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DS4AIR

DIGITAL SKILLS FOR THE AI REVOLUTION

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LITERATURE REVIEW





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Contact Information

Coordinating Institution: B&P Emerging Technologies Consultancy Lab Ltd (Malta)

Email: mail@emtech-lab.com

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Project Brief

The global workforce is today facing a critical period of jobs and skills instability. With a big portion of today's jobs set to disappear or become displaced by AI, robotics and automation, the world today requires a human workforce which possesses proficient digital skills. Pursuant to such predictions, the WEF has recently launched the 'Reskilling Revolution', aimed at providing better education, new skills and better work to a billion people by the year 2030. The DS4AIR project supports innovation through the design, development and evaluation of an online training course on Digital Skills in view of the Artificial Intelligence (AI) Revolution. This is aimed at improving and extending the reskilling of vulnerable adults in the workforce who possess a lower level of knowledge and digital competencies. Consequently, this will future-proof their careers vis-à-vis the anticipated shift and demands in digital skills.

In line with the WEF's initiative and as a proactive (rather than a reactive) measure, the project's objectives are:

- to establish the current state of affairs in the business industry in terms of AI readiness
- to identify the gaps between the required new digital skills and competencies and the demands of the labour market, in view of the Artificial Intelligence Revolution
- to create a learner persona defining the course's target audience
- to design and develop an online self-paced training course on digital skills for the Artificial Intelligence Revolution
- to reskill vulnerable adults whose jobs are threatened by the new technologies, hence ensuring their survival and prosperity in the job market
- to analyse the quality and impact (including the degree of satisfaction) of the course through a summative evaluation of the content and instructional design, vis-à-vis the expected learning outcomes
- to write a short recommendations document on digital skills for corporate training in the Artificial Intelligence Revolution

In terms of the project's expected impact, it is envisaged that the results will yield a high-quality digital learning environment, based on the needs and requirements of vulnerable adults in today's workforce. It is also expected that the digital competence of participating adults, will be enhanced, thus improving their careers prospects. Participating businesses will be equipped in terms of skilled labour to embrace the disruption brought about by emerging technologies and better placed to understand, assess and act upon the reskilling requirements posed by the foreseeable skills mismatch brought about by the Artificial Intelligence Revolution. In terms of the potential longer-term benefits, the online training course will become a valuable open education resource for re/upskilling for businesses and interested individuals around the world. Furthermore, the resulting recommendations document on digital skills for corporate training in the Artificial Intelligence Revolution will complement the Pan-European policy efforts in the popularisation of digital competencies, by providing evidence-based practice for future guidelines.



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1. Introduction

The global workforce today is facing a critical period of job and skill instability. Oxford University researchers claimed that 47% of jobs in the USA would disappear in the coming years (Benedikt & Osbourne, 2013). This position was further supported five years later in the Future of Jobs report (World Economic Forum, 2020), which expected that 75 million jobs would be displaced by Artificial Intelligence (AI), robotics, and automation, but also suggested that 133 million new jobs may be created as an outcome of the shift in work between humans and machines. The net 58 million new jobs will require a human workforce in possession of proficient digital skills. This is also in line with Cedefop's 'Digitalisation, AI and the future of work' project (Cedefop, 2020), which aims at evaluating the impact and drivers of digitalisation and automation, on the ever-changing labour market, in particular the skills needs and mismatch resulting from the evolution of digital technology.

Pursuant to such predictions, the World Economic Forum (WEF) launched the 'Reskilling Revolution', aimed at providing better education, new skills, and better work to a billion people by the year 2030. This strategy reflected the UK Government's industrial strategy to develop a digitally capable workforce. It predicts that "within two decades, 90% of jobs will require some digital proficiency, yet 23% of adults lack basic digital skills" (JISC, 2018).

As a result, this project will support such innovation by designing and developing an online digital skills training course in response to the AI revolution by considering digital skills and competencies in three parts:

- Workforce
- Marketplace
- Artificial Intelligence

By investigating the skills and competencies needed across these three areas, this project will then focus on where they converge with a view to developing an online training course to improve opportunities for all three strands. Consequently, we will:



- Consider AI and its impact across market sectors so vulnerabilities can be identified, and businesses can react in advance of the full impact of those vulnerabilities;
- Define the skills and competencies required by the market sectors and workforces so they can be used to develop a training plan in anticipation of AI's impact;
- Prepare businesses, so they are ready for any transformational and cultural changes required because of the use of AI in their sectors;
- Develop training programmes for organisations and workforces to upskill and reskill staff in advance of a shift in worker profile resulting from the use of AI in the workplace; and
- Use the same AI that is causing the need to re-train to develop learning experiences as a cutting-edge example of how to prepare for changes in workforce and market profiles.



2. Skills and Competencies

2.1 Defining Skills and Competencies

Skills are defined as the specific learned abilities needed to perform a given job well (McNeill, 2019). Competencies, on the other hand, are the person's knowledge and behaviours that lead them to be successful in a job (McNeill, 2019). For the purposes of this literature review, skills will be presented as hard measurable skills, while competencies will be considered soft skills. This position will be key when referencing research in this area, as the definitions are inconsistent across the spectrum of literature pertaining to the topic. For example, the WEF's Future of Jobs report (World Economic Forum, 2020) references the adoption of new technology and advancement of AI technology-related skills as key to positive growth, while it also refers to a need to develop "non-cognitive soft skills" such as creativity, critical thinking, and persuasion as another part of the '2022 skills equation' (World Economic Forum, 2020, p. ix). Using McNeill's (2019) position, those hard technology-related skills will continue to be identified in this review as skills, while the 'human' soft skills will be considered competencies.

Similarly, the DigComp 2.0 Competency Framework combines skills and competencies, including literacy, numeracy, and "transversal skills such as critical thinking, problem-solving and learning to learn" (Vuroikari et al, 2016, p2). A distinction will be made moving forward so that literacy and numeracy are considered measurable "learned abilities", i.e. skills, whilst transversal skills are knowledge and behaviours, i.e. the competency to transform oneself to adapt to the cultural and technological position of an employer and the marketplace. These competencies will be key when considering how to adapt to the changing needs in the global economy because of the rise of AI. This view is in line with the European Commission's Policy on Artificial Intelligence (2020) when preparing for socio-economic changes brought about by this technology. Examples include supporting digital skills and competencies in Science, Technology, Engineering and Mathematics (STEM), entrepreneurship, and creativity while also modernising member states' education and training systems to be more proactive than reactive when considering opportunities in AI development.

This distinction between skills and competencies is also critical for the workforce when considering their value in a marketplace and global economy, which is evolving due to progress in technology in general but also AI specifically. “Because AI can process information, recognise patterns, and solve complex problems far more quickly than humans can, experts believe that the most at-risk roles are those involving repetitive tasks, number crunching, and basic literacy” (Heffernan, 2020). In contrast, because of “the rise of AI, soft skills such as creativity and emotional intelligence have increased in value” (Brynjolfsson & Andrew McAfee, 2015). By defining and assessing skills and competencies in the workforce, staff will be better informed when positioning themselves for new career opportunities arising from the implementation of AI in the global economy. Skills will include those needed in the development, application, and maintenance of an AI-enabled industry, but will be restricted if imagination, creativity, and solution-driven problem-solving competencies are ignored when considering future uses and applications of AI, as it becomes integral to markets and sectors other than those being considered in today’s economies. In other words, the application of hard skills will be suffocated unless adaptability, critical thinking, emotional intelligence, and communication competencies are developed in parallel so new applications and benefits of AI can come to fruition in a 21st-century landscape.

2.2 Broad Categorisation of Skills and Competencies

DigComp 2.1 (Carretero Gomez, Vuorikari, & Punie, 2021) identified skills and competencies for all citizens. However, based on the definitions outlined earlier, they can be sub-divided as:

- Skills, such as information and data literacy, e-safety and digital content creation
- Competencies, such as communication, collaboration and problem-solving

This categorisation is mirrored in other definitions and approaches. For example, South Eastern Regional College defined the transversal skills being developed through its own project-based learning (PBL) initiative as being made up of 8 skills: self-management, working with others, citizenship/participating in society, work professionalism, problem-solving and decision-making, numeracy, digital literacy, communication and literacy. Similarly, Battelle for

Kids (2019), the Partnership for 21st Century Learning, created its own framework as part of its drive to embed 21st century skills development into learning. These included critical thinking, collaboration, communication, creativity, technology literacy, and social-emotional development (Battelle for Kids, 2019). The North Central Regional Educational Laboratory (NCREL) and Metiri Group's (2003) report on 21st century skills also focused on the demands of the digital age, much like this project's focus on developing digital skills due to the demands and developments within AI. They considered literacy, inventive thinking, effective communication, and high productivity as core to their research findings.

2.3 Skills and Competencies in the Workforce

While debate could continue as to what these skills and competencies are called and what elements lie within them, the 21 SMART elements within the DigComp 2.1 framework are fit for purpose within this project (Carretero Gomez, Vuorikari, & Punie, 2021). These clearly outline expectations for workforce change, marketplace change, and skills and competencies needed when AI is considered a catalyst for change within society, the economy, and the environment. DigComp 2.1 has also demonstrated a reproducible method in which each element can be scored by an individual so a digital profile can be produced based on skills and competencies, forming the basis for survey development (Carretero Gomez, Vuorikari, & Punie, 2021).

Personal development plans (PDP) can then be developed with a view to upskilling or re-training the workforce in response to the shift in skills and competencies needed because of AI's influence in industry. For example, it is estimated that the demand for basic cognitive skills, such as data input or word processing will fall by 19% in the USA and 23% in Europe (Heffernan, 2020). On the other hand, "higher-order cognitive skills such as creativity and critical thinking will see a 19% increase in demand in the USA and a 23% increase in Europe", so "workers, for their part, have to be strategic and aim for the jobs least likely to be overtaken by robots or other machines" (Brynjolfsson & McAfee, 2015).

2.4 Broad Categorisation of Skills and Competencies in the Workforce

Although much of the relevant literature discusses ‘digital skills’, this term is used as a shorthand to mean skills, knowledge, behaviours, attitudes, competencies, capabilities, character traits, and more. These so-called ‘21st-century skills’, which can be grouped under a cognitive, intrapersonal, and interpersonal domain (Marzano & Heflebower, 2012), can be further broadened into soft and hard skills. For example, soft skills (competencies) include:

- Creativity;
- Persuasion;
- Collaboration;
- Adaptability; and
- Emotional intelligence

On the other hand, hard skills include, but are not limited to:

- Cloud computing;
- Analytical reasoning;
- Artificial Intelligence;
- UX design;
- Business analysis;
- Affiliate marketing;
- Sales;
- Scientific computing; and
- Video production

Relevant literature discusses the need to equip the future workforce with skills for hybrid jobs, combining soft (competencies) and hard skills. Consideration therefore needs to be given as to what this hybridisation means.

2.5 Hybridisation – Soft Skills vs Hard Skills

Although the elements of the DigComp 2.1 framework (Carretero Gomez, Vuorikari, & Punie, 2021) are distinct, allowing for personal profiles to be written with a view to developing a personal development and training plan, they are all part of the whole product. Burning Glass Technologies (2019) reported that the skills that drive hybridisation fall into five key areas. While some are considered new skills, others are traditional skills being applied in new ways:

- Big data and analytics;
- The intersection of design and development;
- Sales and customer service;
- Emerging digital technologies; and
- Evolving compliance and regulatory landscape.

This approach appears to put a greater emphasis on skills over competencies in contrast to other models, so the balance between them must be considered. For example, workers in traditionally soft-skilled jobs may benefit from cultivating the hard skills that will show employers that they are equipped to keep pace with technological developments in their sector. In contrast, job seekers and employees in technology-oriented and specialised jobs can distinguish themselves by enhancing the soft skills that will enable them to add value beyond the narrow applications of technology.

The COVID-19 pandemic provides parallel examples. Teachers are now facilitators and digital creative developers so they can support their pupils and students online, while small traditional businesses have had to develop the skills needed so they have an online presence and survive in the COVID-19 economy. In contrast, technologically-driven industries have had to develop their people skills (competencies), so they can compete with traditional industries who have built their products and reputations on relationships, teamwork, and customer service.

2.6 Culture of the Organisation and Transformational Change

As argued by the European Commission in the European Skills Agenda (European Commission, 2016), the development of skills and competencies needs to be at the core of any personal and organisational drive. It is no longer enough to be offered opportunities in a fast-changing economy: fast-changing due not only to the change in technology and the opportunities it provides, but also the change in customer and marketplace expectations on what quality products and service mean, as demonstrated during the COVID-19 pandemic.

This culture starts with a shift from managing personal and corporate development to leading it. It is no longer enough to be content with keeping things running smoothly. A change is needed that will inspire individuals and organisations to define what their future will look like and will give them the strength and opportunity to make that happen. This means that they are to plan and implement their digital skills and competencies development by being proactive rather than reactive (European Commission, 2016). With this in mind, the research and development of a personal and corporate development plan can go further by using reflective questioning, which adopts a three-layer approach (Ilkka, 2018): cultural, cognitive, and behavioural. This would then provide all stakeholders with added insight into which aspects of their roles could be impacted by AI, not just which are being impacted now.

In summary, the Chartered Institute of Personnel and Development (CIPD) define CPD as “a combination of approaches, ideas and techniques that will help you manage your own learning and growth” with a focus on results (CIPD, 2019). This means that developing a framework which aligns with the agreed common skills and competencies for workforces, markets, and AI impacted industries is key (European Commission, 2016). In this way, they can measure themselves against it and choose training units/modules from an AI-inspired learning suite, which aligns to the same framework so they, in turn, overcome any shortfalls and obstacles in shaping their vision of their place in an AI-driven future.

3. Artificial Intelligence, the AI Revolution and AI Readiness

3.1 Understanding Artificial Intelligence

AI is a multidisciplinary area of study which seeks to create intelligent machines (Dwivedi et al, 2019; Russel & Norvig, 2002). The term itself is composed of two words, ‘artificial’ and ‘intelligence’. The word ‘artificial’ implies that it is something created by humans. On the other hand, ‘intelligence’ is more difficult to define as there is no universal agreement on what it entails. However, when we view intelligent behaviour, we tend to recognise it immediately and thus, we define intelligence in terms of association (Warwick & Shah, 2016). We consider a machine to be smart if it performs a function that only an intelligent organism (such as a human) or group of organisms (such as bees) (Johnson, 2002) can achieve. In synthesis, AI is that field of study which creates machines which exhibit intelligent behaviour (Dignum, 2018). The benefits of AI are various, and its capabilities are far-reaching. It can be as simple as coordinating climate control (Ngarambe, & Santamouris, 2020) in a building, up to the complexity of automatically managing a nuclear power plant (Sozontov, Ivanova & Gibadullin, 2019). Many therefore consider AI as a horizontal area of study which can quickly transform practically any other field of study. Davenport (2018) cited the benefits of AI to include the automation of various functions, the optimisation of different processes, and the prediction of future events with an accuracy which, in most cases, is much better than any human can achieve.

AI can add value to any organisation (Burgess, 2017). If the organisation retains significant amounts of data, AI can quickly process dual processes and help automate repetitive tasks which might be too tedious or, in some cases, hazardous for humans. An AI system is exact in its work; it does not suffer from boredom or experience fatigue. Furthermore, it can predict future trends and is capable of handling large quantities of data. However, the disadvantages of such a system must be considered. First, from a financial perspective (Davenport & Ronanki, 2018), AI requires an initial capital investment. However, once operational it is easy to maintain and likely to realise a rapid return on investment. Second, the deployment of an AI system will most probably affect the people working in organisations (Bruun & Duka, 2018;

Korinek & Stiglitz, 2017). Some staff may lose their jobs, whilst others may need to be reskilled to learn how to perform different tasks with the assistance of an AI system.

AI is also a very mature technology (Alsheibani, Cheung & Messom, 2019), with it having been implemented in almost every device we use. However, the use of AI in common devices is not often recognised by users, and, as such, consumers are not aware of all the different AI systems they use in their day-to-day lives. The following are some examples:

- Google search – AI sifts through millions of documents to locate the information required
- Facebook – AI decided the posts which are visible to the user
- An AI system manages climate control inside a car
- Ovens use an AI system to automatically adjust the cooking temperature
- AI powers spam filters in email client systems

3.1 The impact of AI in the Workplace

AI is a multidisciplinary area of study which seeks to create intelligent machines (Dwivedi et al, 2019). The impact of AI in the workplace is undeniable, as highlighted in the WEF report (2020). However, it is important to note that AI will not necessarily replace entire jobs; rather, it will replace specific tasks. AI has already started replacing certain routine tasks, and this is expected to continue accelerating in the coming years. In fact, according to the WEF, in 5 years, automation will account for more than 50% of the tasks in existence. There are four scenarios which we should consider: caring jobs and creative professions will not be greatly affected by AI because AI is still not competent at these tasks. However, other jobs will become obsolete. These include drivers (because of the rise of self-driving cars) and factory workers (because of automation). On the other hand, new, non-existent jobs will be created. This could include professions such as organ creator (Arai & Nakayama, 2021; Seok et al, 2021), whereby people will create new human organs, for example, hearts, kidneys, or livers, to replace defective ones and drone flight controllers (Lubrano, Guittet & Mihalachioiu, 2020). However, many existing jobs will change as AI technologies increasingly assist employees in

their duties, thus having a huge effect on the industry. The impact could be as small as helping supermarket staff identify expired products (Patil et al, 2020) or as large as assisting a surgeon during an operation (Wall & Krummel, 2020).

This will not be an easy task, nor will it be a short-term process. Organisations will need to develop strategies to guide them through an AI Transformation Process (AITP), following several well-defined steps. First, it is important to begin by educating individuals about AI. The education process must be driven by senior leaders in communication with staff at all levels of the organisation to mitigate resistance to change and fear of losing their jobs. Second, an AI Readiness Audit ascertains the state of the organisation with regard to adopting AI. After this, a consultation process with all the stakeholders will identify potential short-term AI projects that are essential for the organisation to determine effectiveness and impact. These projects are then prioritised based on feasibility, investment, and potential return. Whether they are implemented in-house or outsourced depends upon the complexity of the project and the expertise available in the organisation. However, AI experts should be used to managing and overseeing the running of the projects. When a project finishes, another more ambitious project is then selected and executed. The cycle continues until the organisation manages to augment its processes with AI. The length of time required to complete such projects depends on its complexity and the many variables to consider, such as what data is available, the quality of the data, the volume of data available, which algorithm to use, identifying the best approach to deploy such systems, what training is required, and many more. An initial pilot project with minimal complexity will most likely take several months. The cycle will then be repeated.

Successful AI projects need people with relevant technical and professional skills. Small businesses are unlikely to have in-house talent and cost would make it prohibitive to engage someone just for a specific project. However, larger organisations may employ IT staff but may not have the required level of skill, required guidance and support. AI graduates or an AI expert overseeing software developers would suffice. The main benefit of engaging an AI expert is not only because of their expertise but also, since AI is a fast-moving field, because the expert



will be able to guide businesses on the use of the most cutting-edge techniques. It is essential that whoever is engaged understands AI and has experience in AI systems since these programs are different from standard software. The central element is the learning part, which goes beyond the available data but which tries to theorise to include unforeseen situations. Our future home and work lives will be transformed as AI continues to help people solve problems effectively. Most probably, computers will become more ubiquitous (Kumar & Paiva, 2020). Large desktops will disappear, and everyday devices will contain AI processors. Information will flow beyond the screen, and AI agents will roam between smart surfaces such as tables or even walls. Tasks will migrate between services seamlessly, thus making work pervasive. The manipulation of data will be simplified, and connected through the Internet of Things (IoT) devices. The future is an interconnected one: powered by AI but with people at the centre. As Malcolm X once said, “the future belongs to those who prepare for it today”. Some people are already dreaming and engineering the solutions of tomorrow. The technology is ripe, we have the processing power, and there is finally the political will to embrace the AI revolution. The President of the European Council, Ursula von der Leyen, declared in 2020 that this decade is going to be the digital decade of Europe. It is only a matter of time before AI becomes the norm, as common as electricity. So, organisations need to take the first step and learn about AI and the key benefits involved.

4. Thriving in the Artificial Intelligence Revolution

4.1 Digital Skills for the Artificial Intelligence Revolution

Acquiring new skills and competencies is not a new phenomenon. Humans have acquired new skills and competencies throughout history but are now facing dramatic and complex changes. Reskilling and upskilling are needed now more than ever. As early as 1967, the legendary Peter Drucker wrote about the “manager and the moron”, cf. (Drucker, 1967). The ‘moron’ here was the computer, and Drucker intelligently argued that, “we are beginning to realise that the computer makes no decisions; it only carries out orders. It’s a total moron, and therein lies its strength. It forces us to think, to set the criteria.

‘Setting the criteria’ also applies to digital skills and competencies in the AI revolution era. We need to understand and define what AI does best and what humans do best. In fact, one might argue that it is a simple question of the division of labour. The competencies which learners need to develop to succeed also need to be considered. Fadel, Bialik, and Trilling (2015) developed a four-dimensional educational approach, which in many ways supplements and enhances the DigComp 2.1 model (Carretero Gomez, Vuorikari, & Punie, 2021). According to Fadel, Bialik, and Trilling (2015), the future competence set is comprised of:

- Knowledge – what we know and understand;
- Character – how we behave and engage in the world;
- Skills – how we use what we know;

And finally, the all-encompassing competence:

- Meta-learning – how we reflect and adapt

AI impacts us in several ways and Luckin, Holmes, Forcier, and Griffiths (2016) and Holmes, Bialik, and Fadel (2019) operationalised how we might use AI in this regard. They suggested the following categorisation of how we learn and thus subsequently work with AI.

- Learning with AI – the contribution of AI when learning a specific subject;
- Learning about AI – how AI is built; and
- Learning for AI – learning to live with AI as a natural part of our lives.



The fourth series of reflections that need to be considered is how the division of labour between AI and humans should evolve. Colson (2019) wrote about different types of decision-making processes and suggested a model which presupposes that humans do not interface directly with the sea of available data, but instead use the possibilities of, firstly, Big Data, secondly AI, and thirdly, the possible actions suggested by all parties. Based on that, the final decision is made by the human. This overall understanding of how decisions are made also impacts the discussion of the skills and competencies needed in an AI era. We need to be able to not only understand the possible actions, but also sort, prioritise, and evaluate those possible actions and understand their ethical implications. All of these skills, sometimes referred to as data literacy and data visualisation, are in high demand and something on which we need to focus, and in a collaborative manner. Wilson and Daugherty (2020) talk about ‘Collaborative Intelligence’ and make a very strong case for how humans and AI are or could be, working together. To work together with AI, humans need to do new and different things as well as do things differently. That, however, maybe the biggest change we need to face.

5. Conclusion

In summary, in addressing the necessary digital skills in view of the AI Revolution, four fundamental questions need to be considered. These are:

- What are the digital skills and competencies, so that employers and employees alike understand the meaning and potential impact on their jobs and markets?
- What is AI, and what is its impact on markets and workforces?
For example, a manager may consider this as a more strategic question in advance of planning training and development for the team, whereas an employee may see this as a personal view on how their job could change and how they should reskill in advance of this potential change.
- What is the importance of upskilling and reskilling considering the need to promote top-down and bottom-up cultural drives in being AI-ready?
- Which digital skills and competencies are important to participants? Why are they important? When, how, and to whom are they useful?

As discussed in this review of literature, the digital skills and competencies that we need to focus on include the following non-exhaustive list:

1. Information and data literacy – the ability to understand and work with data;
2. Digital Safety – the ability to work safely with data and online, regardless of devices, while considering well-being, inclusivity, and environmental impact;
3. Digital Content Creation – the ability to visualise and understand visualised data;
4. Communication and Collaboration – the ability to work in a team synchronously and asynchronously; and
5. Problem-solving – the ability to engage across teams to address the needs of the team, marketplace, and customer, as well as identify gaps for potential improvements.

These same five elements can be further developed to include the following, as a result of how AI will influence them:

1. AI literacy – the ability to learn and work with AI;
2. AI ethics or character – the ability to use AI safely, ethically, and for the benefit of society;
3. AI skills – the ability to design and train AI, e.g. to be able to build an AI and create the necessary content required for its operation;
4. AI-human interface – the ability to communicate and collaborate across man-machine interfaces, including clear definitions of the roles of each; and
5. AI problem-solving – the ability to critically review AI solutions to the benefit of the team, users, markets, and customers.

Without these considerations, the workforce will be able to neither unleash its own potential nor critically determine or influence its own path and development in a 21st-century economy, placing more emphasis on a workforce's soft skills regardless of the marketplace. This conclusion leads to the question of how the workforce should be retrained. In addition to existing continuous professional development possibilities in the established higher education system, a systematic and focused retraining effort should be offered to the general workforce who work with what Heffernan (2020) describes as basic cognitive skills; such as data input, word processing, and most kinds of rule-based tasks. In fact, a very large proportion of today's workforce may require basic digital retraining.



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