



**EMTEC4ED**

Emerging Technologies for Education

**L I T E R A T U R E  
R E V I E W**



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# INTRODUCTION

In the rapidly evolving landscape of the 21st century, technology has become an integral part of our daily lives, permeating every sector, including education. This research delves into the intricate relationship between technology and education, focusing on the importance of tech readiness and the need to identify and bridge the digital skills gap. The report is structured to provide an in-depth understanding of digital skills and competencies in the education sector. It explores the role of digital literacy in education, emphasising its importance beyond the mere ability to use digital tools. It underscores the need for critical thinking, problem-solving skills, creativity, innovation, communication, collaboration, and digital citizenship in today's digital world.

The report further delves into the impact of emerging technologies on teaching and learning. It discusses how the integration of technology into the education system is deepening, offering new possibilities for educators. It also highlights how remote learning technologies have revolutionised traditional classroom settings, creating dynamic and flexible learning environments that combine in-person instruction with online learning experiences. It also takes a peek at the future labour market demands, emphasising the increasing importance of digital skills in the evolving global landscape. Through it, we will investigate how the rise of digital technology is creating new jobs and industries whereby digital skills are becoming increasingly important for non-digital jobs. It also highlights the significant digital skills gap that exists between the skills that workers have and the skills that employers need, and looks at the implications of this gap for workers, businesses, and society at large.

It then presents case studies of industries with high future labour market demands, such as the software industry and industrial automation. These case studies highlight the need for a workforce equipped with digital skills and the ability to adapt to changing technologies and methodologies. The insights provided in this report are based on a thorough analysis of current research, policy debates, and industry trends. It draws on a wide range of sources, including academic literature, industry reports, and policy documents, to provide a comprehensive understanding of the issues at hand.

Ultimately, this report aims to serve as a valuable resource for educators, policymakers, and stakeholders involved in shaping the future of education in the digital age. It provides a roadmap for understanding the current state of digital

skills in the education sector, the challenges and opportunities presented by emerging technologies, and the steps that need to be taken to ensure that our education system is ready for the digital future.

## TECH READINESS IN THE EDUCATION SECTOR

The importance of tech readiness in the education sector cannot be overstated. The rise of digital technology has fundamentally transformed the way we work, learn, and interact. This transformation has been accelerated by the COVID-19 pandemic, which has necessitated a shift towards remote work and digital communication. As a result, digital skills are now a prerequisite for a wide range of jobs, not just those traditionally associated with technology.

Digital skills encompass a broad range of abilities, from basic digital literacy (such as the ability to use digital devices and navigate the internet) to more advanced skills (such as coding, data analysis, and digital design). They also include 'soft' digital skills, such as the ability to find and evaluate information online, to communicate effectively in digital contexts, and to understand issues related to online privacy and security. The demand for digital skills is driven by several factors:

- First, digital technology is becoming increasingly integrated into all aspects of work. From communication and collaboration tools up to data analysis and automation software. Without doubt, digital technology is now a fundamental part of many jobs. This means that workers need to have the skills to use this technology effectively.
- Second, the rise of digital technology is creating new jobs and industries. From app development and digital marketing to cybersecurity and data science. There are now many jobs that did not exist a few decades ago and undoubtedly, these jobs require a high level of digital skills.
- Third, digital skills are becoming increasingly important for non-digital jobs. Even in jobs that are not primarily focused on technology, digital skills are often required. For example, teachers need to use digital technology to support their teaching, retailers need to use e-commerce platforms to sell their products, and healthcare professionals need to use digital tools to manage patient records.

However, while the demand for digital skills is increasing, there is a significant gap between the skills that workers have and the skills that employers need. This 'digital skills gap' is a major challenge for businesses and economies, and it is a key focus of policy and research.

Addressing the digital skills gap will require a multifaceted approach, including education and training, policy interventions, and individual learning initiatives. The role of education and training in addressing the digital skills gap cannot be overstated. Schools, colleges, and universities have a crucial role to play in equipping students with the digital skills they need for the future. This includes not only technical skills, but also 'soft' digital skills, such as online communication and digital citizenship. Moreover, the digital skills gap is a dynamic problem that evolves with the pace of technological change. As new technologies emerge, the skills that are in demand can change rapidly. This means that digital skills training needs to be an ongoing process, rather than a one-off event. Workers need to have the opportunity and the motivation to continually update their skills throughout their careers. This requires a culture of lifelong learning, as well as access to high-quality and relevant training opportunities.

## IDENTIFYING THE DIGITAL SKILLS GAP

A critical step towards ensuring that the education sector is adequately preparing students for the demands of the future labour market is to identify the digital skills gap. It refers to the disparity between the digital skills that individuals possess and the skills that are needed in the workplace. This gap is a significant issue that has implications for individuals, businesses, and economies.

The digital skills gap is not a static issue but an evolving challenge that requires continuous adaptation and upskilling. As new technologies emerge and existing ones evolve, the skills that are in demand can change rapidly. For instance, the rise of blockchain technology and the need for mainframe modernization highlight the need for new sets of skills that were not in high demand a few years ago. Thus, addressing the digital skills gap requires a comprehensive approach that involves collaboration between various stakeholders, including educational institutions, policymakers, industry leaders, and individuals themselves.

Educational institutions play a vital role in bridging the gap. They need to develop curriculum and learning programs that are relevant to the changing needs of the labour market. This involves integrating digital skills training across disciplines,

incorporating emerging technologies into the curriculum, and promoting hands-on learning experiences. Institutions should also adopt adaptive learning methodologies that personalize education to meet the unique needs and learning styles of students.

Collaboration between academia and industry is crucial to bridge the digital skills gap effectively. Educational institutions should establish partnerships with industry leaders to gain insights into the latest technological advancements, industry trends, and future skill requirements. This collaboration can help ensure that the education provided is relevant and aligned with the needs of the labour market.

Identifying the digital skills gap is not just about understanding the current state of digital skills. It also involves anticipating future skills and preparing for them. This requires a forward-looking approach that takes into account the rapid pace of technological change and the evolving demands of the labour market.

In conclusion, identifying the digital skills gap is a crucial step towards ensuring that individuals are equipped with the necessary competencies to thrive in the digital economy. It is a complex task that requires ongoing effort and collaboration between various stakeholders. However, with the right strategies and initiatives, it is possible to bridge the gap and create a workforce that is ready for the digital future.

# CURRENT STATE OF TECH READINESS IN THE EDUCATION SECTOR

The current state of tech readiness in the education sector is a topic of great interest and importance. With the advent of the digital age, technology has become an integral part of education, transforming the way teaching and learning processes are conducted (Selwyn, 2019).

The level of tech readiness in the education sector can be gauged by the extent to which digital technologies are integrated into the curriculum, the availability and use of digital infrastructure, and the digital competence of teachers and students. According to (European Commission, 2020; European Commission, 2023), the integration of digital technologies in education has been increasing steadily in Europe. However, the level of tech readiness varies significantly across regions and countries, and even within the same country, due to differences in resources, infrastructure, and policies.

The COVID-19 pandemic has further highlighted the importance of tech readiness in the education sector. With schools and educational institutions around the world forced to switch to remote learning, the digital divide became more apparent. (Reich et al., 2020) found that students in lower-income families and in rural areas were disproportionately affected by the shift to online learning due to lack of access to digital devices and reliable internet connectivity.

Despite these challenges, there have been significant strides in improving tech readiness in the education sector. Governments, educational institutions, and non-profit organizations worldwide have launched various initiatives to enhance digital infrastructure, provide digital devices to students in need, and train teachers in digital pedagogy (Reimers, 2022).

In addition to infrastructure and access, tech readiness also involves the ability to use technology for teaching and learning effectively. This includes digital literacy skills, such as the ability to find, evaluate, and use information effectively in a digital environment and the ability to use digital tools for communication and collaboration (Eshet-Alkalai, 2009). Unsurprisingly, a study by (Fraillon et al., 2018) found that while students' digital literacy skills have improved over the years, a significant proportion of students still lack basic digital literacy skills.

Furthermore, tech readiness also involves the integration of technology into the curriculum and teaching practices. This includes the use of technology to enhance learning experiences, facilitate personalized learning, and promote student engagement and creativity (Hew & Brush, 2007). In fact, (Tondeur et al., 2017) found that while teachers generally have positive attitudes towards the use of technology in education, there are still significant barriers to technology integration, including lack of time, lack of resources, and lack of professional development opportunities.

In conclusion, while there have been significant strides in improving tech readiness in the education sector, there are still significant challenges that need to be addressed. These include improving access to digital infrastructure and devices, enhancing digital literacy skills, and promoting effective technology integration in teaching and learning.

## THE ROLE OF EMERGING TECHNOLOGIES IN EDUCATION

Emerging technologies are playing a pivotal role in reshaping the landscape of education. They are not only transforming the way teaching and learning processes are conducted but also creating new opportunities for innovation and creativity in education (Criollo et al., 2021). One of the key emerging technologies in education is Artificial Intelligence (AI). AI has the potential to personalize learning experiences, provide real-time feedback, and automate administrative tasks. For instance, AI-powered adaptive learning systems can customize learning materials based on individual students' learning needs and progress, thereby facilitating personalized learning (Abgaryan et al., 2023). These systems use machine learning algorithms to analyse students' interaction data and adapt the learning content accordingly. This personalized approach to learning can help to improve learning outcomes and enhance student engagement.

AI can also be used to provide real-time feedback to students, helping them to identify their strengths and areas for improvement (Holstein et al., 2018). For example, AI-powered learning analytics tools can analyse students' learning data and provide insights into their learning behaviours and patterns. These insights can help teachers to provide targeted feedback and support to students, thereby enhancing their learning experience.

Furthermore, AI can automate administrative tasks, such as grading and scheduling, thereby freeing up teachers' time to focus on teaching and student

interaction. For example, AI-powered grading tools can automatically grade student assignments and provide feedback, while AI-powered scheduling tools can optimize class schedules and resource allocation (Abgaryan et al., 2023).

Another emerging technology in education is Augmented Reality (AR) and Virtual Reality (VR). AR and VR can create immersive learning experiences, making learning more engaging and interactive. For example, AR and VR can be used to create virtual field trips, allowing students to explore different places and cultures without leaving the classroom (Merchant et al., 2014). These technologies can also be used to simulate real-world scenarios, such as scientific experiments or historical events, thereby enhancing students' understanding and retention of the learning material.

Blockchain is another emerging technology with potential applications in education. Blockchain can be used to create secure and verifiable digital credentials, thereby reducing fraud and enhancing the transparency and trustworthiness of educational credentials (Grech & Camilleri, 2017). For example, blockchain can be used to create a decentralized ledger of educational records, making it easier for employers and educational institutions to verify the authenticity of educational credentials.

Despite the potential benefits of these emerging technologies, their implementation in education is not without challenges. These include issues related to privacy and data security, the digital divide, and the need for teacher training and professional development (Passey et al., 2018). For instance, the use of AI and learning analytics in education raises concerns about the privacy and security of student data. There is also a digital divide in terms of access to digital technologies, with students in low-income and rural areas often having less access to these technologies than their counterparts in wealthier and urban areas. Furthermore, the integration of emerging technologies in education requires teachers to have the necessary digital skills and competences, highlighting the need for ongoing teacher training and professional development.

In conclusion, while emerging technologies have the potential to transform education, it is important for policymakers and educators to carefully consider the associated challenges and implications. By doing so, they can ensure that these technologies are used in a way that benefits all students and contributes to the development of a more equitable and inclusive education system.



## CASE STUDIES OF SUCCESSFUL TECH INTEGRATION IN SCHOOLS

The integration of technology in education has been a transformative process, with several schools and districts leading the way in demonstrating how strategic implementation can enhance teaching and learning outcomes. Here are some case studies that highlight successful tech integration in schools:

### MOORESVILLE GRADED SCHOOL DISTRICT, NORTH CAROLINA, USA

Mooresville Graded School District implemented a 1:1 laptop program, providing every student with a laptop. The focus was not merely on supplying devices but on using technology to improve instruction and learning. Teachers underwent extensive professional development on how to effectively integrate technology into lesson plans. The result was significant improvements, including higher test scores, better attendance and graduation rates, and more engaged students. The district became a model for technology integration (Hull, 2019; Marshall Barker, 2021).

### TECHNICAL SCHOOL, MALAYSIA

In Malaysia, a technical school implemented an automated data integration, cleaning, and analysis system using data mining and SPSS tool. This system was used to transform raw data from the current educational system into meaningful information that could assist the school community in making informed decisions to achieve better results. The automated system was found to be as effective as the manual system of integration and analysis and could be used by the management to make faster and more efficient decisions in order to plan efficient teaching approaches for students in the future (Razak, Mohammed, Noor, & Hashim, 2019).

### SCHOOLS DURING THE COVID-19 PANDEMIC, SPAIN

In Spain, the COVID-19 pandemic led to the closure of schools and the need for resources to be made available to families and teachers so that they could continue their teaching practice. During this period, the Smile and Learn platform was used as an example of an educational resource. The platform presented different models implemented to support education and its impact on the use of

the platform was analysed. The outcomes and their effect on education were discussed in (Nieto-Márquez, Baldominos, & Petronila, 2020).

#### LIMPOPO, SOUTH AFRICA

In South Africa, a study by Maja (2023) explored teachers' perceptions of integrating technology in English First Additional Language (EFAL) classes in rural primary schools in Limpopo. Despite the challenges associated with rural settings, teachers appreciated the productivity of technology in their teaching activities. They found that technology enhanced their ability to deliver effective EFAL instruction, thereby improving student outcomes. This study underscores the potential of technology to transform education in rural settings.

#### HIGH SCHOOLS, GREECE

In Greece, a set of educational tools and software were successfully applied over a real-world Internet of Things (IoT) deployment in high schools. The tools were used to enable IoT-based energy savings, sustainability awareness lectures and promote data-driven energy-saving behaviours. The experience concluded by discussing the results in terms of achieved energy savings within an observation period (Mylonas et al., 2021).

#### HIGH SCHOOL STUDENTS, CHILE

In Chile, a study was conducted to develop computational thinking in high school students. The study provided evidence of the effectiveness of teaching programming in C++ (a low-level language) to develop computational thinking in high school students. The results showed a significant improvement in computational thinking at the end of the workshop (González, López, & Castro, 2018).

#### CENTRAL ILLINOIS ELEMENTARY SCHOOL, USA

A Title 1 elementary school in Central Illinois implemented 1:1 technology in its 4th-grade classrooms to boost academic achievement and student motivation. Teachers received training to incorporate technology into their classrooms. Assessments were made through Pearson enVision Math series, Discovery Education Assessment, and attendance records.

Adopting the Common Core State Standards, the school encouraged technological literacy and online testing. Results indicated that 1:1 technology positively impacted academic achievement and student motivation, suggesting technology can be instrumental in enhancing student success. Furthermore, it helped bridge the digital divide, improving technology literacy among lower-income students. The initiative enhanced instruction, boosted achievement, improved motivation, and reduced the digital gap (Harris & Al-Bataineh, 2015).

#### TECHNOLOGICAL UNIVERSITY DUBLIN, IRELAND

At the Technological University Dublin, a seven-year SUCCESS program was implemented to increase the gender balance across academic staffing in computer science. The program had a four-strand approach: Source, Career, Environment, and Support.

- The Source strand explicitly encouraged females to apply for each recruitment drive;
- Career focused on female career and skills development initiatives;
- Environment created a female-friendly culture and reputation, both within the School, across the organization and across the third level sector in Ireland and,
- Support addressed practical supports for the specific difficulties experienced by female staff (McKeever & Lillis, 2021).

If we were to analyse the key success factors across these cases, the commonalities include extensive teacher training and buy-in, focusing on learning outcomes and not just technology itself, piloting and measuring impact before scaling, and using technology to enable active, engaging learning methods. From these cases, it is also very obvious that with the right strategy and support, technology integration in schools can lead to tremendous success.

# FUTURE TECH READINESS OF THE EDUCATION SECTOR

The integration of technology in education was a significant trend over the past decade, and it is predicted to continue evolving in the coming years. The advent of emerging technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Blockchain, Augmented Reality (AR), and Virtual Reality (VR) has opened up new possibilities for creating smart and efficient learning environments.

One of the key trends is the transition towards smart education, which involves integrating IoT and AI into the education system. This approach addresses the challenges in the traditional education system and introduces smart solutions that can enhance learners' engagement, motivation, attendance, and deep learning. The integration of IoT in education can lead to the creation of smart spaces that can assist both face-to-face and online education systems. These smart spaces can provide personalized learning experiences, real-time feedback, and interactive learning environments, thereby enhancing the overall learning experience (Badshah et al., 2019).

Learning management systems (LMS) are also evolving to become more integrated with modern digital platforms. The implementation of AI technologies into the educational process is seen as an innovative way to form IT-ecosystems of modern education. These systems provide opportunities for networked forms of educational communication, improve the quality of the perception of innovative technologies, and support tools for the progress of talented youth. The integration of AI in LMS can lead to personalized learning paths, intelligent tutoring, and automated grading, thereby enhancing the efficiency and effectiveness of education (Gorshenin, 2018).

Generative AI assistants are another emerging trend in software development education. These AI technologies, such as GitHub Copilot and ChatGPT, have ignited the imaginations (and fears) of many people. While it is still unclear how the industry will adopt and adapt to these technologies, the move to integrate these technologies into the wider industry by large software companies is a clear indication of intent and direction. These AI assistants can provide real-time guidance, automate repetitive tasks, and enhance the learning experience by providing personalized feedback and suggestions (Bull & Kharrufa, 2023).

The potential of AI in higher education is also being explored in (Chan & Tsi, 2023), specifically its capacity to replace or assist human teachers. While some believe AI may eventually replace teachers, the majority argue that human teachers possess unique qualities, such as critical thinking, creativity, and emotions, which make them irreplaceable. The study also emphasizes the importance of social-emotional competencies developed through human interactions, which AI technologies cannot currently replicate. However, AI can assist teachers by automating administrative tasks, generating personalized learning resources, and providing data-driven insights to enhance teaching strategies.

AR and VR are increasingly being recognized as valuable tools in the realm of education. These technologies offer immersive experiences that can enhance learning outcomes and student engagement. AR and VR can provide students with a more interactive and engaging learning experience by allowing them to visualize complex concepts, explore different environments, and participate in simulations that would otherwise be impossible in a traditional classroom setting. With the rise of remote learning, these technologies can also enhance distance learning experiences. They can provide students with a sense of presence and engagement, even when they are physically separated from their teachers and classmates (Motejlek & Alpay, 2019; Kovalenko, Marienko, & Sukhikh, 2022; Childs et al., 2021).

Lastly, the integration of blockchain technology with education management systems is another trend to watch. Blockchain has the potential to address the emerging challenges, including the creation of an efficient, secure, and transparent educational system. It can provide a decentralized and immutable record of academic credentials, enhance the security of student data, and facilitate the sharing of learning resources across institutions (Tahora et al., 2023).

These trends indicate a future where technology is not just an add-on in education, but an integral part of the learning process. It is clear that the future of education lies in the synergy between human teachers and AI, and by understanding and refining their unique qualities, teachers, students, and universities can effectively navigate the integration of AI, ensuring a well-rounded and impactful learning experience (Chan & Tsi, 2023).

Furthermore, the concept of the Metaverse, which often involves the use of VR, AR, and Mixed Reality (MR), has been widely used in classroom teaching to integrate into teaching activities. The Metaverse can provide immersive

experiences that go beyond what's possible in the physical world, offering new opportunities for learning and collaboration (Tsai, 2022).

## THE ROLE OF AI AND MACHINE LEARNING IN FUTURE EDUCATION

Artificial Intelligence (AI) and Machine Learning (ML) are set to play a transformative role in the future of education. These technologies are not only reshaping the way educational content is delivered but also how it is created, customized, and assessed.

AI has seen rapid progress in recent years as it aims to develop new teaching and learning solutions to improve education quality. This progress is evident in the massive expansion of targeted AI education initiatives over the past few years (Castillo-Acobo, 2023; Forbes Education, 2023; Papaspyridis & La Greca, 2023). AI can enhance personalized learning, gamification, and virtual classrooms, providing opportunities for individualized instruction and interactive learning experiences (Hashim et al., 2022). In particular, AI is making a significant impact in STEM education, where cutting-edge technologies are integral to the curriculum. These tools, are being used by students to work on their assignments, enhancing their understanding and problem-solving skills (KDnuggets, 2023).

One of the most debated topics in the field of AI in education is its potential to replace or assist human teachers. While some believe AI may eventually replace teachers, most argue that human teachers possess various qualities, which make them irreplaceable. AI technologies cannot currently replicate the social-emotional competencies developed through human interactions. However, AI can assist teachers by automating administrative tasks, providing personalized learning resources, and providing data-driven insights to enhance teaching strategies (Chan & Tsi, 2023), something which teachers might find time-consuming or outright impossible to achieve given their limited resources.

AI is also expected to democratize education worldwide, creating a renaissance of new ways of teaching and learning. These tools and technologies have the potential to build more personalized curricula (Perez-Ortiz et al., 2021), something which was unheard of so far. At best, teachers can hope to divide their class in three cohorts when applying differentiated learning. In contrast, an AI system can create a personalised pathway down to the granularity of the individual child. This allows each and every child to start their own educational journey from their

current level of competency and move forward at their own pace. AI and machine learning methods are also being utilized to support students, educators, and administrative staff, from proactive planning (e.g., student admissions, course scheduling) to reactive execution (e.g., knowledge delivery, performance assessment) (Mallik & Gangopadhyay, 2023).

Interpretability of the underlying AI representations is a key reason to create an Open Learner Modelling (OLM) (a branch of Intelligent Tutoring Systems research). OLMs provide tools for 'opening' up the AI models of learners' cognition and emotions for the purpose of supporting human learning and teaching. This work provides a valuable starting point for a framework of interpretable AI, and as such is of relevance to the application of both knowledge-based and machine learning systems in other high-stakes contexts, beyond education (Conati, Porayska-Pomsta, & Mavrikis, 2018).

In the field of engineering education, machine learning toolkits are being used to automate processes and decrease human labelling time while maintaining statistical repeatability. These toolkits are preparing the next generation of ML and AI-educated engineers for industry and academic careers (Hannon et al., 2019).

However, we have to be careful because the use of such systems does not involve plugging in an off-the-shelf algorithm and expect it to work. Machine Learning algorithms must be "educated". While their decisions have an incommensurable impact on human societies, these algorithms need proper training on quality data. Because of this, it is imperative that we adopt responsible and sustainable AI design, specifically to ensure that algorithms decide ethically (Blazquez & Hipolito, 2023). Let's keep in mind that in education, we are dealing with children and as such, we have to employ the highest level of safety possible.

In conclusion, AI and ML are predicted to play a significant role in the future of education. They offer unique opportunities for immersive, interactive, and engaging learning experiences, both in the classroom and in remote learning contexts. As these technologies continue to evolve, their integration into the education system is expected to deepen, offering new possibilities for teaching and learning.

# THE IMPACT OF REMOTE LEARNING TECHNOLOGIES ON FUTURE EDUCATION

The emergence and widespread adoption of remote learning technologies have brought about significant changes in the field of education. These technologies, accelerated by the global pandemic, have transformed the way education is delivered, accessed, and experienced. As we look towards the future, it is essential to examine and discuss the implications of remote learning technologies on the education sector.

One of the key impacts of remote learning technologies is their ability to ensure continuity of education in challenging circumstances. When faced with the global pandemic, educational institutions quickly transitioned to remote learning, utilizing tools such as video conferencing, learning management systems, and digital content delivery platforms. These technologies have enabled schools and universities to maintain instructional activities and support student learning, even when physical classrooms are not accessible. The flexibility and accessibility offered by remote learning technologies have been crucial in ensuring educational continuity during times of disruption.

The adoption of remote learning technologies has also accelerated the digital transformation of education. Educational institutions have embraced various tools and platforms to facilitate remote learning experiences. Video conferencing applications have become virtual classrooms, allowing real-time interaction between teachers and students. Learning management systems have streamlined the organization and delivery of online learning materials, assignments, and assessments. Online collaboration tools have facilitated group work and project-based learning in virtual environments. These technologies have revolutionized traditional classroom settings, creating dynamic and flexible learning environments that combine in-person instruction with online learning experiences.

Remote learning technologies have also democratized education, breaking down barriers of time and location. Students can now access educational resources and participate in learning activities from anywhere, at any time. This flexibility has opened up opportunities for lifelong learning, personalized learning pathways, and inclusive education. Individuals who may have previously faced geographical limitations or time constraints can now engage in learning experiences that suit their needs and circumstances. The democratization of education through remote



learning technologies has the potential to create a more equitable and inclusive education system.

Blended learning, which combines in-person and online learning experiences, has become a prominent approach in education. Remote learning technologies have facilitated the integration of technology into traditional classroom settings, creating blended learning environments. Teachers can leverage digital resources, multimedia content, and interactive tools to enhance their instructional approaches. Blended learning allows for differentiated instruction, catering to the diverse needs and learning styles of students. It also provides opportunities for self-paced learning, allowing students to progress at their own speed. By combining the best of in-person and online learning, blended learning offers a flexible and personalized educational experience.

While remote learning technologies have brought about numerous benefits, they also present challenges that need to be addressed. One crucial challenge is ensuring equitable access to these technologies. The digital divide and disparities in access to technology and reliable internet connectivity can create inequalities in educational opportunities. Bridging the digital divide and providing equitable access to remote learning technologies is crucial to ensure that all students have equal opportunities to participate and succeed in remote learning environments. Additionally, digital literacy skills among students and educators play a vital role in maximizing the benefits of remote learning technologies. Providing support and resources for digital literacy development is essential to empower both teachers and students in utilizing these technologies effectively (EdTechReview).

Ethical considerations are also crucial when implementing remote learning technologies. The collection and use of student data, privacy concerns, and algorithmic biases are important aspects to consider. It is essential to ensure the ethical design and implementation of these technologies, safeguarding student privacy and promoting transparency in data collection and usage. Additionally, maintaining meaningful teacher-student interactions in remote learning environments requires deliberate strategies and support. Building and nurturing teacher-student relationships in online settings can contribute to students' engagement and motivation in their learning journeys (Xiao et al., 2023).

Recent research and academic studies have provided valuable insights into the impact of remote learning technologies on future education. (Elshareif & Mohamed, 2021; Yahiaoui et al., 2022) conducted a study investigating the impact of remote learning technologies on student engagement. Their findings revealed

that students who had access to well-designed online platforms and interactive tools showed higher levels of engagement and motivation in their learning. This suggests that remote learning technologies have the potential to enhance student engagement and participation in educational activities.

(Goin & Taylor, 2021) focused their research on the challenges of remote learning. They highlighted the importance of addressing equity issues, such as the digital divide and access to technology, to ensure that all students have equal opportunities to participate and succeed in remote learning environments. Their study emphasized the need for concerted efforts to bridge the digital divide and provide equitable access to remote learning technologies.

(Nesenbergs et al., 2020) explored the effectiveness of virtual reality (VR) in remote education. Their research showed that VR simulations and virtual environments enhanced students' understanding and engagement in complex subjects, creating immersive learning experiences that were not possible in traditional classroom settings. This suggests that VR technologies can play a transformative role in remote learning environments.

(Sushama, 2022) examined the role of AI in remote learning. They highlighted the potential of AI to personalize instruction, provide adaptive feedback, and support students' individual learning needs. Their study emphasized the importance of ethical considerations in the design and implementation of AI-powered remote learning technologies.

(Xiao et al., 2023) focused their research on maintaining effective teacher-student interactions in remote learning environments. They highlighted the importance of deliberate strategies and support systems in building and nurturing meaningful teacher-student relationships in online settings. Their study emphasized the impact of teacher-student interactions on student engagement and motivation in remote learning environments.

In conclusion, the impact of remote learning technologies on future education is profound and multifaceted. These technologies have revolutionized the education landscape, enabling educational continuity, driving digital transformation, expanding access to education, and fostering innovative instructional approaches. By integrating technology and embracing the concept of blended learning, education can become more flexible, personalized, and inclusive. However, addressing challenges such as equitable access, digital literacy, and ethical considerations is crucial for the successful implementation of remote

learning technologies. The future of education will be shaped by the seamless integration of traditional and digital learning experiences, empowering students and educators in their pursuit of knowledge.

## PREDICTED TRENDS IN TECH INTEGRATION IN EDUCATION

Looking ahead to the coming decade, several predicted trends in tech integration are expected to drive educational transformation. These trends anticipate how technology will revolutionize pedagogy, enhance student engagement, and empower educators. The following is an overview of some of the key predicted trends for tech integration in education.

**Personalized Learning** has gained significant traction in recent years, and it is expected to continue as a prominent trend in the coming years. With advancements in technology, personalized learning has the potential to reach new heights. Adaptive learning platforms and intelligent tutoring systems leverage AI algorithms to tailor instruction to individual student needs. These technologies analyse student data, such as performance, preferences, and learning styles, to deliver customized learning experiences. By personalizing instruction, students can learn at their own pace, explore their interests, and receive targeted feedback (Mikic et al., 2022).

Moreover, current research supports the effectiveness of personalized learning. Various studies by (Raj & Renumol, 2022; Fariani et al.; 2023) found that personalized learning approaches using technology positively impacted student outcomes, including academic achievement and engagement. The studies also emphasized the benefits of adaptive learning platforms in promoting individualized learning experiences, thus making students responsible and take control of their own education.

**Augmented Reality (AR) and Virtual Reality (VR)** are poised to revolutionize education by providing immersive and interactive experiences. AR overlays digital content onto the real world, while VR creates simulated environments. These technologies have the potential to transform learning across various subjects and disciplines. In the classroom, students can explore historical sites, simulate science experiments, or engage in virtual field trips through AR and VR. By incorporating these technologies, educators can enhance student engagement and understanding by creating experiential and immersive learning environments. The release of various headsets in the past months such as the Quest 3 by Meta

and the Apple Vision Pro mixed reality headset augurs well for the widespread availability of this technology in the classroom.

This will eventually lead to further research on the benefits of AR and VR in education. A study by (Li et al., 2020) explored the impact of VR simulations on student learning outcomes. The findings revealed that students who engaged with VR simulations demonstrated higher levels of knowledge retention and engagement compared to traditional instructional methods. Most probably, this is because VR tends to stimulate more senses than a normal classroom based lesson. The study also highlighted the potential of VR to provide authentic and immersive learning experiences, thus providing children with experiential learning.

**Artificial Intelligence (AI) in Education** is expected to play a significant role in transforming education by automating tasks, personalizing instruction, and providing intelligent support to both students and educators. AI-powered tools and platforms have the potential to automate administrative tasks, such as grading and scheduling, freeing up educators' time for more personalized interactions with students. AI algorithms can analyze vast amounts of student data to provide personalized recommendations, adaptive learning pathways, and intelligent tutoring. By leveraging AI, educators can optimize learning resources, provide targeted interventions, and enhance student engagement.

A study conducted by (Kamruzzaman, 2023) examined the role of AI in personalized learning. The findings highlighted the ability of AI to provide adaptive feedback, track student progress, and tailor instruction to individual needs. Something which is impossible to achieve in a traditional classroom setting. The study also emphasized the importance of ethical considerations in the design and implementation of AI-powered educational technologies.

**Data Analytics and Learning Analytics** is gaining momentum in education. Educational institutions are leveraging data-driven insights to enhance teaching and learning practices. Data analytics involves the analysis of large datasets to identify patterns, trends, and correlations related to student performance, engagement, and learning outcomes. Learning analytics focuses specifically on the analysis of data generated by digital learning platforms to gain insights into student progress, identify areas for improvement, and personalize instruction.

Various studies such as (Banihashem et al., 2018; Akçapınar et al., 2019; Foster & Siddle, 2020) explored the use of learning analytics in identifying students at risk

of academic failure. The findings demonstrated that early identification of at-risk students through learning analytics facilitated timely interventions and support, leading to improved student outcomes. The study emphasized the importance of data-informed decision-making in education.

**Gamification and Game-Based Learning** are gaining popularity as effective strategies for enhancing student motivation, engagement, and learning outcomes. By integrating game elements and mechanics into educational activities, teachers can create interactive and immersive learning experiences. Gamified platforms and educational games provide students with challenges, rewards, and opportunities for collaboration. Through gamification, students can develop problem-solving skills, critical thinking abilities, and teamwork.

A study by (Martinez & Johnson, 2022) examined the effects of gamified learning activities on student motivation and achievement. The results showed that students who participated in gamified activities demonstrated higher levels of motivation and engagement, leading to improved academic performance. The study emphasized the potential of gamification in promoting active and enjoyable learning experiences.

In conclusion, the predicted trends in tech integration for education hold immense potential to transform teaching and learning experiences. Personalized learning, AR/VR, AI, data analytics, and gamification are expected to reshape educational practices and empower students to become active and engaged learners. As these trends continue to evolve, educators and institutions must stay abreast of the latest research and best practices to effectively leverage technology and maximize its impact on education.

# CURRENT DIGITAL SKILLS AND COMPETENCES

## OVERVIEW OF THE CURRENT DIGITAL SKILLS AND COMPETENCES IN THE EDUCATION SECTOR

Digital skills and competences have become increasingly important in the education sector. They encompass a range of abilities, from basic IT skills to more advanced competences such as data literacy, digital content creation, online safety, and digital communication (Rubach & Lazarides, 2021; Yue, 2022). These skills are no longer optional extras but are now seen as fundamental capabilities that students need to acquire to succeed in the 21st-century digital world.

The integration of these skills into the curriculum is becoming the new norm in many schools, reflecting the growing recognition of their importance in preparing students for a digital future (Mauerer et al., 2022). This shift towards a more digitally-focused curriculum is not just a response to the increasing prevalence of technology in society, but also a proactive measure to ensure that students are equipped with the skills they need to succeed in a digital world. It's a recognition that digital skills are not just about using technology, but also about understanding how to use it effectively for learning, communication, and problem-solving.

Within this context, the role of educators is crucial. They are not just imparting knowledge but are also guiding students in developing digital competences. This involves teaching students how to use digital tools, but also helping them understand the ethical implications of digital technology, the importance of online safety, and the ways in which digital technology can be used to enhance learning and communication (Basilotta-Gómez-Pablos et al., 2022; Mattar, Ramos & Lucas, 2022).

Digital literacy, in particular, is becoming increasingly essential in today's education. It goes beyond the ability to use digital tools and involves critical thinking and problem-solving skills, creativity and innovation, communication and collaboration, as well as digital citizenship (Tinmaz et al., 2023). These competences are crucial for students to fully participate in our society, where digital technology permeates every aspect of life.

Moreover, the current digital skills and competences in the education sector are not static; they continue to evolve in response to technological advancements and societal changes. As such, it is important for educators to stay abreast of these changes and continually update their teaching practices and curricula to ensure that students are learning the most relevant and useful digital skills. This involves not just keeping up with the latest digital tools and technologies, but also understanding how these tools can be integrated into the curriculum in a way that enhances learning and fosters digital competences (Meissner et al., 2022).

In the next section, we will delve deeper into the role of digital literacy in education, exploring its importance and how it is being integrated into educational practices.

## THE ROLE OF DIGITAL LITERACY IN EDUCATION

Digital literacy plays a crucial role in modern education. It equips students with the skills they need to navigate the digital world, preparing them for a future where digital skills are increasingly in demand (Thompson et al., 2014; Zhu et al., 2023). Digital literacy's role extends beyond technology; it also involves critical thinking, problem-solving, and digital citizenship (Eshet-Alkalai & Chajut, 2009).

Digital literacy is not just about using digital tools; it's about understanding how to use them effectively and safely. This includes the ability to engage with digital content, to communicate and collaborate using digital tools, and to solve problems using digital resources (Hatlevik & Christophersen, 2013). It also involves understanding the ethical implications of digital technology and the importance of online safety.

However, the importance of digital literacy in education is not just about preparing students for the future. It's also about addressing the present. As (Ritzhaupt et al., 2013) point out, a student's ICT literacy differs based on socio-economic status, ethnicity, and gender, indicating a digital participation divide. This underscores the importance of digital literacy in promoting digital inclusion and ensuring that all students can participate fully in the digital world.

Moreover, as (Van Deursen & Van Dijk, 2019) note, the digital divide is shifting from inequalities in physical access to inequalities in material access. This means that it's not just about whether students have access to digital tools, but also about

whether they have the skills and knowledge to use these tools effectively. This further underscores the importance of digital literacy in education.

In addition, digital literacy plays a significant role in enhancing students' information security in the virtual space. As (Luic et al., 2021) argue, knowledge of the issue of identification and authentication significantly affects the information security of adolescents in the virtual space. This suggests that digital literacy education should also focus on equipping students with the skills and knowledge to protect their information security in the digital world.

Furthermore, digital literacy is not a static concept; it evolves over time, reflecting changes in technology and society. As (Eshet-Alkalai & Chajut, 2009) point out, digital literacy changes over time, necessitating continuous learning and adaptation. This highlights the need for education systems to be flexible and responsive, continually updating their digital literacy education to keep pace with technological advancements and societal changes.

Finally, we have to keep in mind that digital literacy education should not be a one-size-fits-all approach. As (Zhu et al., 2023) suggest, the use of digital tools in education needs to be optimized by considering the topics being taught and the disciplinary backgrounds of students rather than applying it uniformly. This underscores the importance of a tailored approach to digital literacy education, taking into account the specific needs and contexts of different students.

In the next section, we will look at some case studies of successful digital skills training in schools, providing concrete examples of how digital literacy can be integrated into the curriculum and how it can enhance student learning.

## SUCCESSFUL DIGITAL SKILLS TRAINING IN EDUCATION

Digital skills training programs have been successfully implemented in various educational settings worldwide. These case studies highlight the potential of such programs to enhance education and prepare students for the digital world. They also underscore the importance of a comprehensive and adaptable approach to digital skills training that incorporates both technical skills and soft skills and is tailored to the specific needs and contexts of different educational institutions and learners.



At a large London university, a university-wide digital skills training program was implemented that was designed to provide effective training in digital skills for all students. The program was particularly focused on addressing individual differences in the training experience. The program was found to be particularly beneficial for Black and Minority Ethnic (BAME) students and international students, who felt that the training made a greater contribution to their skill levels and resulted in greater behavior change and impact, as well as intention to undertake further training (Raji, Busson-Crowe, & Dommett, 2023).

In a culturally diverse multilingual classroom, Digital Storytelling (DS) was used to enhance public speaking skills. DS, which involves making/telling short stories using animation, website, audio video, and graphics, was found to improve vocabulary enrichment, oral skills, and made students' speech more coherent and cohesive. The study underscores the potential of innovative digital tools, such as DS, to enhance learning and engage students (Roza & Rustam, 2023).

In universities across five European countries, namely Spain, Lithuania, North Macedonia, Romania, and Slovenia, key training programs were implemented to assist higher education teaching staff to acquire the multimedia competencies required to be technologically proficient in their classes. The programs covered a wide range of skills and offered courses at several levels of development, catering to staff at all levels, from beginners to those needing more advanced tools. The study highlights the importance of comprehensive and adaptable digital skills training programs (de Juana Espinosa, Brotons, Sabater Sempere, & Stankevičiūtė, 2022).

At the University of Zaragoza in Spain, a study was conducted to analyze whether university training fits the new skills and abilities required for professional interventions in the twenty-first century. The study concluded that training in digital skills must gain space in university training plans, underscoring the importance of continuous learning and adaptation in the digital age (Gómez-Poyato, Eito-Mateo, Mira-Tamayo, & Matías-Solanilla, 2022).

In the United Arab Emirates, two preservice teachers completed action research projects during their final year of teacher training. The participants comprised four groups of children aged between four and six years. The preservice teachers conducted interviews, classroom observations, and journaling, while a supervising instructor monitored their progress. The findings suggest that action research can positively impact literacy teaching using visual arts and 21st-century skills in early

childhood despite limited space and resources (AlShamsi, AlShamsi, & AlKetbi, 2022).

In Zarqa, Jordan, a study was conducted to explore the role of e-training programs on developing the digital skills of social studies teachers as perceived by school directors. The study found that e-training programs played a significant role in developing the digital skills of teachers, but challenges such as teachers' lack of time for training, non-positive attitudes towards technology, and lack of innovative capacity in their teaching processes were identified (Alomoush & Alkhozahe, 2022).

At The University of Newcastle, Australia, a detailed intrinsic case study was conducted outlining the process and critical elements that shaped the selection of suitable teaching content, software development, hardware solutions, and implementation of four new virtual reality (VR) teaching applications. The study underscores the potential of innovative digital tools, such as VR, to enhance learning and engage students (Kluge, Maltby, Kühnel, Evans, & Walker, 2022).

These case studies provide valuable insights into successfully implementing digital skills training programs in various educational settings. They highlight the potential of such programs to enhance education, prepare students for the digital world, and promote digital inclusion. They also underscore the importance of a comprehensive and adaptable approach to digital skills training that incorporates both technical skills and digital literacy and is tailored to the specific needs and contexts of different educational institutions and learners.

# FUTURE LABOUR MARKET DEMANDS

## PREDICTED TRENDS IN FUTURE LABOUR MARKET DEMANDS

The future of labour market demands is a topic of considerable interest and concern, given the rapid pace of technological change and the ongoing effects of global events such as the COVID-19 pandemic or the Ukrainian war. Several trends are emerging that are likely to shape the labour market of the future, and these trends are the subject of much discussion and debate among academics, policymakers, and industry leaders.

One of the most significant trends is the growing demand for roles related to technology and digital skills. The World Economic Forum's (Future of Jobs Report, 2023) predicts that by 2025, 85 million jobs may be displaced by a shift in the division of labour between humans and machines, while 97 million new roles may emerge that are more adapted to the new division of labour between humans, machines, and algorithms. This shift is likely to be seen across industries, with a particular emphasis on roles related to data analysis, AI, and cloud computing.

This trend towards digitalization and automation has sparked a lively debate. On one hand, there is optimism about the potential of technology to create new jobs and drive economic growth. (Bessen, 2023) argues that AI will create new jobs that we cannot yet foresee, suggesting that the rise of technology could lead to a net increase in employment. Similarly, (Brynjolfsson & McAfee, 2023) argue that AI will create new business models and job opportunities.

On the other hand, there are concerns about the potential for technology to displace jobs and exacerbate inequality. (Frey & Osborne, 2017) provide a detailed analysis of how susceptible jobs are to computerisation, suggesting that a significant proportion of jobs could be at risk. However, they also note that the impact of technology on jobs will depend on a range of factors, including the pace of technological change, the adaptability of workers, the flexibility of businesses, and policy responses.

Another important trend is the continued high value placed on soft skills. Despite the increasing automation of tasks, skills such as critical thinking, creativity, and emotional intelligence are still expected to be in high demand (Chan & Tsi, 2023). These skills are not easily replicated by machines and are crucial for navigating

the complex and rapidly changing work environment. This highlights the importance of a balanced skill set that combines technical skills with interpersonal and cognitive skills.

The demand for green jobs is also expected to increase. As the world grapples with the challenges of climate change, roles related to environmental science, renewable energy, and sustainability are likely to see increased demand (Dumitrescu, 2023). This trend reflects a broader shift towards a more sustainable and resilient economy, and it presents both opportunities and challenges for workers and businesses.

Finally, the future labour market will likely be characterised by increased flexibility. The COVID-19 pandemic has accelerated trends towards remote work and flexible working arrangements, which are expected to continue into the future (Vyas, 2022; Hajal, 2022). This trend has implications for work-life balance, productivity, and inequality. Thus, it is the subject of ongoing research and policy debate.

In conclusion, in the future labour market, we will experience a shift towards roles requiring digital and soft skills, an increase in demand for green jobs, and increased flexibility in working arrangements. However, the exact nature of these changes remains uncertain and will be influenced by various factors, including technological developments, policy decisions, and societal trends. As such, it is crucial to continue monitoring and researching these trends and to engage in informed and inclusive policy debates about the future of work.

## DIGITAL SKILLS IN FUTURE LABOUR MARKET DEMANDS

In the evolving landscape of the labour market, digital skills are becoming increasingly important. As we move further into the digital age, these skills are no longer a luxury but a necessity for individuals to thrive in the workplace. The role of digital skills in future labour market demands is a multifaceted issue that warrants a thorough discussion.

The rise of digital technology has fundamentally transformed the way we work, learn, and interact. This transformation has been accelerated by the COVID-19 pandemic, which has necessitated a shift towards remote work and digital communication. As a result, digital skills are now a prerequisite for a wide range of jobs, not just those traditionally associated with technology (Olughor, 2023).

These skills encompass a broad range of abilities, from basic digital literacy (such as the ability to use digital devices and navigate the internet) to more advanced skills (such as coding, data analysis, and digital design). They also include 'soft' digital skills, such as the ability to find and evaluate information online, to communicate effectively in digital contexts, and to understand issues related to online privacy and security. (Bhatt, 2012) explores this concept of digital literacy practices and argues for a layered understanding of digital literacy, suggesting that it's not just about technical proficiency but also about understanding how to use digital tools in a responsible and effective way.

The demand for digital skills is driven by several factors.

- First, digital technology is becoming increasingly integrated into all aspects of work. From communication and collaboration tools to data analysis and automation software. Digital technology has become a fundamental part of many jobs. This means that workers need to have the skills to use this technology effectively (Pouliakas & Souto-Otero, 2023).
- Second, the rise of digital technology is creating new jobs and industries. From app development and digital marketing to cybersecurity and data science, there are now many jobs that did not exist a few decades ago. These jobs require a high level of digital skills (World Economic Forum, 2023). (Harteis et al., 2022) discusses this impact of digitalization in the workplace from an educational perspective, arguing for the importance of continuous learning and adaptation. He suggests that as new digital roles and industries emerge, workers will need to continually update their skills and knowledge to keep up with the pace of change.
- Third, digital skills are becoming increasingly important for non-digital jobs. Even in jobs that are not primarily focused on technology, digital skills are often required. For example, teachers need to use digital technology to support their teaching, retailers need to use e-commerce platforms to sell their products, and healthcare professionals need to use digital tools to manage patient records (Cepal, 2021). (Ilomäki, Kantosalo & Lakkala, 2016) discuss this concept of digital competence as a boundary concept for policy and educational research, suggesting that digital skills are becoming integral to a wide range of roles and industries.

However, while the demand for digital skills is increasing, there is a significant gap between the skills that workers have and the skills that employers need. This

'digital skills gap' is a major challenge for businesses and economies and a key focus of policy and research. (Ferrari et al., 2012) analyses various digital competence frameworks, providing a comprehensive understanding of the skills and knowledge required in the digital age. They suggest that addressing the digital skills gap will require a multifaceted approach, including education and training, policy interventions, and individual learning initiatives.

The digital skills gap is not just a problem for employers; it also broadly has implications for workers and society. Workers without the necessary digital skills may find it difficult to access job opportunities and to participate fully in society. This can exacerbate social inequalities and lead to a 'digital divide', where some groups are left behind in the digital transition. Therefore, addressing the digital skills gap is not just an economic issue but also a social justice issue.

Moreover, the digital skills gap is a dynamic problem that evolves with the pace of technological change. As new technologies emerge, the skills that are in demand can change rapidly. This means that digital skills training needs to be an ongoing process, rather than a one-off event. Workers need the opportunity and motivation to continually update their skills throughout their careers. This requires a culture of lifelong learning and access to high-quality and relevant training opportunities.

The role of education and training in addressing the digital skills gap cannot be overstated. Schools, colleges, and universities have a crucial role to play in equipping students with the digital skills they need for the future. This includes not only technical skills, but also 'soft' digital skills, such as online communication and digital citizenship. However, it's not just about formal education. Informal learning opportunities, such as online courses, coding bootcamps, and workplace training, can also play a crucial role in developing digital skills.

In addition to education and training, policy interventions are also needed to address the digital skills gap. This could include policies to promote digital inclusion, to support the development of digital infrastructure, and to facilitate the recognition and validation of digital skills. Policymakers also need to work closely with industry to ensure that training programs are aligned with the needs of the labour market.

In conclusion, digital skills are crucial for the future labour market. They are required for a wide range of jobs, they are driving the creation of new jobs and industries, and they are becoming increasingly important for non-digital jobs.

However, there is a significant digital skills gap that needs to be addressed. This requires a concerted effort from all stakeholders, including governments, businesses, educators, and individuals. It also requires a multifaceted approach, including education and training, policy interventions, and a culture of lifelong learning.

## INDUSTRIES WITH HIGH FUTURE LABOUR MARKET DEMANDS

In this section, we will explore case studies of industries with high future labour market demands. These industries are not only expected to grow but also to evolve, requiring a workforce equipped with digital skills and the ability to adapt to changing technologies and methodologies.

**The Software Industry:** is expected to continue its growth trajectory, with a particular emphasis on cloud computing, AI, and ML. The demand for software developers and engineers who can create and maintain sophisticated software systems is expected to increase. According to a report by (Grand View Research, 2022), the software industry is expected to grow by 11.5% annually until 2030. Furthermore, a study by (Bessen, 2018) emphasizes the importance of digital skills in the software industry, stating that the ability to work with complex software systems and understand coding languages will be crucial. A recent study on the gap between higher education and the software industry also highlights the need for continuous learning and adaptation in this field (Dobslaw et al., 2023).

**Industrial Automation:** is another sector that is expected to see significant growth. With the rise of Industry 4.0, the demand for professionals skilled in robotics, machine learning, and data analysis is set to increase. The (World Economic Forum, 2023) report predicts that by 2025, 85% of companies in the manufacturing sector will have implemented some form of industrial automation. Additionally, a study by (Petrillo et al., 2018) highlights the importance of digital skills in this sector, particularly in the areas of data analysis and machine learning. The integration of 5G with Time-Sensitive Networking (TSN) is also seen as a prerequisite for a highly flexible future in industrial automation (Gundall et al., 2020).

**The Healthcare Industry:** is undergoing a digital transformation, with technologies such as telemedicine, electronic health records, and AI-powered diagnostic tools becoming increasingly prevalent. A report by (Deloitte, 2022) predicts that the

digital health market will reach \$639.4 billion by 2026. Furthermore, (Fombu, 2018; Knight, 2021) discuss the importance of digital skills in healthcare, stating that healthcare professionals will need to be comfortable using digital tools and interpreting data. The future of healthcare is seen as a partnership between humans and machines working together to obtain better outcomes.

**The E-Commerce Industry:** has seen exponential growth in recent years, a trend that is expected to continue. With the rise of online shopping and digital marketing, there is a growing demand for professionals skilled in digital marketing, data analysis, and website development. A report by (Hushko et al., 2022) estimated that global e-commerce sales reached \$6.4 trillion by 2024. Additionally, a study by (Pascucci, Savelli & Gistri, 2023) discusses the importance of digital skills in e-commerce, particularly in the areas of data analysis and digital marketing. The future of e-commerce is seen as a road with major trends including growth of social commerce, personalization, voice shopping, AR and VR, omnichannel retail, mobile commerce, international expansion, and focus on sustainability.

**Cybersecurity Industry:** As digital technologies become increasingly integral to our lives, the need for cybersecurity professionals is growing. The cybersecurity industry is expected to grow as businesses and governments seek to protect their digital assets and data. A report by (Cybersecurity Ventures, 2023) predicts that there will be 3.5 million unfilled cybersecurity jobs globally by 2023. Furthermore, a study by (Fernández-Caramés & Fraga-Lamas, 2020) highlights the importance of digital skills in cybersecurity, particularly in the areas of data analysis and encryption. The future of cybersecurity is seen combined with major technologies including; cloud computing, Internet of Things, automation, data storage systems, networking, applications, managed security services, zero trust security, and mobile security.

**The Data Science Industry:** is expected to grow significantly in the coming years. With the rise of big data and AI, there is a growing demand for data scientists who can analyse and interpret complex datasets to inform decision-making. A report published by (Miller & Hughes, 2017) noted the increase in data science jobs and this was further reinforced by the Occupational Outlook Handbook<sup>1</sup> which predicted that the increase will be of 36% up till 2031. Furthermore, a study by (Cao, 2017) discusses the importance of digital skills in data science, particularly in data analysis, machine learning, and statistical modelling. The future of data

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<sup>1</sup> <https://www.bls.gov/ooh/fastest-growing.htm>



science is seen as having significant trends, including increased demand for data scientists and analytics talent, growth of ML and AI, demand for data science in non-tech industries, advancements in data science tools and technologies, focus on data engineering and governance, cross-functional data science teams, and consideration of ethical and social implications.

In conclusion, these case studies highlight the growing importance of digital skills across various industries. As these industries continue to evolve and integrate digital technologies, the demand for professionals with digital skills will continue to increase. This underscores the need for education systems to adapt and equip students with the necessary digital skills to meet future labour market demands. The integration of digital skills into the curriculum is not just about teaching students how to use technology, but also about helping them understand how digital technologies are transforming industries and what skills they will need to succeed in the future labour market.

# THE GAP BETWEEN REQUIRED NEW DIGITAL SKILLS AND COMPETENCES AND FUTURE LABOUR MARKET DEMANDS

## OVERVIEW OF THE CURRENT DIGITAL SKILLS GAP

The digital skills gap is a pervasive issue that affects various sectors, including technology, accountancy, finance, and small and medium-sized enterprises (SMEs). This gap is not merely a shortage of individuals with technical skills; it also represents a lack of diversity in the workforce. As (Ely & Thomas, 2020) notes, attracting diverse talent and fresh perspectives is crucial to effectively address the skills shortage. This diversity extends beyond demographic characteristics to include a diversity of skills and experiences. For instance, individuals with backgrounds in humanities or social sciences can bring unique perspectives to problem-solving in the digital realm.

Moreover, the digital skills gap is not just about the number of people entering the digital workforce, but also about the quality of skills they bring. The rapid pace of technological change means that digital skills can quickly become outdated, and continuous learning and upskilling are necessary to keep up. This presents a challenge for both individuals and organizations, as they need to invest time and resources in ongoing education and training.

Security and data protection concerns also contribute to the digital skills gap. As reported by (Startups.co.uk, 2023), uncertainty around security and data protection can deter individuals from pursuing careers in the digital sector. This highlights the need for education and training programs that not only equip individuals with technical skills but also foster an understanding of the ethical and security implications of digital technologies. In addition, organizations need to create a culture of security, where data protection is seen as everyone's responsibility, not just that of the IT department.

The European Union (EU) has recognized the importance of addressing the digital skills gap. The EU has highlighted the need for peer learning and exchanges on the development / assessment of digital skills (European Commission, 2020; European Commission, 2023). This suggests that collaborative learning environments and shared resources could play a significant role in bridging the

digital skills gap. It also underscores the importance of international cooperation in addressing this global issue.

Furthermore, (Wachs, 2023) discusses the impact of brain drain on the digital skills gap, particularly in the context of the Russian invasion of Ukraine. Brain drain refers to the emigration of highly skilled individuals from their home country to other countries. In the case of Russia, he found that many of the most active and central developers in the collaboration network had left the country. This highlights the geopolitical factors that can exacerbate the digital skills gap and underscores the importance of political stability and favourable working conditions in retaining digital talent.

(Goupil et al., 2022) delve into the skill gap in cybersecurity, a field that is particularly affected by this issue due to the rapidly evolving nature of cyber threats. They found a substantial undersupply in several crucial skill categories, such as software and application security, security management, requirements engineering, compliance, and certification. This underscores the specific areas within the digital sector where the skills gap is most pronounced and suggests that education and training programs should prioritize these areas.

(Fareri et al., 2023) present a software designed to map the skills currently possessed by workers, identifying misalignment with those they should ideally possess to meet the renewed demands that digital innovation and environmental preservation impose. The Worker Profiler, provides a practical solution for identifying skills gaps at the individual level and can inform the development of customized retraining strategies. This underscores the potential of digital tools in addressing the digital skills gap.

In conclusion, the current state of the digital skills gap is characterized by a shortage of skilled professionals in various sectors, a lack of diversity in the workforce, and concerns about security and data protection. The gap is most pronounced in specific areas within the digital sector, such as cybersecurity. Tools that can accurately assess the digital skills of the workforce and identify areas for improvement are needed to address this gap effectively. Efforts to bridge the digital skills gap should also consider geopolitical factors and the importance of political stability and favourable working conditions in retaining digital talent. Furthermore, it is important to recognize that the digital skills gap is not a static issue but one that evolves with the rapid pace of technological change. As such, strategies to address the gap need to be flexible and adaptable, capable of responding to new developments and trends in the digital sector. This includes

not only technical developments but also changes in the way work is organized and conducted, such as the increasing prevalence of remote work and the growing importance of soft skills like communication and collaboration in the digital workplace. Finally, addressing the digital skills gap is not just a matter of producing more digital professionals, but also of ensuring that all members of society have a basic level of digital literacy. This is crucial for ensuring that the benefits of digital technology are widely shared and that everyone can participate fully in the digital society.

## Predicted trends in the digital skills gap

To effectively bridge this gap, it is crucial to examine the predicted trends that are expected to shape the demand for digital skills in the future labour market. By understanding these trends, educators, policymakers, and individuals can develop strategies to address the evolving needs of the digital economy.

One of the key trends that is anticipated to impact the digital skills gap is the growing adoption of e-commerce and digital trade. According to the World Economic Forum (WEF) in their "Future of Jobs Report 2023," it is projected that 75% of businesses will adopt e-commerce and digital trade in the near future (World Economic Forum, 2023). This significant shift towards digital business models implies a greater demand for individuals with skills in online marketing, data analytics, supply chain management, and digital customer service.

Furthermore, the European Commission has set ambitious targets to ensure that a significant portion of the European population possesses basic digital skills and to increase the number of ICT specialists by 2030 (European Commission Digital, 2023). Regarding skills, they aim to have 20 million ICT specialists while ensuring gender convergence. Additionally, they strive for at least 80% of the population to possess basic digital skills. The digital transformation of businesses is another focus, with a target of 75% of EU companies adopting technologies such as Cloud, AI, and Big Data. The commission also aims to foster innovation by supporting scale-up growth and financing to double the number of EU Unicorns. Furthermore, they expect more than 90% of SMEs to reach a basic level of digital intensity. The EU envisions secure and sustainable digital infrastructures, including universal Gigabit connectivity, doubling the EU's share in global semiconductor production, establishing 10,000 climate-neutral and highly secure edge nodes for data processing, and developing the first computer with quantum acceleration. Lastly, the digitalisation of public services is prioritised, aiming for 100% online availability

of key public services, access to medical records online for all citizens, and ensuring that 80% of citizens have access to digital identity. This emphasis on digital literacy and specialisation reflects the recognition of the critical role that digital skills play in driving economic growth and innovation.

In addition to these broader trends, it is crucial to consider the specific technological advancements that are expected to shape the digital skills landscape. (Forbes Work, 2023; Bhattacharya, 2023) highlights several key tech trends that will likely influence the digital skills gap. The metaverse, for instance, represents a virtual reality space where individuals can interact with a computer-generated environment and other users. This emerging technology has the potential to revolutionize various sectors, including entertainment, gaming, education, and even remote work.

AI is another transformative technology that is anticipated to have a significant impact on the digital skills gap. According to a study conducted by (Malik et al., 2021; Washull et al., 2020), AI is expected to automate repetitive tasks, augment human decision-making, and drive innovation across industries. Consequently, there will be a growing demand for individuals skilled in machine learning, data analysis, natural language processing, and AI ethics.

Cloud computing is yet another trend that is reshaping the digital landscape. As organizations increasingly migrate their infrastructure and software to cloud-based platforms, there is a growing need for individuals with expertise in cloud architecture, cybersecurity, cloud-native development, and cloud management. This shift is outlined by a research paper by (Catteddu, 2010; Tabrizchi & Kuchaki, 2020; Alouffi et al, 2021; ), which discusses the advantages and challenges of cloud adoption in various sectors.

Decentralized systems, including blockchain technology, are also expected to impact the digital skills gap. Such a technology has the potential to revolutionize industries such as finance, supply chain management, healthcare, and cybersecurity. Individuals with knowledge and skills in blockchain development, smart contract programming, and decentralized application development will be in high demand as organizations seek to leverage the benefits of decentralized systems.

Lastly, mainframe modernization is an emerging trend that highlights the need to upgrade and optimize legacy mainframe systems. According to (Khabouze, 2022), many organizations still rely on mainframe technology to support critical business

processes. However, there is a shortage of skilled professionals who can effectively maintain, modernize, and integrate mainframe systems with modern technologies.

These predicted trends indicate that the digital skills gap is not a static issue, but rather an evolving challenge that requires continuous adaptation and upskilling. To bridge this gap, it is crucial to implement effective strategies that address the anticipated demands of the future labor market.

## STRATEGIES TO BRIDGE THE DIGITAL SKILLS GAP

Addressing the digital skills gap requires a comprehensive approach that involves collaboration between various stakeholders, including educational institutions, policymakers, industry leaders, and individuals themselves. The following strategies can be implemented to bridge the digital skills gap and ensure that individuals are equipped with the necessary competencies to thrive in the digital economy.

**Relevant and adaptive curriculum:** Educational institutions play a vital role in preparing individuals for the digital workforce. They need to develop curriculum and learning programs that are relevant to the changing needs of the labour market. This involves integrating digital skills training across disciplines, incorporating emerging technologies into the curriculum, and promoting hands-on learning experiences. Additionally, institutions should adopt adaptive learning methodologies that personalize education to meet the unique needs and learning styles of students.

Research conducted by (Frey & Osborne, 2017) emphasizes the importance of aligning education with the future demands of the labour market. They argue that educational programs should focus on developing skills that are complementary to technology rather than being susceptible to automation. By integrating digital skills into the curriculum, educational institutions can equip individuals with the necessary competencies for the digital era.

**Industry-academia collaboration:** Collaboration between academia and industry is crucial to bridge the digital skills gap effectively. Educational institutions should establish partnerships with industry leaders to gain insights into the latest technological advancements, industry requirements, and skill demands. This collaboration can take the form of joint research projects, internships,

apprenticeships, and industry-sponsored training programs. By aligning curriculum with industry needs, students can acquire practical skills and industry-specific knowledge, increasing their employability.

A study by (Jantunen & Hynninen, 2022) highlights the benefits of industry-academia collaboration in developing digital skills. The researchers found that students who participated in industry-focused projects and internships had a better understanding of real-world challenges and were more prepared for the demands of the digital workplace. These findings accentuate the importance of fostering strong connections between academia and industry to bridge the digital skills gap effectively.

**Upskilling and reskilling programs:** Continuous upskilling and reskilling programs are essential to ensure that individuals can adapt to the evolving demands of the digital economy. Governments, educational institutions, and organizations should offer training initiatives that enable individuals to acquire new digital skills or enhance existing ones. These programs can take various forms, such as online courses, boot camps, workshops, and certifications. Special attention should be given to individuals from underrepresented groups or marginalized communities to ensure equitable access to digital skills development opportunities.

(Jaiswal et al., 2022) emphasizes the significance of upskilling programs in reducing the digital skills gap. The researchers conducted a study on the effectiveness of a data science upskilling program and found that participants significantly improved their data analytics skills and were able to apply them in real-world scenarios. This highlights the potential of targeted upskilling initiatives in addressing the digital skills gap.

**Promotion of digital literacy:** Digital literacy is the foundation for acquiring more advanced digital skills. Governments and educational institutions should prioritize promoting digital literacy among individuals of all ages, starting from primary school education. This involves providing comprehensive training on basic digital skills, internet safety, data privacy, and critical thinking in the digital age. By empowering individuals with digital literacy, they can navigate the digital landscape with confidence and participate fully in the digital economy.

According to (Lankshear & Knobel, 2015), digital literacy is crucial for individuals to engage meaningfully in the digital era. The researchers argue that digital literacy encompasses not only technical skills but also the ability to critically evaluate information, communicate effectively, and participate responsibly in

online communities. By promoting digital literacy, individuals can develop a solid foundation for acquiring more advanced digital skills.

**Lifelong learning mindset:** In the fast-paced digital world, individuals need to adopt a lifelong learning mindset to remain competitive. The rapid advancements in technology require continuous learning and adaptation. Educational institutions and organizations should foster a culture of lifelong learning by providing opportunities for professional development, encouraging self-directed learning, and promoting a growth mindset. Individuals should take ownership of their learning journeys, actively seek new knowledge and skills, and embrace ongoing personal and professional development.

(Harteis & Billet, 2022) emphasizes the importance of a lifelong learning mindset in the digital age. The authors argue that individuals need to develop self-regulated learning strategies and embrace a growth mindset to keep pace with technological advancements. By cultivating a culture of lifelong learning, individuals can bridge the digital skills gap and remain adaptable in the face of technological disruptions.

**Diversity and inclusion:** Ensuring diversity and inclusion in the digital workforce is vital to bridge the digital skills gap effectively. Organizations should strive to create inclusive environments that value and embrace individuals from diverse backgrounds, including women, racial and ethnic minorities, individuals with disabilities, and individuals from low-income communities. This involves eliminating bias in hiring processes, creating inclusive work environments, and providing equal opportunities for individuals from diverse backgrounds. By embracing diversity, organizations can benefit from a broader range of perspectives, ideas, and innovation.

A study by (Chaudhry et al., 2021) emphasizes the significance of diversity and inclusion in bridging the digital skills gap. The researchers found that organizations with diverse workforces were more innovative, adaptable, and better equipped to address complex challenges in the digital age. By fostering diversity and inclusion, organizations can attract and retain a diverse pool of talent, closing the digital skills gap and driving organizational success.

**Public-private partnerships:** Bridging the digital skills gap requires coordinated efforts between the public and private sectors. Public-private partnerships can facilitate collaboration, resource sharing, and joint initiatives to address the digital skills gap. Governments can provide incentives and funding for organizations to



invest in digital skills development programs, while businesses can contribute their expertise, mentorship, and resources. By leveraging the strengths of both sectors, effective solutions can be implemented to bridge the digital skills gap.

The World Bank in its Digital Development Partnership<sup>2</sup> highlights the importance of public-private partnerships in addressing the digital skills gap. The initiative emphasizes the need for governments, businesses, and educational institutions to work together to create an enabling environment for digital skills development. Through collaboration and shared resources, public-private partnerships can drive significant progress in bridging the digital skills gap.

In conclusion, the digital skills gap is a pressing challenge that requires proactive strategies to bridge the divide between the required skills and competencies and the future labour market demands. By understanding the current state of the digital skills gap, anticipating future trends, and implementing comprehensive strategies, we can ensure that individuals are equipped with the necessary digital skills to thrive in the digital economy. The collaboration of educational institutions, policymakers, industry leaders, and individuals themselves is essential to create a digitally literate and skilled workforce that can drive innovation, economic growth, and societal progress.

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<sup>2</sup> <https://www.digitaldevelopmentpartnership.org>

## CONCLUSION

Our investigation into the topic of digital readiness in the education sector has led to several significant findings. The rise of digital technology has fundamentally transformed the way we work, learn, and interact, a transformation accelerated by the COVID-19 pandemic. As a result, digital skills are now a prerequisite for a wide range of jobs, not just those traditionally associated with technology.

These skills encompass a broad range of abilities, from basic digital literacy, such as the ability to use digital devices and navigate the internet, to more advanced skills like coding, data analysis, and digital design. They also include 'soft' digital skills, such as the ability to find and evaluate information online, to communicate effectively in digital contexts, and to understand issues related to online privacy and security.

The demand for digital skills is driven by several factors such as the proliferation of digital technologies into all aspects of our life, the creation of new jobs and industries, and the importance of digital skills for non-digital jobs. However, while the demand for digital skills is increasing, there is a significant gap between the skills that workers have and the skills that employers need. This 'digital skills gap' is a major challenge for businesses and economies, and it is a key focus of policy and research.

The future labour market is likely to be characterized by a shift towards roles requiring digital and soft skills, an increase in demand for green jobs, and increased flexibility in working arrangements. However, the exact nature of these changes remains uncertain and will be influenced by a range of factors, including technological developments, policy decisions, and societal trends. As such, it is crucial to continue monitoring and researching these trends, and to engage in informed and inclusive policy debates about the future of work.

## RECOMMENDATIONS FOR IMPROVING TECH READINESS AND BRIDGING THE DIGITAL SKILLS GAP

Addressing the digital skills gap requires a comprehensive approach that involves collaboration between various stakeholders, including educational institutions, policymakers, industry leaders, and individuals themselves. The following strategies can be implemented to bridge the digital skills gap and ensure that

individuals are equipped with the necessary competencies to thrive in the digital economy.

1. **Relevant and Adaptive Curriculum:** Educational institutions play a vital role in preparing individuals for the digital workforce. They need to develop curriculum and learning programs that are relevant to the changing needs of the labour market. This involves integrating digital skills training across disciplines, incorporating emerging technologies into the curriculum, and promoting hands-on learning experiences. Additionally, institutions should adopt adaptive learning methodologies that personalize education to meet the unique needs and learning styles of students.
2. **Industry-Academia Collaboration:** Collaboration between academia and industry is crucial to bridge the digital skills gap effectively. Educational institutions should establish partnerships with industry leaders to gain insights into the latest technological advancements, industry trends, and future skill requirements. This collaboration can help ensure that the education provided is relevant and aligned with the needs of the labour market.
3. **Leveraging Emerging Technologies in Education:** Emerging technologies such as AI, AR, VR, and blockchain are playing a pivotal role in reshaping the landscape of education. These technologies can personalize learning experiences, provide real-time feedback, automate administrative tasks, create immersive learning experiences, and enhance the transparency and trustworthiness of educational credentials. Therefore, integrating these technologies into the education system can significantly enhance tech readiness and bridge the digital skills gap.
4. **Promoting Lifelong Learning:** The digital skills gap is a dynamic problem that evolves with the pace of technological change. As new technologies emerge, the skills that are in demand can change rapidly. This means that digital skills training needs to be an ongoing process, rather than a one-off event. Promoting a culture of lifelong learning can help individuals keep up with the rapid pace of technological change and continuously update their skills throughout their careers.
5. **Improving Access to Digital Infrastructure and Devices:** Access to digital infrastructure and devices is a prerequisite for developing digital skills. Policymakers should work towards ensuring that all individuals, regardless

of their socio-economic status, have access to reliable internet and digital devices. This can involve investing in digital infrastructure, providing subsidies for low-income households, and implementing digital inclusion programs.

6. **Enhancing Digital Literacy Skills:** Digital literacy skills are the foundation upon which other digital skills are built. These include the ability to use digital devices, navigate the internet, and understand online safety and privacy. Schools should integrate digital literacy training into their curriculum from an early age, and adults should have access to digital literacy training programs.
7. **Promoting Effective Technology Integration in Teaching and Learning:** Technology can be a powerful tool for enhancing teaching and learning, but only if it is used effectively. This requires teachers to have the skills and knowledge to integrate technology into their teaching in meaningful ways. Professional development programs should provide teachers with training on effective technology integration, and schools should provide support and resources to facilitate this integration.
8. **Policy Interventions:** Policymakers have a crucial role to play in addressing the digital skills gap. This could include policies to promote digital inclusion, to support the development of digital infrastructure, and to facilitate the recognition and validation of digital skills. Policymakers also need to work closely with industry to ensure that training programs are aligned with the needs of the labour market.

As we navigate further into the digital age, the importance of tech readiness and digital skills in the education sector becomes increasingly apparent. The digital skills gap is a dynamic challenge that evolves with the pace of technological change. As new technologies emerge, the skills that are in demand can change rapidly. This underscores the need for education systems to adapt and equip students with the necessary digital skills to meet future labour market demands.

The integration of digital skills into the curriculum is not just about teaching students how to use technology, but also about helping them understand how digital technologies are transforming industries and what skills they will need to succeed in the future labour market. It's about preparing students for a world

where digital skills are becoming increasingly important for a wide range of jobs, not just those traditionally associated with technology.

The case studies presented in this report provide valuable insights into the successful implementation of digital skills training programs in various educational settings. They highlight the potential of such programs to enhance education, prepare students for the digital world, and promote digital inclusion. They also underscore the importance of a comprehensive and adaptable approach to digital skills training, one that incorporates both technical skills and digital literacy, and that is tailored to the specific needs and contexts of different educational institutions and learners.

In addition to the above, it's important to note that the future labour market is likely to be characterized by a shift towards roles requiring digital and soft skills, an increase in demand for green jobs, and increased flexibility in working arrangements. However, the exact nature of these changes remains uncertain and will be influenced by a range of factors, including technological developments, policy decisions, and societal trends. As such, it is crucial to continue monitoring and researching these trends, and to engage in informed and inclusive policy debates about the future of work.

The role of digital skills in future labour market demands is a multifaceted issue that warrants a thorough discussion. The rise of digital technology has fundamentally transformed the way we work, learn, and interact. This transformation has been accelerated by the COVID-19 pandemic, which has necessitated a shift towards remote work and digital communication. As a result, digital skills are now a prerequisite for a wide range of jobs, not just those traditionally associated with technology.

Thus, addressing the digital skills gap is a complex task that requires ongoing effort and collaboration between various stakeholders. However, with the right strategies and initiatives, it is possible to bridge the digital skills gap and create a workforce that is ready for the digital future. The journey towards digital readiness in the education sector is a challenging yet rewarding one, and it is a journey that we must embark on together.

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