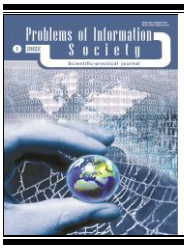

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13 (1)
2022

Industry 4.0 digital educational technologies (Instructional canvas with techniques)

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ARTICLE INFO

http://doi.org/10.25045/jpis.v13.i1.03

Article history:
Received 16 September 2021
Received in revised form
18 November 2021
Accepted 19 January 2022

Keywords:
Emerging technologies
Industry 4.0
Digital learning
Machine Skills
Self-Managing Skills
Transformed education

ABSTRACT

As connectivity to its customary base methods, transformed education marks itself as a relaxed, pleasant and accessible phenomenon, through educational technology modules tutored, and transformed teaching through digital learning processes has more associated advantages. Technology transformed education benefits students to get motivated for a new way of learning with the quick ability to absorb the use of technology. Deriving a fresh significance as offers for the educational transformation using emerging technologies, prepares students for a lifelong learning through new approaches and mobile technologies that are already part of their lives. This paper delivers a comprehensive view of industry 4.0 grooming Skills and Education 4.0, through a decade long pertinent research review progression, carried out for preparing the potential employees into the evolving 4th industrial revolution scenario.

Sənaye 4.0 rəqəmsal təhsil texnologiyaları (texniki-təlimat proqramı)

Açar sözlər:
İnkişaf etməkdə olan texnologiyalar
Sənaye 4.0
Rəqəmsal öyrənmə
Maşın bacarıqları
Öz-özünü idarə edən bacarıqlar
Transformasiya edilmiş təhsil

Standart metodlar əsasında transformasiya edilmiş təhsil tədris olunan texnoloji modullar hesabına rahat və əlçatan olmuşdur. Rəqəmsal öyrənmə vasitələri ilə təkmilləşdirilmiş tədris prosesləri bir sıra üstünlüklərə malikdir. Texnologiyalara əsaslanan rəqəmsal təhsil tələbələrə yeni öyrənmə üsullarını təklif edir. İnkişaf etməkdə olan texnologiyalardan istifadə etməklə təhsildə baş verən transformasiyalar tələbələrə yeni yanaşma və mobil texnologiyalar vasitəsilə ömür boyu təhsil imkanı yaradır. Təqdim edilmiş məqalədə potensial işçilərin təkamül prosesində olan 4-cü sənaye inqilabının mümkün senarilərinə hazırlıqlı olmalarına dair Bacarıq və Təhsil 4.0-ın inkişaf meylləri son on ildə aparılmış tədqiqatlar əsasında təhlil edilmişdir.

Промышленность 4.0 цифровые образовательные технологии (Техническая программа обучения)

Ключевые слова:
Новые технологии
Промышленность 4.0
Цифровое обучение
Машинные навыки
Самоуправляющиеся навыки
Трансформированное образование

Обучение, трансформированное на основе стандартных методов, стало удобным и доступным благодаря внедрению модульных технологий образования. Процессы обучения, совершенствованные посредством использования современных цифровых средств образования, имеют ряд преимуществ. Цифровое образование, базирующееся на технологиях, предлагает учащимся новые способы обучения. Трансформации в образовании как результат технологического развития предоставляют учащимся возможность обучения на протяжении всей жизни с помощью новых подходов и мобильных технологий. В данной статье на основе исследований, проведенных за последнее десятилетие, представлен всеобъемлющий обзор развития навыков и образования 4.0 в направлении подготовки потенциальных работников к возможным сценариям развития 4-й промышленной революции.

1. Introduction

ICT is a dominant revolutionary agent for formal transformed educational system, bringing modifycations in program content, instructional methods, evaluation, instructor learning etc., through information storage, recovery, and automation on the accumulated knowledge [1]. Education enables student's to become future leaders in all fields with tools at their disposal, exciting to lean, peer teach and challenge themselves, with the best use of the technology available to them [2]. Digital Learning system help student develop into an aggregated level of capability, becoming a free, responsible, adequate, and motivated; through surroundings which delivers more of knowledge in quantity, quality and development of reasoning ability [1].

2. The Grooming Template

The digital paraphernalia keeps deriving new technology applications into industry 4.o requirements. The skills grooming template, has an acronym MASTER. The competent skills as in figure 1, Industry 4.0 grooming skills, under this umbrella are,

- Machine Skills
- Academic excellence
- Self-managing Skills
- Technology Skills
- Engagement Role Skills
- Radiant Skills

These skills are analyzed for performance factors such as

- Specificity - student motivation determined by the content being taught to them, theory for creating situational interest and practical expectancy valued through engagement and achievement outcomes
- Accuracy – repeated test measures analyzed for the variance, at various frequencies
- Ethicality – is to understand morality and recognize honesty, self-reliance, and build character.

Then assigned on the cluster of personal skills namely the individual's cerebral, behavioral Finetunes, and applications. Digital technology will make transformed educational delivery more dynamic and effectual, by deploying to create a disruptive drift in the global transformed education market; where digital learning will travel away from a capital and talent intensive one into an easy fit digital facilitation easing for a competitive and more personalized delivery in transformed education, seeking more learners to engage in reskilling themselves to demands of the changing market needs.

3. Machine Skills

The machining skills are concepts which integrate the concept of CPS and IOT [3], where Cyber physical systems architecture (5C) are Connection, Conversion, Cyber, Cognition, and Configuration. Cyber-Physical Systems combines computation and physical systems, together concerned with the actual interaction, thus completing the design concept, with the embedded systems controlling the processes as a sub-set of the inclusive CPS [4].

4. Academic Excellence Skills

The five key practices for academic excellence ae determining a vision, generating a friendly climate, refining leadership, enriching instruction, processing people, information and methods for improvement [5]. Based on these the parameters are identified as Knowledge, analytical and executional skills, where knowledge includes basics, applied, and advanced; analytical covers numerical, logical, graphs, maps, and charts; while execution involves planning, articulation, group discussion, creativity, modelling, and presentation. The midpoint of assessment is academic features for the ability to provide evidence on the progress and achievement for a summative assessment and experience of engaging in sufficient in-depth subject knowledge and shaping the ability to engage in application for future [6].

5. Self-Managing Skills

The technical achievements can be the desired outcomes, but the list of non-technical skills that help student to manage themselves to easily achieved the technical outcomes is self-managing skills [7]. To successfully persuade others, skills such as sympathetic communication, inspiration, empowerment, and self-awareness are compulsory, these are set of individual orientations which align with individuals Attitudes, Perception and Motivation. Initially hierarchy skills are for control through managing personal stress, up keep time, self-awareness and analytical problem solving. Then evolve clan or collaborating skills are communication, helpfully constructing teams and permitting teamwork are nurtured. These should evolve for market competitive skills such as encouraging others, gaining power and inspire to deal conflict. Finally culminating to proceed to create problems solving, creatively leading positive change, and fostering Innovation [8].

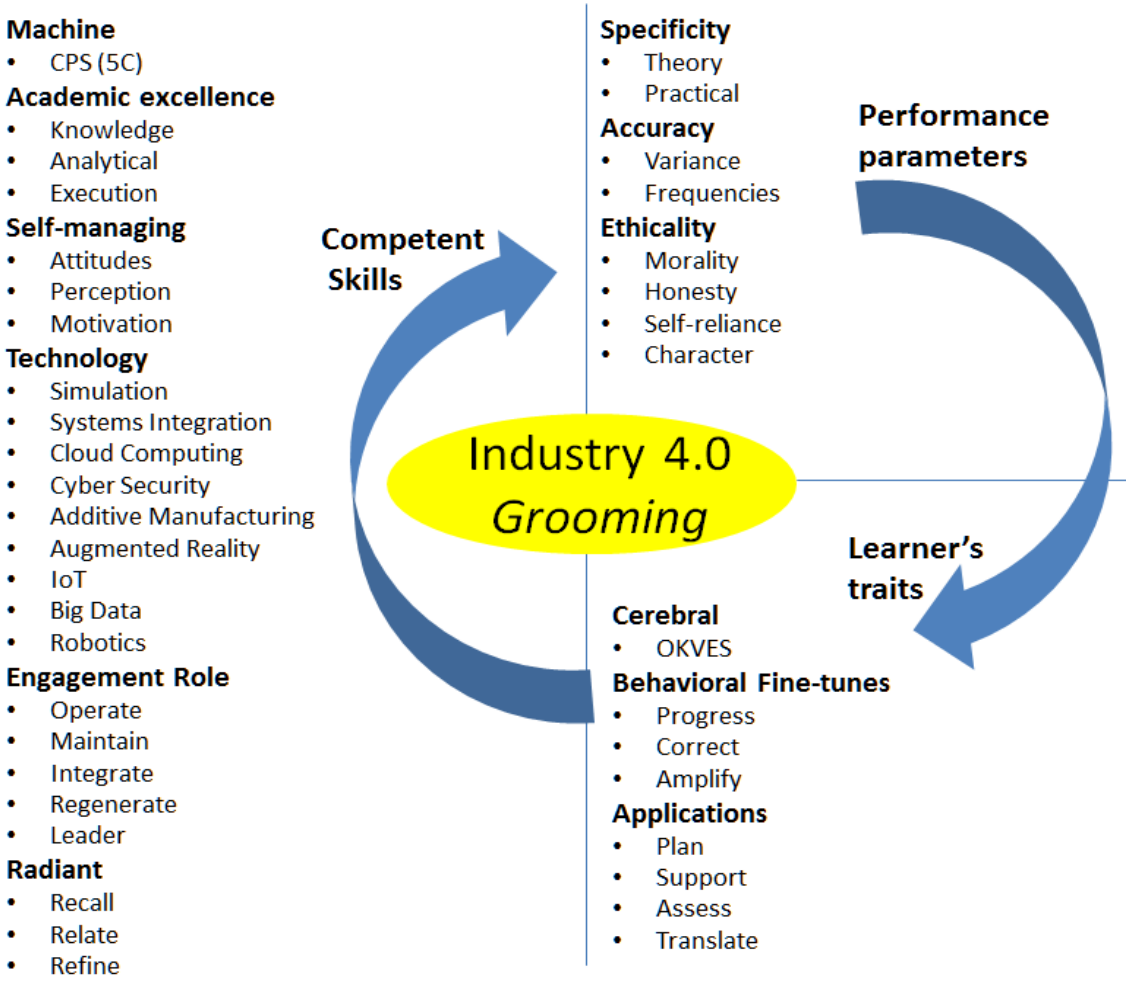

Fig 1. Industry 4.0 Grooming Skills

6. Technology Skills

Technology crops to offer various paybacks, extensive adoption of ICT has led to the emergence of the need to regulate business in response to industry disruptions and automation. Familia-rizing technology to reform education is crucial to spring up economic growth, by addressing chal-lenges, picking decisions built on the limitations in infrastructure and connectivity 9]. Technology permits teachers to distinguish, direct upgrading, dive profoundly into areas of study, motivate students to engage completely in a higher level and increase their academic achievement [10]. The industry 4.0 technologies are Simulation, Systems Integration, Cloud computing, Cyber security, Additive manufacturing, Augmented reality, IoT, Big data and Robotics.

7. Engagement Role Skills

Work engagement frameworks includes job resources such as self-sufficiency, skill diversity, social care, performance response, supervisor training, openings for expansion, and digital learning culture; individual's resources such as self-efficacy, confidence, and self-esteem; and work difficulties namely overwork, physical and emotional stresses, and work life balance; and values specifically performance, turnover intent, org citizenship - creative behaviors, customer delight, and returns are roles that are required at work [11]. Industry 4.0 engagement roles have skills such as Operate, Maintain, Integrate, Regenerate and Leader. Form a improved context for complete revolution and approval of outcomes complete comprehensive participant engagement, on a shared vision and enhancing cooperation [12].

Operate includes connecting sensors, tethering, plug and play of interconnected machines. Sensors alter physical into electrical signs, to measure quantities in the environment, data is sent to the processing unit with minimal delay, real-time analysis to increase valuable insights [13], tether spooling and articulation of the sensor-head allows for observing the entire surroundings in real-time conditions [14]. Sensors and tethered structure host benefits for information processing [15]. The

sequence is maintain, integrate, regenerate and finally leader. Maintenance is to understand the performance of the machine with respect to aging, degradation, and health. To get the most out of maintenance, selection of mathematical model with optimization which operators are aware as per maintenance policy is crucial [16]. Integration is to handle Time and Memory space constraints of the machine, includes cluster analysis and data mining for optimizing, minimizing, or maximizing the output of the machine. Processing performance with the time and space complexity of algorithms are related to data dimensionality with attributes such as scalability, I/O performance, fault tolerance, real-time processing, and iterative task algorithms, computed with increasingly exponential data size for very large datasets [17]. AI can enhance human capacity by managing and exploring substantial datasets considerably swifter by communication through language processing, knowledge depiction in memory, machine learning and draw new conclusions without explicit programming and distinguish patterns and acclimatize to new situations. Regeneration includes simulation, synthesis, diagnosis, visualization, and decision making. Here the operators engage with various machines to achieve the enterprise goals by scheduling and routing all the available machines.

Cognition features to arrive solutions based on adaptive, Interactive, Iterative and contextual. While the scope involves engagement, decision and discovery, the landscape and include IBM Watson, Microsoft Cognitive Services, Google Deep Mind, and Cognitive Scale etc. Leader position requires them to configure machines to become self-control on resilience, variations and disturbances. These have great bearing on the things that relate to one another, with challenge on values of AI bioethics to be covered along with guidelines for new evolutions.

8. Radiant Skills

This forms to include the following namely - Recall, Relate and Refine. Recall is linked to knowledge, remembrance, memory, recognition, identification, information retrieval, and 5WiH description. Relate is associated with applications, such as in problem solving; information to produce some result; use of facts, rules and principles, example of, or how significant, the context is. Refinement in the instructions, adjustment to the content or additional clarification, over time by getting the best response possible, improving the etiquettes through assignments, activities to improve based on experience of the responses effectiveness.

9. Industry 4.0 education

This is an evolving education process which is innovative to include and deliver to satisfying the needs of the learners, as in Fig 2. Education 4.0.

9.1. Visualization

Visualization is also called as See-learn, which includes displays, simulations, animations, videos, prototypes, working models, laboratory experiments, and online presentations. Visualization raises the level of communication, intensifies the critical thinking and delivers an analytical line to several snags inspiring the students to absorb, create supplementary appendages and emerge with newer skills suitable for handling perilous situations that would erupt during the application process. To achieve better visualization, the approach of experimentation leading to various methods of extraction of results can be envisaged. This improves the mental imagery during learning, instead of stressing complicated tasks of reading, writing, and math. These inputs leave lesser cognitive space to visualize content and ideas, and quite mundane instead of the enjoyable element that can enhance learning, recall, and emotional instruction.

Visualizing is not limited to mere imagination but includes more utilization of other senses such as touch, sound and taste etc. as the case may be for additional and influential digital learning results. Visualization aids in memory, communicates a lot of information, stimulates individuals to perform better during learning applications, and enhances attention as it retains the audience become very attentive on the subject matter. Machine learning and IoT integration increases automation, enhances communication, and facilitates self-evaluation to construct, analyze and diagnose subject matters even without the need of human intervention. Industry 4.0 emphasis Data visualization, hence requiring to groom the individuals in the ability to tune the human visual systems deliver firm connect and swift retort of solution through the manufacturing or business process taking care of various constraints across numerous levels of parametric and heterogenic data spaces; proves vital.

9.2. Personalization

Personalization is mode for facilitating Self-learn within the student. This covers all mode of transformed education that includes beyond

classroom cloud computing, mobile apps, Massive Open Online Courses (MOOC) and Social Media facilitations, informal learning, and peer learning. Personalized learning approach customizes digital learning for every individual student's capability oriented input. Each student have unique strengths, requirements, abilities, and expectations, hence they should be delivered with learning plan's that are suited to their best of acceptance criteria. However in spite of the students learning skills and understanding pace, their absorption should be planed and kept on track meeting the standards transformed educational requirements, such as common evaluation, and application that would be either short or long-term goals. Personalized approaches are tested with customizable software that allows students to advance through body of knowledge (BOK), at their own pace of learning. This opens a novel technique of transformed education which focuses on technology, where the student's set their own goal independently matching their interests, and facilitating them to progress on their strengths and also face challenges.

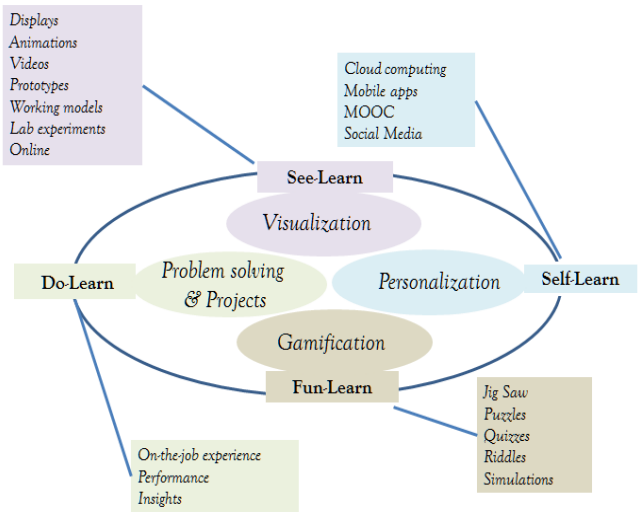

Fig 2. Education 4.0.

The use of the IoT linking physical objects, sensors, integrated with cloud computing, augmented reality, and big data can set the transformed educational environment to provide useful data for mass personalization. Continuous innovations in transformed education identifies methods of digital learning and transformed teaching to learn-unlearn and relearn new ways of transforming the technology application to achieve able collaboration and coordination, which is inclusive and ubiquitous in its presence and operation.

9.3. Gamification

Gamification is associated with an element of informal approach to scintillate learning and teaching for better remembrance and recall. This process is also called as fun-learn, where the activities expands creativity and innovation, jig saw, puzzles, quizzes, riddles and interactive gaming simulations. In transformed education, the mode of gamification facilitates more possibilities in student engagement and inspiration through online settings. The teachers can position their students in realistic settings for grooming their abilities and expand directly with responses for their advancement and happenings, get recognized for performance, and feel through the learning experience as a contested task. Learning application through games needs to be derived from various sources such as implementing activities in a playground, or simulations of board games or even that of video games. This is a continuous evolution undergoing changes adopting scholarly inputs and improving by addition of new resources and technological enhancements consenting progressive course work experimentation [18]. Teaching establishments offers an ample tenacity of supplying knowledge encounters to take the lead through the unrecognizable awareness to the radiance of understanding. Every country needs a very careful, synchronized and high-quality progression of transformed teaching as it is the key conditions for the advancements that lead a culture established on learning and expertly deliver tremendous employment opportunities. Teacher's main responsibility is to develop competence, build capability to simplify and cheer students to connect the constraints of the job and oppose the challenges surrounding tutoring skills, rigorous didactic concepts and specialized skills. Industry 4.0 requires a variation in the orientation of teachers to be as facilitators of learning, then as contributors to teaching, safeguarding the transformed educational inputs and grow at the speed where the digital students are subjected to relentless checkup of emerging technologies lengthwise with conventional practices and also recommend anticipated changes pertinent to transformed education. Game permits to restart, play again, learn from mistakes, freedom to fail, test without fear and intensifies engagement. The use of gamification in the field of e-learning gains more popularity as it relates essentials connected with cinematic mechanics and dynamics than which is observed in a simple learning environment. This offer to intensify the student's engagement and endorse assured actions blended technologically to have a superior influence on online learning [19].

9.4. Problem solving & Projects Enhancement: do-learn form

On-the-job experience, performance, insights (OPI), includes all analytical, critical, creative thinking, computing skills and Networking. Practical, insightful intelligence focused on significant belief and action that is conclusive on the need provides better options to solve problems. Analytical thinking has various phases which when applied leads to discovery the efficacy of learning the origination. Critical thinking is the ability of investigation, combination, estimation, develop aids, simplify, and generate rationale to evolve a result, set-up points, being acute and complete in itself. In industry 4.0 environment this process is a digital design allowing students to contemplate and decipher problems along with their peers, and social networks through learning, organizing and promoting activities in problem representation, explore solutions, and apply corrective actions using multimedia features that allow them to interrelate and record the best option possible evolved through the directed process for innovation [20]. Industry 4.0 problems require application of knowledge and demanding activities, which cover acquiring, depicting, diffusing, operating, and controlling, as dynamic roles for in problem solving. The digitization of knowledge and demanded actions along with computing, and ICT in organizations have integrated horizontal and vertical intelligence that permits manufacturing through data being agile and converted into information, supporting seamless connection between physical and cyber spaces through embedded systems for executing cognitive tasks including those that are critical for the advancement of both the operational and business process [21]. Projects support student's to comprehend the consequences through technology assisted instruction; advance to build partnerships among various peer groups across institutional units, businesses, community associates and transact successful methods, facilities and scenarios. Students' expectations and evaluation of deliverables do have a jumble of inherent fear, to handle catastrophes, revelations and comparison phobia, which is otherwise a lesson from experience that can never be matched through any theoretical didactic inputs. Hence formative evaluation frames students for realizing on their wide-ranging assessments, which is the conclusion of learning along with feedback. Which ultimately diminishes the rebuffs including that of the comparison phobia? Modifications in personal self towards the approval of Industry 4.0 change initiatives include the engagement roles that would offer benefits, based on their appointments in different kinds of roles that they would get to be positioned in the hierarchy of the organization. Interventions that which integrate basic skills along technical bring more positive attitude to have transformed education sandwiched between learners and enriched fulfilment. Therefore, it is essential that today's pedagogy conveys to students a lifelong success path through a global platform. Every establishment will have to expand its present skills support beyond the bar of that being acquired as a talent pool. Employees should be adaptable in attitude, participate in active learning, groom superior cognitive skills and be well informed in digital technologies.

9.5. Pedagogy & learning

Choose knowledge and skills that are worth learning includes digital skills used in the digital devices, communication applications, and networks to access and manage information. The basic digital skills have to be learned by older generations. The internet brings a level of precision and scale unknown in the pre-digital age. Specific digital skills are required with support from expert practitioners for focusing on particular discipline as a strategy to bring social media with management tools on performance measurement, channel research, brand presence, influencer marketing, and paid verses organic connect the prospective and current users. Digital marketing mix, role significance, and professional lives are to be befitted from AI which offers an increasing role in new businesses, comparatively to the cinematic lore, to which it is exaggerated. In future machine learning will automatically facilitate utilities perform their jobs, predict and make decisions based on detailed computation of past experiences. Acquiring digital skills would determine, in the not-too-distant future, to allow people to compete in context, with all non-manual roles will fulcrum on digital skills. The need for digital skills will become more pronounced for career climb as that necessary for those seeking promotions. The real encounter for Industry 4.0 is technological developments which endure rapidly to reap the benefits of fitment to business context. Students and teachers are puzzled with the array of tools and capabilities noticeable as an innovation opportunity, however unclear on the business situation linkage that has to be established. Those firms that handpick Industry 4.0 innovation validate their financial case and get to employ even though they are working on uncertain, exclusive barriers to change that should be cleared to renew

through Industry 4.0, unraveling eminent paths which could be selected, rationalized for leveraging the functionalities that are available to them.

9.6. Set tasks above base capability within achievable limits

Industry 4.0 undoubtedly powers significant improvements in the technology, with enormous cultural and change elements that necessitates varied combinations and determined resolution those efforts, the act of transforming the early hurdles to sluggishness. Firms should prompt their core processes and identify the aching sockets redress with prospects that can certainly ironed out for facilitating transformation. The strategy should be complete and should not be inadequate like selectively picking emerging technologies such as IoT, AI, ML, DL, A/VR, Cloud-fog-edge etc., and find a usage for implementation, that would evidently bring unevenness in results declining the credibility of the development. IoT is an inter-relative structure of AI, and enterprises are still functioning to plug the fissures in its security, thus complication of the activities shrinks its capabilities. While the manufacturing technologies increases the product and service quality. Industry 4.0 leads to solve the problem of structured manufacturing into a flexible, on demand style, enabling human capital to carry out multifaceted, agile responsibilities with production oriented training required with new technologies [22].

9.7. Risks and stretch in learning

Correlated with the development of skills are risk management, leadership, and self-organization. Industry 4.0 implementations create financial, environmental, technical, and communal risks, largely due to job losses. Social risks can be organized by reskilling for the technical risks, carefully handling the IT security. Management with able predictive tools can anticipate and manage all threats though complex in nature can be digitalized and collaborated to generate fresh behavior, communal and comercial practices [22]. Industry 4.0 aids to reduce the need for workers as the key carters in manufacturing or services; In addition they support mass customization in enterprises which see flexible claims from their consumers who are very demanding, than the deliverables from standard product. Fall in labor cost, improved asset use, reimburses modernization related depreciation, better value of product's improvement in quality, and flexibility for customization which allows for enhanced changeover time, downtime, reliability and inventory. Industry 4.0 determines to transform organization's processes, enhance the output of industrial technologies create real-time digital twins of engineering settings that is vital to acclimatize to the varying environment of the digital resources. Firms for adoption of Industry 4.0 range in all forms, from uninterested to fully- automated, are evaluated for level of impact across key indicators such as virtualization, value chain, disruption, resource efficiency, and policy regulations.

9.8. Encourage community of learners

Emerging technologies applications for transformed teaching and learning, develops capable resources groomed for sustainable growth and expectations, leading to superior efficiency in the business flow and progress autonomous acumen for taking advantage with Industry 4.0 structure. The level integration of systems, create smart machines and products that communicate and work in flow with one another [22]. Millions of youths globally are employed below their expectations either as un or under employed, whereas the firms have job requirements that cannot get filled. The mismatch between available skills and expected needs are unaddressed, intensifying the problem affecting the progression towards Industry 4.0 Revolution which is an amalgamation of assets both physical and digital aiming to transmute the smart society, to flourish economically offering job opportunities and enriching quality of lives. To support potential employees to discover their opportunities and obtain employment, to prosper within their employment, inputs such as core knowledge, mathematical proficiency, digital suaveness, content writing and presentation, professionalism such as timely delivery, following social norms and etiquettes are groomed.

9.9. Choice to pick interest areas, and model with a mentor

Economic and social changes in the surroundings challenge business with substantial forces, demanding to implement value optimization models and advance their earnings, margins, and share of market. Innovation models result from data; analytics and automation changes. Competitive lead through affordable skills in workforce progressively positions developing markets onto a enlargement model, reaming financial emergence, incipienting the economic needs into educational and training facilitations to develop skills, specially the digital learning demanding a spurt in the employment

market [22]. To support the employable by integrating and collaborating with stakeholders viz. customers, peers, and leadership requires polishing of communicating and critical thinking skills. Creative collaborative adaptation with initiative for socio-emotive team connect offering to build confidence and empathetic mindset with inclusive of awareness in culture leads to 4.0 leadership. The technology driven technical domain expertise, required to perform tasks that are job-specific can be reached by developing programming skills in coding, PMS, cost and finance prudence, sector specific operation, including those functions that are multi skilled for internal and external coordination.

9.10. Online 'learning – asynchronous' & 'teaching – synchronous'

For Industry 4.0, subject to the industry, there would be sector specific skills to be developed in the human inputs that would be different from others and divergent with respect to the processes, abilities requires for and demanding tasks. The human capital will therefore have significant partaking in the labor and would endure a transferal of careers and learning. Industry 4.0 era would have involved people contribution in the all-inclusive manufacturing or service system, which could comprise of system designers who are workers as well as customers of products or goods serviced. The requests and wants of every employee collaborated in the value stream would get built-in into the structure interacting with their necessities and obligations amid every person connected [22]. It is very common nowadays that many education institutions started offering online and blended instructions with in-person teaching. This flexibility came up due to influencing factors which included meeting student's flexible schedules, additional courses and student enrollments leading to access enhancement for higher education [23]. The industry 4.0) has changed the landscape, controlled by AI and cyber physical system that enabled Man-Machine interface revolutionized to deliver future work life with smart robots replacing human activities. Thus education was guided to connect information and abilities for innovation leading to focus educational development and skill enhancements to be customized, accessible globally and become virtual [24]. Built on systematic models and optimization of processes, all information related to the product, process and resources are merged and collated as a knowledge and skill pool [25]. This book of knowledge is taught on a synchronous mode while the learning is facilitating through asynchronous mode. Synchronous teaching means two or more learners are connected to the teacher simultaneously and in real-time through the same platform or communication channel, such as a video conference. While asynchronous enables learners to access the same shared content from various time zones and locations, using a e-learning websites from different locations [26].

10. Conclusion

There are various traits being expected to fulfill the skilling part in the people resources such as Initiative, creativity, innovation, resilience, industriousness, curiosity, risk-taking, courage, acumen on execution of business and optimism with future. These are required so that the knowledge and abilities can support in creation and construction of a workplace opportunity into a success drive for a new entrant to be flexible and offer their services to be either a freelancer, or work on contract and engage into a self-initiated at work. Tomorrows industry will be lean-mean and agile, with optimum use of less resources as that which is required for serving the customer requirement, on-demand with less time to response and enhanced credibility to delivery parameters.

References

1. David, Moursund. (2005). Introduction to Information and Communication Technology in Education, 1-121. https://darkwing.uoregon.edu/~moursund/Books/ICT/ICT Book.pdf
2. Kanika, Budhwar. (2017). The Role of Technology In Education, International Journal of Engineering Applied Sciences and Technology, 2(8), 55-57.
3. World Bank Group (2020). Remote learning, distance education and online learning during the COVID19 pandemic, A Resource List Prepared by the World Bank's Edtech Team, 1-44.
4. Ioan, Dumitrache. Ioan, Stefan, Sacala. Mihnea, Alexandru, Moisescu. & Simona, Iuliana, Caramiha (2017). A Conceptual Framework for Modeling And Design Of Cyber-Physical Systems, Studies in Informatics and Control 26(3), 325-334.
5. Wallace (2013). The School Principal As Leader: Guiding Schools to Better Teaching and Learning, The Wallace Foundation, 1-28.
6. Alfredo, Becky, Alison. (2018). Soft Skills (Academic Guide / Teaching Materials), European Commission, England: Shoo Fly Publishing.
7. AMM, Sharif, Ullah. (2020). What is knowledge in Industry 4.0?, Engineering Reports. 1-21. https://onlinelibrary.wiley.com/doi/epdf/10.1002/eng2.12217
8. Barbara, Karni. (2020). What Technology Can and Can't Do For Education, Inter-American Development Bank, 1-143.
9. David, A, Whetten. & Kim, S, Cameron. (2011). Developing Management Skills, Prentice Hall, 1-744.

10. Hagen, Schempf. (2009). Self-Rappelling Robot System For Inspection And Reconnaissance In Search And Rescue Applications, Advanced Robotics, 1-30.
11. Horizon (2020). Work Programme 2018-2020 Food security, sustainable agriculture and forestry, marine, maritime and inland water research and the bioeconomy, European Commission Decision.
12. J, Endrenyi and G, J, Anders. (2006). Aging, maintenance, and reliability - approaches to preserving equipment health and extending equipment life, IEEE Power and Energy Magazine, 4(3), 59-67. https://doi.org/10.1109/MPAE.2006.1632455
13. Jennifer, L, Harris, Mohammed, T, Al-Bataineh & Adel, Al-Bataineh. (2016). One to One Technology and its effect On Student Academic Achievement and Motivation, Contemporary Educational Technology, 7(4), 368-381.
14. Jonathan, Scott. Elaine, Khoo. Sinduja, Seshadri and Michael, Cree (2018). Assessment of Self-Management Skills in a Project-Based Learning Paper, SESSION C2: Interdisciplinary and cross-disciplinary engineering programs, AAEE2017 CONFERENCE, Manly, Sydney, Australia, 1-10.
15. Marko, Urha. Goran, Vukovic a. Eva, Jereba. and Rok, Pintar (2015). The model for introduction of gamification into e-learning in higher education, 7th World Conference on Educational Sciences, (WCES-2015), 05-07 February 2015, ScienceDirect Procedia - Social and Behavioral Sciences 197, 388 – 397.
16. Mueller, E., Chen, XL. & Riedel, R. (2017). Challenges and Requirements for the Application of Industry 4.0: A Special Insight with the Usage of Cyber-Physical System. Chin. J. Mech. Eng., 30, 1050–1057.
17. Nahit, Yılmaz. & Cevriye, Gencer (2017). Sensor and Location Selection Problem for Tethered Surveillance Aerostats, International Journal of Engineering Science Invention, 6(7), 11-17.
18. Parama, Kwangmuang. Suwisa, Jarutkamolpong. Watcharee, Sangboonraung and Srisuda, Daungtod. (2021). The development of learning innovation to enhance higher order thinking skills for students in Thailand junior high schools, Heliyon, 12, 1-13. DOI:https://doi.org/10.1016/j.heliyon.2021.e07309
19. Shahroom, A.A., & Hussin, N. (2018). Industrial Revolution 4.0 and Education. International Journal of Academic Research in Business and Social Sciences, 8(9), 314–319.
20. Srikanth, Namuduri. Barath, Narayanan, Narayanan. Venkata, Salini, Priyamvada, Davuluru. Lamar, Burton. and Shekhar, Bhansali (2020). Review—Deep Learning Methods for Sensor Based Predictive Maintenance and Future Perspectives for Electrochemical Sensors, Journal of The Electrochemical Society, 167, 1-13.
21. Sun, A., & Chen, X. (2016). Online education and its effective practice: A research review. Journal of Information Technology Education: Research, 15, 157-190.
22. Varina, Paisley (2013). Gamification of Tertiary Courses: An Exploratory Study of Learning and Engagement, 30th Ascilite Conference. Proceedings, 671-675.
23. Violeta, Sima. Ileana, Georgiana, Gheorghe. Jonel, Subi´c. and Dumitru, Nancu. (2020). Influences of the Industry 4.0 Revolution on the Human Capital Development and Consumer Behavior: A Systematic Review, Sustainability 2020, 12, 4035, 1-28. https://doi.org/10.3390/su12104035
24. Woocheol, Kim. Soo, Jeoung, Han. & Jiwon, Park (2018). Is the Role of Work Engagement Essential to Employee Performance or 'Nice to Have'?, Sustainability 11, 1050, 1-16, https://doi.org/10.3390/su11041050
25. A, L'Heureux. K, Grolinger. H, F, Elyamany and M, A, M, Capretz. (2017). Machine Learning with Big Data: Challenges and Approaches, IEEE Access, 5, 7776-7797, https://doi.org/10.1109/ACCESS.2017.2696365.
26. Yang, TH., Yang, SC., Kao, HM. Hsu (2018). Cyber-physical-system-based smart water system to prevent flood hazards. Smart Water 3, 1. https://doi.org/10.1186/s40713-018-0008-3

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