledge.
- Promoting active learning, by allowing learners to actively engage with subject matter using digital technologies (e.g. using different senses, manipulating virtual objects, varying the problem set up to enquire into its structure, etc.).
- Encouraging the development of learner groups for peer learning and discussion, remotely monitored with intervention when needed, while allowing for student self-regulation.

Modules are mapped to the seven elements of the Digital Teaching Professional Framework, which promotes a set of professional standards for supporting learning through technology with the aim to establish a common understanding of digital skills development (Box 5.7).

Source: Education and Training Foundation (2020[46]), Enhance Digital Teaching Platform, www.et-foundation.co.uk/supporting/edtech-support/enhance-digital-teaching-platform.

References

Abdul Jabbar, A. and P. Felicia (2015), "Gameplay engagement and learning in game-based learning", *Review of Educational Research*, Vol. 85/4, pp. 740-779, https://doi.org/10.3102/0034654315577210. [41]

Amazon Web Services (2021), *AWS Partner Story: VDAB & Radix.ai*, https://aws.amazon.com/partners/success/vdab-radix-ai/. [6]

Angel-Urdinola, D., C. Castillo Castro and A. Hoyos (2021), *Meta-Analysis Assessing the Effects of Virtual Reality Training on Student Learning and Skills Development*, World Bank Group., http://documents.worldbank.org/curated/en/204701616091079027/Meta-Analysis-Assessing-the-Effects-of-Virtual-Reality-Training-on-Student-Learning-and-Skills-Development. [10]

Bower, M. et al. (2017), "Improving the computational thinking pedagogical capabilities of school teachers", *Australian Journal of Teacher Education*, Vol. 42/3, pp. 53-72, https://doi.org/10.14221/ajte.2017v42n3.4. [42]

Cattaneo, A., C. Antonietti and M. Rauseo (2022), “How digitalised are vocational teachers? [32]
Assessing digital competence in vocational education and looking at its underlying factors”, *Computers & Education*, Vol. 176, p. 104358, https://doi.org/10.1016/j.compedu.2021.104358.

Cedefop (2018), *Mapping the landscape of online job vacancies. Background country report:* [21]
United Kingdom, http://www.cedefop.europa.eu/en/events-and-projects/projects/big-data-analysis-online-vacancies/publications.

Celio, C., J. Durlak and A. Dymnicki (2011), “A meta-analysis of the impact of service-learning on [40]
students”, *Journal of Experiential Education*, Vol. 34/2, pp. 164-181, https://doi.org/10.1177/105382591103400205.

Dallas ISD’s CTE Department (2021), *Virtual Internship Toolkit*, [9]
https://cte.careertech.org/sites/default/files/files/resources/Dallas_Virtual_Internship_Toolkit.pdf (accessed on 19 May 2023).

DeTijd (2023), *AI-bedrijf Radix helpt VDAB jobs op maat aan te bieden*, http://www.tijd.be/de-tijd- [7]
vooruit/tech/ai-bedrijf-radix-helpt-vdab-jobs-op-maat-aan-te-bieden/10313389.html.

Dichev, C. and D. Dicheva (2017), “Gamifying education: What is known, what is believed and [44]
what remains uncertain: A critical review”, *International Journal of Educational Technology in Higher Education*, Vol. 14/1, https://doi.org/10.1186/s41239-017-00.

Dumont, H., D. Istance and F. Benavides (eds.) (2010), *The Nature of Learning: Using Research* [37]
to Inspire Practice, Educational Research and Innovation, OECD Publishing, Paris, https://doi.org/10.1787/9789264086487-en.

ECBO (2019), *Onderwijsinnovaties met moderne ICT in het mbo, Expertisecentrum*, [5]
https://ecbo.nl/wp-content/uploads/sites/3/Rapport-Onderwijsinnovaties-met-moderne-ICT.pdf (accessed on 6 November 2022).

Education and Training Foundation (2018), *Taking Learning to the Next Level: Digital Teaching* [35]
Professional Framework, Education and Training Foundation, London, https://www.et-foundation.co.uk/wp-content/uploads/2018/11/181101-RGB-Spreads-ETF-Digital-Teaching-Professional-Framework-Full-v2.pdf.

Eductation and Training Foundation (2020), *Enhance Digital Teaching Platform*, Education and [46]
Training Foundation website, https://www.et-foundation.co.uk/supporting/edtech-support/enhance-digital-teaching-platform/.

e-Estonia (2023), “Education and Research”, *School and Managment Systems*, https://e- [18]
estonia.com/solutions/education_and_research/school_management_systems/ (accessed on 27 January 2023).

EPFL (2022), *Flipped Classrooms*, https://www.epfl.ch/labs/ml4ed/92-2/research/mining-online- [15]
interaction-traces-for-student-success-prediction-in-flipped-classrooms/ (accessed on 4 January 2023).

EPFL (2022), *Logistics*, https://www.epfl.ch/labs/chili/dualt/completed-projects/logistics/ [14]
(accessed on 4 Janury 2023).

Government of Canada (2022), *Flexibility and Innovation in Apprenticeship Technical Training*, https://www.canada.ca/en/services/jobs/training/support-skilled-trades-apprentices/flexibility-innovation-technical-training.html (accessed on 4 January 2023). [8]

Haridus - Ja Noorteamet (2023), *IT Academy Program*, https://harno.ee/it-akadeemia-programm#kutseharidus (accessed on 27 January 2023). [31]

Hippe, R., A. Pokropek and P. Costa (forthcoming), "Cross-country validation of the SELFIE tool for digital capacity building of Vocational Education and Training schools". [34]

HolonIQ (2019), *10 charts that explain the Global Education Technology Market*, https://www.holoniq.com/edtech/10-charts-that-explain-the-global-education-technology-market/ (accessed on 21 September 2020). [3]

Järvelä, S. (2006), "Personalised learning? New insights into fostering learning capacity", in *Personalising Education*, OECD Publishing, Paris, https://doi.org/10.1787/9789264036604-3-en. [39]

Khan, A., F. Ahmad and M. Malik (2017), "Use of digital game based learning and gamification in secondary school science: The effect on student engagement, learning and gender difference", *Education and Information Technologies*, Vol. 22/6, pp. 2767-2804, https://doi.org/10.1007/s10639-017-9622-1. [11]

Kuczera, M. and S. Jeon (2019), *Vocational Education and Training in Sweden*, OECD Reviews of Vocational Education and Training, OECD Publishing, Paris, https://doi.org/10.1787/g2g9fac5-en. [24]

Lucas, B., E. Spencer and G. Claxton (2012), *How to Teach Vocational Education: A Theory of Vocational Pedagogy*, City & Guilds Centre for Skills Development, London, pp. 59-84. [43]

Ministry of Education (2023), *Strategi for digital kompetanse og infrastruktur i barnehage og skole: 2023-2030*, https://www.regjeringen.no/no/dokumenter/strategi-for-digital-kompetanse-og-infrastruktur-i-barnehage-og-skole/id2972254/?ch=1. [22]

NDLA (2023), *Figures and Reports*, https://om.ndla.no/tall-og-rapporter/ (accessed on 4 January 2023). [28]

NDLA (2023), *What is NDLA?*, https://om.ndla.no/hva-er-ndla/ (accessed on 4 January 2023). [26]

NDLA (2021), *Annual reports for the National Digital Learning Arena*, https://om.ndla.no/wp-content/uploads/2022/05/NDLA-a%CC%8Arsmelding.pdf (accessed on 4 January 2023). [27]

Nedelkoska, L. and G. Quintini (2018), "Automation, skills use and training", *OECD Social, Employment and Migration Working Papers*, No. 202, OECD Publishing, Paris, https://doi.org/10.1787/2e2f4eea-en. [1]

Nesta (2019), *EdTech Innovation Fund*, https://www.nesta.org.uk/project/edtech-innovation-fund/meet-the-grantees/ (accessed on 31 January 2021). [30]

OECD (2022), *Strengthening Apprenticeship in Scotland, United Kingdom*, OECD Reviews of Vocational Education and Training, OECD Publishing, Paris, https://doi.org/10.1787/2db395dd-en. [20]

OECD (2021), *OECD Digital Education Outlook 2021: Pushing the Frontiers with Artificial Intelligence, Blockchain and Robots*, OECD Publishing, Paris, https://doi.org/10.1787/589b283f-en. [2]

OECD (2021), *Teachers and Leaders in Vocational Education and Training*, OECD Reviews of Vocational Education and Training, OECD Publishing, Paris, https://doi.org/10.1787/59d4fbb1-en. [4]

OECD (2020), *Strengthening the Governance of Skills Systems: Lessons from Six OECD Countries*, OECD Skills Studies, OECD Publishing, Paris, https://doi.org/10.1787/3a4bb6ea-en. [19]

OECD (2019), *TALIS Survey 2018 database*, http://www.oecd.org/education/talis/talis-2018-data.htm. [33]

Oslo Economics (2022), *Markedet for digitale læremidler og læringsressurser i grunnskolen og videregående opplæring*, https://osloeconomics.no/publication/markedet-for-digitale-laeremidler-og-laeringsressurser-i-grunnskolen-og-videregaende-opplaering/. [23]

Paniagua, A. and D. Istance (2018), *Teachers as Designers of Learning Environments: The Importance of Innovative Pedagogies*, Educational Research and Innovation, OECD Publishing, Paris, https://doi.org/10.1787/9789264085374-en. [38]

SERI (n.d.), *Leading Houses*, https://www.sbfi.admin.ch/sbfi/en/home/education/vpet-planning-and-policymaking/vet-pet-research/leading-houses.html. [12]

SERI (n.d.), *Technologies for Vocational Training*, https://www.sbfi.admin.ch/sbfi/en/home/education/vpet-planning-and-policymaking/vet-pet-research/leading-houses/technologies-for-vocational-training.html. [13]

Shah, M. (2014), “Impact of Management Information Systems (MIS) on School Administration: What the Literature Says”, *Procedia - Social and Behavioral Sciences*, Vol. 116, pp. 2799-2804, https://doi.org/10.1016/j.sbspro.2014.01.659. [17]

Small Business Innovation Research (2020), *Small Business Innovation Research website*, https://www.sbir.gov/about (accessed on 31 January 2021). [29]

Utdanningsdirektoratet (2020), “The Education Miror”, *Education Miror 2020*, https://www.udir.no/tall-og-forskning/publikasjoner/utdanningsspeilet/utdanningsspeilet-2020/del-2/digital-undervisning-under-koronastengte-skoler/ (accessed on 26 January 2023). [25]

Victoria State Government (2023), *Teach with digital technologies*, https://www.education.vic.gov.au/school/teachers/teachingresources/digital/Pages/teach.aspx#:~:text=Digital%20technologies%20are%20electronic%20tools,across%20all%20curriculum%20learning%20areas. (accessed on 4 January 2023). [47]

Visscher, A. (2001), “Computer-Assisted School Information Systems: The Concepts, Intended Benefits, and Stages of Development”, in *Information Technology in Educational Management*, Springer Netherlands, Dordrecht, https://doi.org/10.1007/978-94-017-1884-4_1. [16]

Vlaanderen Onderwijs en Vorming (2023), *InnoVET: wat, hoe en waarom?*, https://onderwijs.vlaanderen.be/nl/onderwijspersoneel/van-basis-tot-volwassenenonderwijs/lespraktijk/innovet/innovet-wat-hoe-en-waarom (accessed on 5 January 2023). [36]

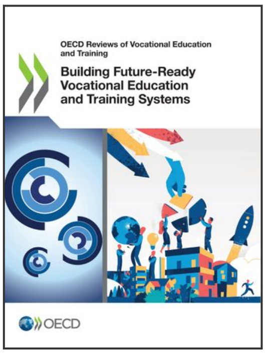
World Economic Forum (2016), *New Vision for Education: Fostering Social and Emotional Learning through Technology*, World Economic Forum, http://www3.weforum.org/docs/WEF_New_Vision_for_Education.pdf. [45]

Notes

[1] Digital technologies (or digital solutions) refer to electronic tools, systems, devices and resources (such as personal computers and tablets, cameras, software and apps, augmented and virtual reality and the internet) that generate, store or process data. Digital learning is any type of learning that uses technology (Victoria State Government, 2023[47]).

[2]SELFIE is a free online tool designed to help schools embed digital technology into teaching, learning and assessment. SELFIE anonymously gathers the views of students, teachers and school leaders on how technology is used in their school (OECD, 2021[4]).

[3] The study looks at three category of VET professionals: teachers in VET schools for apprentices, trainers of apprentices from companies and training centres and VET teachers in bachelor VET programmes. The findings are similar across the three groups.



From:

Building Future-Ready Vocational Education and Training Systems

Access the complete publication at:
https://doi.org/10.1787/28551a79-en

Please cite this chapter as:

OECD (2023), "Innovation in vocational education and training", in *Building Future-Ready Vocational Education and Training Systems*, OECD Publishing, Paris.

DOI: https://doi.org/10.1787/eb90e4d8-en