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Vocational Education 4.0 for Future Skills

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Abstract

Globalization, demographic shifts, and technological advancements are key drivers of contemporary change, shaping the trajectory of the world ahead. This rapid change brings with it uncertainty and imposes pressures on financial, environmental, and social fronts. To navigate this evolving landscape, both the realms of work and education must transform uncertainty into opportunity, complexity into clarity, and problems into potential. This necessitates a redefinition of essential skills for the future, with a focus on continuous education and training systems to equip the workforce with the necessary competencies. While educational institutions have endeavored to incorporate new skill sets into their programs, there remains a gap between graduate competencies and the demands of the workforce. The skills required in the future differ significantly from those of previous generations, presenting challenges in anticipating the needs of tomorrow's graduates and the evolving job market.

Keywords: *Vocational Education, Future Skills, Job, Market*

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Introduction

A survey conducted in 2023 among 19,500 workers in the Asia Pacific region highlighted six factors influencing their employability skills: business viability, employee sentiment, workforce skills, emerging technology, work environment, and climate action. The findings of the survey revealed four key points [1]. Firstly, both employees and company leaders anticipate that organizations failing to adapt will struggle to survive beyond a decade. Secondly, while workers expect significant changes in the skills required for their jobs in the coming years, they lack clarity on which specific skills will evolve. Thirdly, adaptability, collaboration, and critical thinking skills are deemed more crucial than technical expertise. Lastly, there's a widespread belief that Artificial Intelligence (AI) will enhance productivity and efficiency in workplaces. These findings align with a previous survey by the Economist Intelligence Unit sponsored by Google in 2015 [2], which identified problem-solving, teamwork, communication, critical thinking, and creativity as the most sought-after skills in the workplace. Similarly, the World Economic Forum's 2023 report listed analytical thinking, creativity, resilience, flexibility, motivation, technological literacy, dependability, empathy, leadership, and quality control as the top ten skills.

Considering these skill requirements, what impact will they have on vocational education graduates entering the job market? Vocational education is designed to prepare individuals with the necessary skills to work independently or within a specific field. Its goal is to provide practical skills and knowledge relevant to both work and everyday life. The curriculum typically includes a mix of general knowledge and industry-specific training. For vocational education to remain effective, it must ensure that the skills taught are adaptable and applicable to various job contexts. How does vocational education ensure its graduates are equipped to meet future challenges in a rapidly changing job market? The answer lies in transformation. Adapting to change is essential for the ongoing success of vocational education, as its future depends on its ability to evolve.

A World Bank analysis of the relationship between vocational education and the labor market in Indonesia[4], focusing on demand trends, gaps, and supply, revealed shortcomings in the country's vocational education system. It was found that the system fails to meet the needs of industries and employers, with deficiencies observed in areas such as teacher qualifications and industry-relevant training programs. Initially, it was deemed financially unfeasible to heavily invest in vocational systems at the expense of general education systems. However, recent research contradicts this perspective. Modern sectors like manufacturing, tourism, finance, and healthcare increasingly seek skilled graduates from vocational schools. Indeed, data on formal sector employment and wage premiums indicate that graduates from vocational high schools outperform their counterparts from general high schools [8]. This data underscores the high employability skills of vocational school students [20], which encompass communication, teamwork, problem-solving, initiative, planning, self-management, learning, and technology proficiency.

Data from the 2015 Indonesian Labor Force Survey (Sakernas) confirms that vocational school graduates generally earn slightly higher salaries compared to high school graduates (see Table 1). With the implementation of the ASEAN Economic Community [5], it is anticipated that the mobility of skilled and educated workers will increase. Indonesia is also taking steps to enhance vocational education standards. However, one notable weakness of the formal vocational education system is the limited number of teachers with relevant job qualifications and practical work experience, especially in comparison to those with academic degrees (bachelor's or master's)[6]. Moreover, vocational schools often lack up-to-date laboratories and equipment. This inadequacy indicates that the quality of vocational education is not sufficiently assessed by accreditation standards, which are typically similar to those of general high schools [7].

Table 1. Ratio of Secondary and Tertiary Graduates' Earnings to Primary Graduates' Earnings, 2005–2015

Level of Education attainment	2005	2015
General junior secondary school	1.23	1.21
Vocational junior secondary school	1.70	1.51
General senior secondary school	1.72	1.62
Vocational senior secondary school	1.92	1.69
College (1-2 years)	2.25	2.23
Junior college (3 years)	2.51	2.40
University	2.95	3.10

Source: Calculated from Indonesian Labour Force Survey (Sakernas)

The majority of vocational education graduates feel that their school experiences have equipped them with the necessary skills for transitioning into the workforce. Nonetheless, many companies express dissatisfaction with the skill levels of job

applicants. This discrepancy negatively impacts company productivity and performance. Effective vocational education is anticipated to address this issue by ensuring students acquire skills aligned with future demands.

The inadequate skills of vocational school graduates highlight the perceived ineffectiveness of the current learning methods in keeping pace with the rapid and continuous changes in the world. Educators must constantly consider that what they are imparting today will equip students for the challenges of tomorrow, enabling them to carve out their own futures. Therefore, it is crucial to prepare students by imparting diverse skills and training tailored to meet future demands. In response to the challenges posed by the Fourth Industrial Revolution, educators can adopt innovative teaching approaches supported by technology to foster creativity and innovation, shaping the future world. Vocational education instructors should focus on nurturing students' potential and fostering self-directed learning to enable them to innovate in the evolving landscape. By understanding the dynamics of the current job market, this paper aims to assist policymakers, managers, teachers, and vocational education students in harnessing their potential to succeed in attaining their objectives.

The Labour-Market Impact of The Fourth Industrial Revolution

Observation in this study involves a data collection technique wherein the direct measurement of river velocity is systematically conducted over a period of 7 days. During this phase, the researcher measures the velocity of the river current using a Water Current Meter, positioned at 3 predetermined locations, and observes the measurement results. Subsequently, the researcher records the findings of the research object conducted over a span of 7 days and 1 hour per location. Measurements are carried out in the morning, afternoon, and evening. The research workflow is presented in Figure 1.

Presently, the labor market is experiencing a profound shift propelled by technological progress and the rise of artificial intelligence (AI), compounded by economic and geopolitical upheavals, and escalating social and environmental stresses. It is imperative to go beyond solely examining technological advancements and acknowledge and tackle the labor market ramifications of various simultaneous trends, such as green and energy transitions, macroeconomic influences, as well as geoeconomic dynamics and alterations in supply chains.

The World Economic Forum 2023 [3] presents ten significant findings. Firstly, economic, health, and geopolitical trends have notably influenced global labor markets, with high-income countries experiencing tight labor markets while low- and middle-income countries continue to grapple with elevated unemployment rates post-COVID-19. Secondly, technology adoption remains the primary catalyst for business transformation over the next five years, with organizations increasingly embracing new technologies and enhancing digital access. Moreover, the widespread implementation of Environmental, Social, and Governance (ESG) standards is expected to exert a considerable impact. Thirdly, environmental, technological, and economic trends have the most substantial influence on job creation and destruction. Fourthly, in terms of technology adoption, big data, cloud computing, and AI stand out as having significant potential for uptake. Fifthly, the majority of technologies are anticipated to have a positive effect on employment in the next five years, with big data analytics, climate change management technologies, and encryption and cybersecurity being key drivers of job growth. Sixthly, employers predict a considerable shift in the labor market structure and disruption of workers' skills, with about 23% expecting changes and 44% anticipating skill disruptions by 2027. Seventhly, six out of ten workers will require training before 2027, although there is pessimism regarding talent availability. Eighthly,

a combination of macro trends and technology adoption will shape fluctuations in employment opportunities, with job growth propelled by technology, digitalization, and sustainability, while roles primarily affected by technology and digitalization are expected to decline rapidly. Furthermore, significant job growth is foreseen in education, agriculture, digital commerce, and trade, while declines are projected in administrative, security, factory, and commerce roles. Analytical and creative thinking remain crucial skills for workers. Ninthly, employer-identified important skills are not adequately addressed in companies' skills improvement strategies. Tenthly, investment in workforce education and training, coupled with process automation, are the predominant strategies employed to achieve business goals.

The Future of Jobs

Following the aftermath of the Covid-19 pandemic, the global landscape is grappling with health, economic, and geopolitical turbulence concurrently, resulting in heightened social and environmental pressures. This surge has reshaped the global labor market, altering the future demand for jobs and skills, thereby influencing the economic structure. Moreover, the advent of the Fourth Industrial Revolution, evolving expectations among workers and consumers, and the imperative for energy and environmental transitions have further transformed the sectoral composition of the workforce and spurred demand for novel jobs and skills. Additionally, global supply chains are compelled to swiftly adapt to mounting challenges stemming from escalating geopolitical instability, economic unpredictability, surging inflation, and escalating commodity prices.

Over the past couple of years, there has been notable fluctuation in the demand and supply of goods and services, primarily due to lockdowns and disruptions in supply chains. As the global economy rebounds, there have been shifts in the distribution of employment across various industries. Consequently, there is a heightened necessity for swift and efficient reallocation of jobs across sectors. The upcoming five years present an opportunity for both the business community and policymakers to leverage the realm of employment to spur economic growth. LinkedIn's research for its 2023 Future of Jobs Report outlines [3] the 100 occupations that have consistently and rapidly grown on a global scale over the past four years, commonly referred to as "Jobs on the Rise."

According to 2018 OECD data [9] and the International Labour Organization (ILO) [10], the Information Technology and Digital Communication sector has witnessed significant growth. This sector's prominence is evident in the fact that Technology and IT occupations constitute 16 out of the 100 Jobs on the Rise, ranking third among all job categories. The top two positions are occupied by Sales Growth and Customer Engagement, followed by Human Resources and Talent Acquisition (Talent Acquisition and Recruitment).

The anticipated influence of technology integration on business evolution and employment, as outlined by The Fourth Industrial Revolution, has blurred the lines between humans and machines across different sectors. While technology is altering our work methods, it is also reshaping job content, necessitating new skill sets, and determining which roles will be displaced [10] Acknowledging the profound impact of technology on the job market, it is imperative to assess whether society can successfully transition from job loss to future employment opportunities [11].

The Future of Jobs Survey [3] also explores the favorable impact of technology adoption on employment, with nearly all technologies anticipated to generate net job opportunities in the next five years. Big data analytics, climate change and environmental management technologies, and encryption and cybersecurity are

forecasted to be the primary catalysts for job creation. Conversely, agricultural technology, digital platforms and applications, e-commerce and digital trade, and AI are projected to significantly disrupt the labor market. Many companies anticipate a redistribution of jobs within their organizations, accompanied by an expansion of employment opportunities elsewhere. AI, in particular, is garnering considerable attention, with 19% of the workforce reporting that half of their tasks are automated by AI. While AI may lead to job displacement, it also has the potential to stimulate job growth.

The survey findings indicate significant growth in occupations such as Agricultural Equipment Operators, Heavy Truck and Bus Drivers, and Vocational Education Teachers (see Figure 1). Conversely, roles such as Data Entry Clerks, Administrative and Executive Secretaries, and Accounting, Bookkeeping, and Payroll Clerks are projected to undergo substantial job reductions.

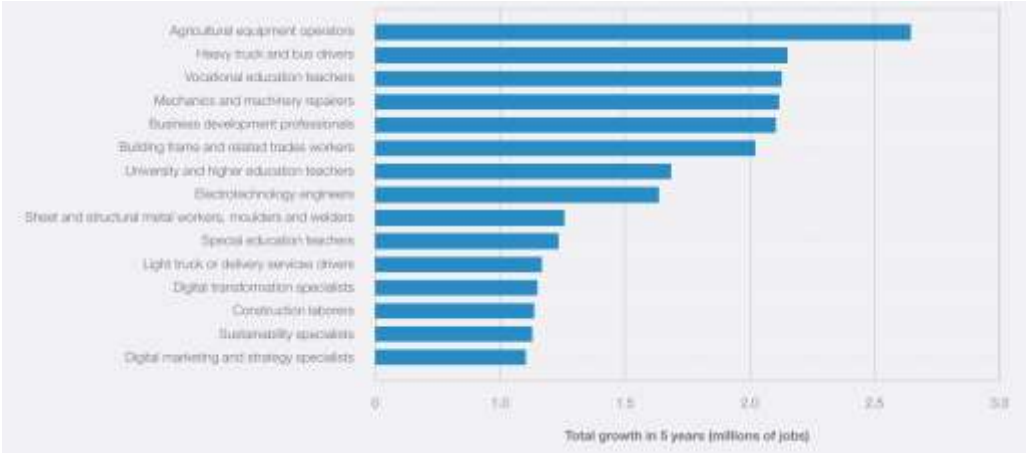

Figure 1. Largest job growth, millions

Source: World Economic Forum, Future of Jobs Survey 2023.

There are seven job clusters exhibiting positive trends and anticipated rapid growth, including: (1) Jobs enabled by digital access and digital trade, (2) Jobs related to energy transition and climate change mitigation, (3) Advanced technology roles, (4) Education-related occupations, (5) Jobs in agriculture, (6) Positions for repairers, factory workers, and laborers, and (7) Jobs in supply chain and logistics. Conversely, seven job clusters are experiencing negative trends and are expected to phase out, namely: (1) Data entry clerks, (2) Administrative and executive secretaries, (3) Accounting, bookkeeping, and payroll clerks, (4) Security guards, (5) Building caretakers and housekeepers, (6) Cashiers and ticket clerks, and (7) Material-recording stock-keeping clerks. The outcomes of The Future of Jobs Survey [3], focusing on skills as categorized by the World Economic Forum's Global Skills Taxonomy[14], provide a prioritized framework for reskilling and upskilling strategies in the 2023–2027 period.

Expected disruptions to skills

a. Core skills in 2023

The core skills highly sought after by workers today primarily encompass analytical thinking, which is regarded as a key competency by more companies compared to other skills. Other cognitive abilities such as creative thinking are also highly valued, followed by self-efficacy skills encompassing resilience, flexibility, and agility. Additionally, motivation and self-awareness, as well as curiosity and lifelong learning, are considered essential attributes. The fourth self-efficacy skill outlined in the

Global Skills Taxonomy, namely dependability and attention, ranks seventh, following technological literacy. The top 10 core skills are further complemented by two interpersonal attitudes – empathy and active listening, as well as leadership and social influence – along with quality control. In contrast, management skills, engagement skills, technology skills, ethics, and physical abilities are generally deemed less critical compared to cognition, self-efficacy, and interpersonal skills.

b. Skill evolution 2023–2027

The business sector's outlook on the evolution of skills among its workforce in the upcoming five years underscores the growing significance of cognitive abilities, particularly in problem-solving within the workplace. Moreover, creative thinking is projected to gain prominence slightly more rapidly than analytical thinking. Technology literacy emerges as the third-fastest-growing core skill. Similarly, self-efficacy skills are increasingly valued for collaborative work and are pivotal in business contexts. Socio-emotional attitudes deemed increasingly crucial by the business community include curiosity and lifelong learning, resilience, flexibility, and agility, as well as motivation and self-awareness. Additionally, systems thinking, AI and big data proficiency, talent management, and service orientation and customer service skills rank within the top ten. Concerning ethical competencies, many companies anticipate that heightened consumer activism on social and environmental issues will likely instigate organizational transformation in the next five years.

c. Reskilling and upskilling priorities in the next 5 years

In response to skills deficiencies, businesses implement training initiatives. As indicated in the Future of Jobs Report [3], nearly half of the workforce has undergone training to address skills gaps. Recognizing the skills gap within the local labor market as a significant impediment to industrial transformation, businesses are prioritizing investment in education and job training as the most effective workforce strategy to attain their business objectives. Consequently, companies are formulating crucial reskilling and upskilling strategies for the next five years to optimize their business performance. Key elements of the company's training strategy for the Future of Jobs encompass analytical thinking, creative thinking, AI and big data proficiency, leadership and social influence, and self-efficacy.

d. AI and big data

While AI and big data are currently positioned as the 15th core skill for widespread employment, they hold the third position in the company's training strategy until 2027. Moreover, AI and big data emerge as the most emphasized skills within various sectors, including Insurance and Pensions, Management, Media, Entertainment and Sports, Information and Technology Services, Telecommunications, Business Support and Premises Maintenance Services, and Electronics industries. In the domain of technology skills, adeptness in utilizing AI tools has surpassed that of computer programming, networking, cybersecurity, general technological literacy, and user design expertise. Over the next five years, AI and big data will constitute over 40% of technology training programs offered by companies in the United States, China, Brazil, and Indonesia. Following closely behind, design and user experience are the next most emphasized technology skills.

e. Attitudes

In various sectors, roughly two-thirds of the skills deemed crucial for workforce enhancement belong to the Skills, Knowledge, and Abilities category outlined in the

Global Skills Taxonomy by the Forum. The remaining third consists of Attitudes, particularly emphasizing socio-emotional skills. Industries like Medical and Healthcare Services, Infrastructure, Consumer Goods Production, Mining and Metals, and Advanced Manufacturing prioritize socio-emotional skills training within the Attitudes group. Meanwhile, "hard" skills, referring to skills, knowledge, and abilities, take precedence in sectors such as Insurance and Pensions Management, as well as in the digital realm encompassing Information and Technology Services and Telecommunications.

Vocational Education Model in The Fourth Industrial Revolution

The future classroom embodies a novel educational paradigm tailored to meet the demands of the Fourth Industrial Revolution. Future vocational education, as outlined in The WEF Education 4.0 Framework, must encompass eight key "critical characteristics" as delineated below. Firstly, it should adhere to a global citizenship skills standard, enabling individuals to actively engage in the global community. Secondly, it should foster innovation and creativity, honing skills in problem-solving, analytical thinking, and creative expression. Thirdly, it should instill technological proficiency, encompassing digital skills, programming, and responsible technology use. Fourthly, it should emphasize interpersonal skills, including emotional intelligence, empathy, and leadership. Fifthly, it should promote personal and independent learning, tailored to individual student needs and pace. Sixthly, it should ensure accessible and inclusive education, granting every individual equitable access to learning opportunities. Seventhly, it should advocate problem-based and collaborative learning, shifting from process-oriented to problem-centric learning models that encourage collaboration among students. Lastly, it should endorse lifelong and student-driven learning, encouraging continuous skill enhancement tailored to individual requirements.

In the context of preparing for the future, emphasis is placed on fostering creativity, critical thinking, problem-solving, and technological proficiency, with a notable focus on interpersonal and socio-emotional aptitudes in their application. This entails cultivating abilities to collaborate, coordinate, and communicate effectively with others. Education plays a pivotal role in readying young learners for this evolving landscape. As the demand for these skills rises, there is a necessity to embrace a comprehensive learning approach that not only encompasses tangible skills essential for economic prosperity but also instills attitudes and values conducive to lifelong learning. This encompasses embracing interpersonal and societal values that foster cohesive and tolerant societies, respecting and upholding institutional integrity, and acknowledging the delicate balance of the natural environment.

The Fourth Vocational Education Taxonomy

The Vocational Education 4.0 Taxonomy presents a thorough framework of talents structured in a hierarchical manner. Talent, as defined here, represents an abstract and transferable aspect of learning, which can be cultivated through instruction rather than being an inherent trait. According to insights from the World Economic Forum [14], prevalent educational taxonomies spanning childhood to secondary education typically categorize talents into three primary groups: abilities and skills, attitudes and values, and knowledge and information (see Figure 2). The Education 4.0 Taxonomy places particular emphasis on the first two categories, in response to indications from experts and entrepreneurs that these areas of learning will require greater attention in future educational systems compared to their current focus. However, traditional knowledge forms and associated learning methodologies retain significance and will continue to have a role in educational content and approaches.

Therefore, the Education 4.0 Taxonomy encompasses the branch of knowledge and information to ensure comprehensive coverage. These three main branches constitute the initial level of the taxonomy, further branching into several second-level subcategories. While the taxonomy maintains a series of mutually exclusive and collectively exhaustive categories at the first and second levels, the concepts discussed at the third level are not exhaustive but represent the talents that Education 4.0 aims to foster. These capabilities have been underscored by literature on the future of work and emphasized through consultations with employers, experts, and organizations dedicated to educational innovation.

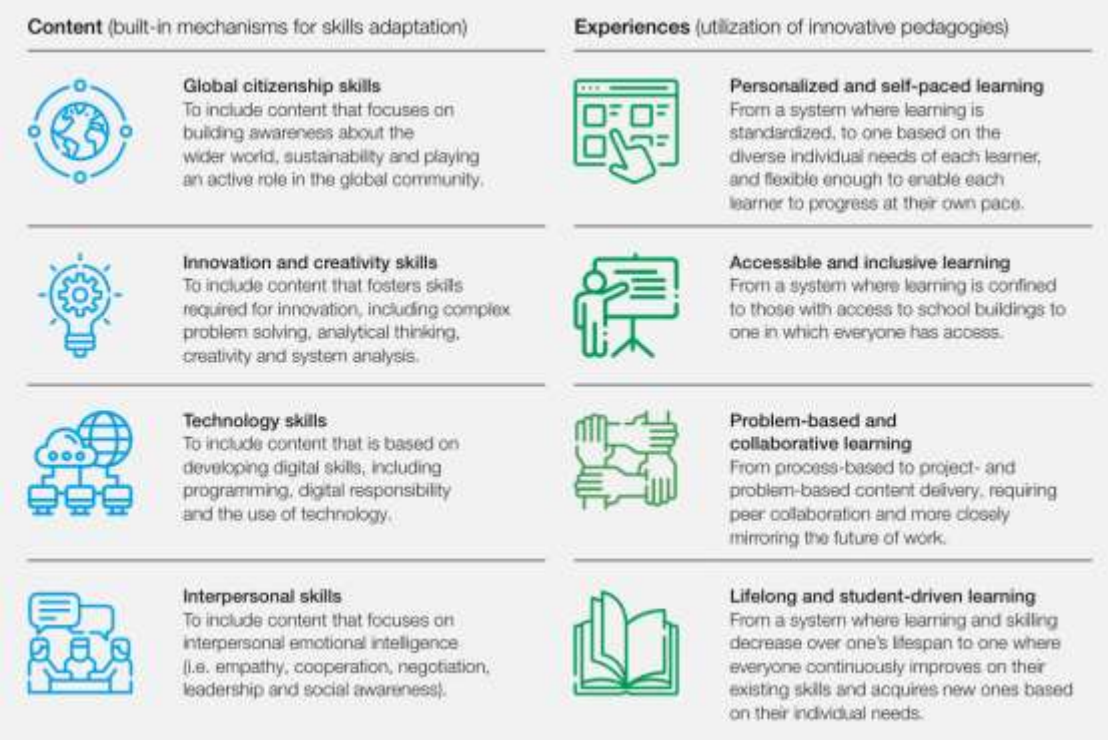

Figure 2. The World Economic Forum's Education 4.0 framework

Sources: World Economic Forum (2023) "Defining Education 4.0: A Taxonomy for the Future of Learning"

a. Abilities and skills

Abilities and skills encompass a range of process-driven competencies that empower individuals to accomplish specific objectives. Broadly categorized, these abilities and skills can be classified into either: (1) cognitive and analytical capabilities, which encompass creativity, critical thinking, and problem-solving; or (2) interpersonal (non-cognitive) capabilities, which include communication, collaboration, and a spectrum of socio-emotional skills. Skills falling within these domains are highly valued by employers. For instance, in a study analyzing 2 million online job postings, the top five skills frequently requested by employers were communication, creativity, collaboration, creative problem-solving, and critical thinking [15]. Historically, education systems have prioritized cognitive and analytical abilities over interpersonal skills. Despite employers' long-standing emphasis on interpersonal skills, these abilities remain a significant hurdle in the hiring process. Research indicates that socio-emotional skills impact academic performance, which in turn influences job readiness and employability [16]. Moreover, it's been observed that beyond academic achievements, students who develop strong interpersonal skills early in life, such as by

the age of three, tend to exhibit better mental health outcomes later in primary school [17].

b. Attitudes and values

Attitudes and values encompass a collection of beliefs shaping self-regulatory behaviors, personal motivation, and engagement with society's broader aspects, including moral and ethical considerations. While principles like learning mathematical operations may hold universal standards, concepts like good citizenship may vary in interpretation across cultural and national contexts. Nonetheless, instilling these qualities is crucial in cultivating a growth mindset and resilience in children, fostering lifelong learning habits, and promoting social cohesion among the globally interconnected generation of today. Attitudes and values focus less on the "how" of tasks and more on the "why" behind them, driven by a strong motivational aspect necessary for overcoming challenges, including those inherent in the learning process. The Education 4.0 Taxonomy categorizes attitudes and values into intra-personal qualities like curiosity, confidence, and initiative, vital for nurturing a growth mindset, as well as extra-personal societal aptitudes like cultural competence and civic responsibility. Philosophers such as John Dewey advocated integrating values into education early in the 20th century, recognizing their significance in shaping societal norms and individual actions [18]. For instance, teaching moral and ethical principles equips individuals to resolve conflicts through reasoning and negotiation, rather than resorting to deceit or violence, thereby influencing broader societal directions [19]. As technology rapidly advances, ethical considerations become increasingly critical to ensure fair treatment, safety, and preservation of freedoms. Technologies like gene editing, machine learning algorithms, self-driving vehicles, and data surveillance systems will necessitate ethical guidance to safeguard individuals' rights and maintain societal balance.

c. Knowledge and information

Knowledge and information will continue to be fundamental to education and learning, with even traditional methods like rote memorization expected to retain relevance to some extent in future educational practices. However, advancements in technology have transformed how people engage with information. The widespread availability of the internet and mobile devices has resulted in a significant surge in the volume of knowledge and information exchanged among individuals. Conversely, the sheer magnitude of available knowledge and information necessitates the development of new technologies for its collection, processing, and interpretation. Consequently, future economies will demand advanced skills and capabilities to navigate the burgeoning volume of information effectively, alongside the requisite attitudes and values to steer these interpretations. Hence, the Education 4.0 Taxonomy prioritizes indirect approaches to address knowledge and information, placing less direct emphasis on them and instead focusing on other aptitudes within the taxonomy.

Conclusion

The future of vocational education centers on empowering young learners to cultivate and enhance their innate human competencies, which are irreplaceable by technology. The framework of the future vocational education model is built upon the principles of learning that prioritize abilities, skills, attitudes, and values pertinent to the "Industrial Revolution 4.0," as outlined by the World Economic Forum. Achieving this framework necessitates collaborative efforts from various stakeholders to ensure a comprehensive approach to skill development from students' school years through their professional lives. In line with the broad definition of skills outlined in the Education

Taxonomy 4.0, educators, parents, employers, and governmental bodies must collaborate to foster and broaden opportunities for students to nurture these skills during their academic years. Essential activities for stakeholders in fostering skills relevant to the Industrial Revolution 4.0 include:

1. Teachers are pivotal figures in facilitating learning and are essential for supporting skills development aligned with the Industrial Revolution 4.0. They can prepare their students for the future workforce by:
   a. Modifying teaching methodologies to prioritize skills development relevant to the Industrial Revolution 4.0.
   b. Educating students and parents about the significance of these key skills for future employability.
   c. Adjusting assessment methods to emphasize tracking skills development pertinent to the Industrial Revolution 4.0.
   d. Providing opportunities for students to witness how skills relevant to the Industrial Revolution 4.0 are applied in real-world settings.
2. Parents also play a crucial role in fostering skills development relevant to the Industrial Revolution 4.0 by:
   a. Cultivating skills related to the Industrial Revolution 4.0 at home to foster innovation and creativity.
   b. Creating opportunities for children to engage in community-oriented activities that promote the development of attitudes and values congruent with the skills required in the Industrial Revolution 4.0.
3. The government plays a crucial role in shaping vocational education to align with the demands of the evolving workforce, as outlined in the Taxonomy of Education for the Industrial Revolution 4.0. To effectively implement this taxonomy, the government can collaborate with various stakeholders and incorporate feedback from entrepreneurs by:
   a. Enhancing vocational education teacher training programs to integrate teaching methodologies that emphasize skills relevant to the Industrial Revolution 4.0. This initiative can be developed in partnership with universities, the private sector, and relevant communities.
   b. Offering ample opportunities for teachers to implement skills relevant to the Industrial Revolution 4.0 in vocational school curricula.
   c. Updating national curriculum standards for vocational education to emphasize skills pertinent to the Industrial Revolution 4.0.
   d. Engaging in outreach efforts to educate teachers and parents about the significance of skills relevant to the Industrial Revolution 4.0 in preparing students for future needs.
4. Entrepreneurs are often at the forefront of global skills development efforts aimed at bolstering the economy. They can contribute to skills development aligned with the Industrial Revolution 4.0 by:
   a. Offering vocational school students opportunities to acquire essential skills through practical work experiences or internships at their companies, bridging the gap between classroom learning and real-world application.
   b. Involving teachers in broader educational and training initiatives.
   c. Supporting programs that empower teachers to integrate skills relevant to the Industrial Revolution 4.0 into industrial settings.

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