Chapter Nine

Industry 4.0 technologies applied in teaching & learning

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Abstract

With COVID -19 pandemic, the whole world has put learning and teaching into online mode. This is only a tip of the iceberg. The infrastructural changes that are going to happen in the future, in the post COVID-19 scenario, is very phenomenal towards an emancipation of knowledge explosion, resulting in "know-what", "know-how", "know-why", and "know-where" is going to become widely visible, available and accessible to everyone. Knowledge is no more a latent resource that could be held hostage by an author or by a facilitator or by a user for claiming benefits. The recent online conduct of Teaching and Learning methodology through digital contents is going to gather mass by volume and will also get analysed for quality pruning. In addition, it would also get customised for various target group consumption. The ingredient of learning will change the quality of thinking, usage, and innovation possibility across the world. Industry 4.0 technologies are depending on such explored knowledge repositories and would get astonishing breakthroughs by artificial intelligence (AI) applications. With less of travel and more of virtual connection the world is expected to bloom with inclusivity in people for using a knowledge-cloud that will loom to remove geographical limitations.

Keywords: Industry 4.0, Learning, Teaching, Online, Artificial intelligence, Machine learning, Knowledge management

Introduction

Knowledge excellence is a sum of basics, applied and advanced levels of acquired input suited to industry 4.0. Education is a pertinent basis for knowledge and innovation communities. Careful investigation reveals to distinguish communities of practice from that of knowledge. The communities of practice have specialized in knowledge management, since 1990, for the

need to evaluate and promote the transfer of knowledge. Sharing information and experiences, among the members of the group generated common knowledge. The process included arriving at resolution of the issue with the experience based knowledge in the memory of its members, who articulated it collectively and solved it by trial and error, iteratively resulting in a common patrimony of the community of practice (Javier et al., 2010).

These communities affect performance and have an inherent potential to get over the glitches from a slow-moving outdated order in a fast going simulated economy, as an active way for establishments to handle amorphous issues, share facts outside the conventional structure and maintain long-term organizational memory. The community is exposed, and hence will offer a inexpensive substitute to the highly estimated all-time learning agendas at this time being obtainable by the educational establishments and claim them to offer more supple provisions for appreciation of informal erudition. This transmissive pedagogics, from specialists to those considered less expert leads to leverage the use of artificial Intelligence (AI). The use of artificial intelligence and machine learning technology are poised to impact radical modifications across the world. AI application includes ML, robotics, neural networks, vision, NLP, and speech processing interdisciplinary connected with fields other than computer science, comprising psychology, neuroscience, cognitive science, philosophy, linguistics, probability, and logic.

Industry 4.0 requires a variation in the orientation of teachers to be as facilitators of learning, then as contributors to teaching, otherwise the absence of shared knowledge, organizational and semantic boundary can lead to conflicts, regarding the performed, exhibited, formal, or conceptual nature of the context (Johnson, 2018). The digital conduit of virtualisation is through the cloud, which is the facilitating step in the process of a global culture evolution through big data. This process is accelerated through the networks, link data centres, devices, organizations, and individuals thus creating an unique global super intelligence (Mosco, 2014).

Industry 4.0 reassembles the scattered individuals into virtual communities. With distinct features when compared with other types of communities cemented the evolution of a formidable power to create actual communities. Social combinations occur when individuals transmit on deliberations which are long enough, with enough social feeling, to form networks of private dealings in the Internet, interacting on a completely novel level, interconnected computer networks. Affected by different stages of political and economic changes, digital educational processes become a crucial goal for the network with the idea of transforming them into a real community of knowledge (Javier et al., 2010). In a society intended mainly to focus on individual's needs to live and relate to move in the direction bringing the vision stretched to spell out know-all, however incomplete and biased to all peers, students, and teachers (Kashtan, 2014). Learning cannot be limited only to the practice of education, but is also politicised with respect to the conditions and position of the learner (Chan, 1998). To establish a common virtual collaborative space and safeguard educational technology and to grow at the rate ordered by the current pervasive digital learners, a constant examination of developing technologies along with conventional teaching practices and invoke the necessary changes is a very pertinent educational need.

It is more important to have knowledge of anthropology than of political science (Phelps, 1993), which affects the spreading acquaintance, belief among associates, and the intelligence of togetherness, increasing the probability of understanding, open transaction and allocation, thought to be more problematic through computer-mediated connections (Alex et al., 2006). When politics become personal, emotions can move the energies and fire the knowledge base towards commitment (Chan, 1998), however avoidance of expression on political perspectives can negate social issues (Rhett, 2017). In order to support the learners, it is better to keep away the politics, and better understand the things as seen and learn through online education. Knowledge is not the same as science, it is a set of denotative statements, which questions the competence with the simple resolve and submission of the principle of existence (Lyotard, 1984). Knowledge is essentially connotative in landscape, not grounded methodically upon evidences, instead stranded narratively, upon private understandings and empathies to suggest discrete facts.

The process of garnering the information is by assessing, and semiotically communicating via representations of the world around us; which leads to the knowledge being acquired daily by simply watching and observing the activities. Acquisition of such knowledge can lead to the implementation of new practices. Feelings, notions of autonomy, safety, enablement, and conceit; impacts power, gender, and information; and manifests tactual sensation, for a personal space. Deriving nice relationships between concepts helps us to see some new light. Teaching and learning is not only for cognitive knowledge, skills and perspectives acquired significantly with the feelings of empowerment (Chan, 1998). Implicit or tacit knowledge resonates with practical knowledge- “know-how” which is distinct portions for chore and role drives as it is impossible to articulate fully in words, as it is nonverbal and non-measurable. Know-how reasoning is not learned, but by affecting sets of clearly recognized values or by merely accruing itemized abilities it is comprehensible. In an educational perspective, use of testable aptitudes checklist for tutor 'know-how' can facilitate the ability to manage with diverse facility clusters, retain to the aim of the content, and comprise a period for response. Even in situations of an inexperienced teacher pursuing the know-how of an experienced teacher can be expressed in her work, as a character kind of information, developed empirical and background for executing and by contagious application by applying continually (Green, 2007).

Dealing experience and enriching it to be added explicitly is possible more with the use of technology; can be encapsulated in an explicit, generalizable form (Dunne, 2003). The cloud and big data are appliances that influence informational free enterprise even as they empower a progressively overriding way in knowledge management. Cloud computing has an enormous impact across societies, extending from transitioning their information and software program to the cloud, planning and executing tactics in the cloud, to universities and campuses that are exploiting the cloud to alter instruction, and storing their identities in the cloud (Mosco, 2014). Dissemination of knowledge later held on to the concept of innovation. The emerging data social order, is a composite society unified with several and assorted groups based on plurality of communities of knowledge (Javier et al., 2010). The needs and responsibilities of teachers and student’s roles have changed dramatically which requires both to work in collaboration for achieving the aims and objectives of education (Mohd et al., 2014).

Visualisation

This is a mode of "See learn" along with prototypes, working models, laboratory, videos, and online teaching and learning materials. Visualization is a cerebral picture where the capability to generate images inside one's cognizance influences the learning in students. The cerebral images permit people to envisage their understandings, existing thoughts, or imminent estimates. These cerebral imaginings can ensue instinctively, otherwise they can be persuaded over submission. Imagination is energetic for learning as it can benefit pupils to endure attention, make networks to preceding knowledge, image readings for better-quality delight, envisage concepts before scripting, apply recall approaches, and increase remembrance. Data visualization techniques using spreadsheets and various web-based tools, covers determining the best type of data visualization for data creation, format visual displays, and to create a word cloud from a variety of information sources (Carolyn et al., 2016). Movielike agility has meaningfully progressed with Smartphones can now advance superiority images and transmit them promptly to a common digital space in the cloud; an omnipresent poignant picture is flaking additional covering of its physicalness by codification. Through cloud, phone and camera, an unparalleled customization of picture formation to the theme of drenching documentations and their viewpoint on the world. Customizing the cloud usage to concertedly generate flicks with individuals globally. The selfless plan signals and moves the desire for evolving the medium by authoring the media, editing to preclude elements of aliveness inherent in the form of a video (Case, 2016).

Personalisation

This is a "Self-Learn" mode where the practice of computer based and facilitated blended learning grasps countless capacity as a lucrative and democratic facilitation to aid students to encounter trials in the fierce competitive world. The crucial to creation of tailored learning work caters to a larger population of participants in an adaptive digital surroundings and involvements, predominantly through its skill to exactly correct itself to the discrete learner. Attractive and customized content is substituting instructional learning contents or inputs from involved teachers to invest in innovative technological paraphernalia exploding to evolve new models which are demonstrating encouraging results to benefit personal digital learning thus offering to boosts persistence; with calibration enabled contents for providing lessons at the right level which can facilitate the learning progress; and finally accessible anytime, anywhere - teaching and learning; thus expands the availability of great teachers and smart content to everyone. Engagement hinge on whether participating students discover the theme appealing and whether the instructor can score a teaching space movement to riven teaching period such that the learners can commence by means of the tool, contribute in a thoughtful debate with the tutor, and then reappear to use the tool (Richard, 2020). Personalized learning thus includes all informal learning through Social Media, MOOC, and Peer learning, which are replacing education opportunities into a flexible, virtual blended classroom. Appealing to learners on a continuous 24 x 7 hours every day of the week, available anytime as and when required, cannot be made skillfully deprived of creatively as long as the class period and university experiences online. Inexpensive costs to use Internet access around the world is a great opportunity to

students population globally to take benefit of massive open online courses (MOOCs) and supplement online tutoring substitutions (Sharma et al., 2017).

Gamification

This is a "Fun-Learn" mode, supported with numerous technologies that consume and deliver development to improve student's inspiration through instructive simulation or games, as they comprise many features that endorse drive and therefore students make adaptations to be fundamentally driven to perform in games. This technique is being accepted within an enlightening context and has been to create an optimistic influence on learning. Every gaming activity to be motivating; should be designed carefully by applying strategies which are specifically developed to influence learner motivation. Contemporary teaching is obligatory in which the tutors cannot take learner's inspiration as approved, but they have an accountability to protect learner's inspiration to absorb. Therefore, tutors must encourage learners to do what they want-to-do by guiding and influencing the students' behavior in constructive directions (Richard, 2020), by the way of participation in Puzzles, Riddles, Jig Saw, Experimentation, Working Circuits and Quiz etc.,. Pondering the tenets of Industry 4.0, the teachers must empower their students to handle through and further investigate on the topic for a life-long learning. Tangible engineering skills both in processing and thinking can apply to emerging technologies, and should be embraced with the knowledge and experience in augmented reality, automation, machine learning, robotics, and model-based design. To deliver these new sets of skills, universities need to furnish educational patterns that can create interdisciplinary technology which has to be entrenched in interaction, be personalized, collective and applicable to social needs (Mogoş et al., 2018).

Problem solving & Projects

This is a "Do-Learn" mode, where experience results in knowledge, understanding of insight of the industrial requirements, its realities, data, explanations, skills obtained through recognizing, realizing, and understanding. The knowing field unfolds ideologically, as wide as all convictions which allows in the first place to just perceive all different views (Mayr, 2010). These comprise cooperative reliable actions, project-based education, flipped erudition settings, and online concerted environments. Collaborative settings that inspire students to reason disparagingly and put on facts and aids is a dominant constituent of social learning concepts. As teachers endeavor to generate cooperative erudition experiences for learners, authentic activities and anchored instruction promote sociocultural perspectives of learning by cheering the contextualization of erudition in the imitation of applied glitches, the expansion of artistic services through directed partaking in concerted clusters, and the usage of linguistic to both connect and adopt learning. Reliable actions contextualize erudition and permits for an assorted claim of skills and knowledge in the real-time situations. The operation of collective, dependable actions in conditioning practices classically contains students to collaborate to crack issues fixed in reality, shimmering the knowledge over the positioned reasoning. Educators, teachers, and coordinators provide a way to sustenance of these concerted exertions by framing the process of learning with paraphernalia and support, requesting enquiries that sustain learners' comprehension, and serving students to make intellect of the snags. Project-

based education engages learners in collaborative situations with complex problems and challenges requiring a collaborative learning nurturing students' to develop higher order skills (Richard, 2020).

Industry 4.0 employable skills

The employment should finally lure and hold the employees with rewards that offer motivation and speed up their contribution to the upliftment of the organization performance, which pushes the economic rewards and bonus or incentives to be a sought after effect which can be linked to their involved performance. Precise decision making, Coordination, Support services, Managing complexity, Higher levels of abstraction, Problem-solving, Self-driven, Excellent communication skills and Ability to organize their own work are the required human skills sets, in the future. Industry 4.0 touches the technology of Information and Operation requirements, to generate a cyber physical setting, therefore leading to unceasing growth in the Internet of Things (IoT), Big Data (BD), Cloud based computing, Reality scenarios involving Augmented and Virtual supports. Industry 4.0 advancements through deployment of Internet of Things (IoT) in identification tags using Radio Frequency (RFID) track to manage, along with software integrated machines and process systems are used to collect real-time data about their condition and performance (to cyber-physical systems), will break down silos, thus facilitating the customized manufacturing along with visual controls in robots taking on many human tasks. ML / DL procedures spread over commanding computational algorithms to analyse massive quantities of data sets, while the data visualization paraphernalia permits factories to effortlessly comprehend the content which the information communicates. Artificial intelligence (AI), robotic automation, self-directed or unmanned vehicles, augmented manufacturing (3-D printing) have all made much progress by comprehending and improving learning algorithms, nevertheless the encounter with the usage or application of artificial intelligence (AI) remains to continuously evolve (Bengio, 2009).

Future material progresses are now happening in nanostructures such as the innovative photovoltaic things involving nano crystalline silicon slim films and new chalcogenides, new catalysts with additional available surface area, nano arranged catalyst appendages and membranes. Light-emitting diodes (LED) with improved quantum effectiveness for illumination devices have more potentiality of use. The research and development space has opened up to new technologies in nano-bio, materials for energy storage, and enhanced computing in quantum mechanics. Nanophase Materials Science and Applications include carbon nanotubes, graphene, ceramic nanofiber networks, storage of energy in fuel cells, nano sensors, photonics, and growth of thin films. Technology-based e-learning incorporates the usage of the internet and additional imperative technologies to crop materials for education, impart learners, and regulate courses in an organization. With the emergence of telematics networks, interactive learning processes and the development of activities on the Internet emerged very significantly to create knowledge, as well as to distribute it through various knowledge networks (Javier et al., 2010). A web-based education provides to facilitate students with learning materials which are available and appropriately resourceful. Social understanding of web-based instructive exchanges, makes the individual learning processes and organizational dynamics in the distributed, digital instructional realm very easy. The Internet

replaces the prevailing teaching which is a monopoly to dissolve and make the teaching and learning conducive to flow in which a teacher shares the learning materials by space and time (Woolf et al., 2002). Change initiatives required as part of educational grooming includes the technical competence and most sought after, preparation for an engagement role in the new age industry with industry 4.0 specialties. These engagements would be of different kinds and that would be completely different from a subordination role that is currently practiced as "Do-as-said" to "Do-what-is-expected" role, wherever they get positioned. The organizational hierarchy will become a flat and circular matix type of organization with initiatives which integrate basic skills along technical terms and bring a more positive attitude to learning sandwiched between learners and enhanced fulfilment.

The use of the technologies for enhanced learning in engineering education depends on factors, like management decisions, institutional support, easy adaptation of the curriculum to be taught on some key technologies, openness of teachers to teach these technologies, stakeholders involvement and creation of learning environments that can simulate the use of emerging Industry 4.0. The acceptance of industry 4.0 technologies for enhancing learning in engineering education can be a very good solution to create the framework that the student needs (Mogoş et al., 2018). Industry 4.0 Learning enablers are in a nascent stage and are evolving, of course boosted to visibility of use during this pandemic, an illustrative list as in figure 1, throws some light on its emergence (Umachandran, 2020). The use of several technologies in the educational process will provide more interesting avenues and experience to both the teachers and students. The driver for using these technologies is facilitated by the timing of pandemic promoting an inclusive interconnection and integration of various disciplines in engineering to come together as an interdisciplinary initiative. These several users have broken the bigger and more complex systems into simpler ways for providing the community of learning with the opportunity to use several technologies at the same time. Enhancing the learning process using technologies for education requires to store data in cloud, using web conferencing tools such as Zoom, Google Meet, CISCO WebEx, FreeConferenceCalls along with Google Drive or OneDrive of Microsoft, and in some specific cases other simulation software and hardware are also connected through the Internet. Having each technology with its own particularities, putting and using them together in a single system represents an important challenge for an institution (Mogoş et al., 2018).

Teachers can use their learning objectives to determine the specific technology tools that are most appropriate to use, that which is familiar and comfortable to them. While deciding the implementation of the use of technology, first work with the relevant partners to select technology that is compatible with their goals, capacity and then create a plan to support students' ability to participate fully in the course. Sharing resources to help students access and troubleshoot technology, will be helpful to remind students that they should use their licensed versions and accounts, rather than a free account which may have limitations and time restrictions. Creating multiple options for students participation will require various levels of privilege and technological access to meet the course objectives. Hence teachers need to be flexible and determine a wholesome participation, by being lenient and considerate with students for issues related to their access to technology (Ginsberg, 2020).

Figure 1: Industry 4.0 learning enablers

Industry 4.0 Learning Enablers					
#	Area of application	Technology	#	Area of application	Technology
1	Self-learning Student & Teacher interactions	Web Conferencing Platforms	7	Assigning Rights Trails Disaster Management Systems Encryption Intrusion Malwares Hacking Incident Response	Cyber Security
2	Language Processing - Listening - Speaking - Reading - Writing Webinar	Web Conferencing Platforms	8	SaaS PaaS IaaS	Cloud-Fog-Edge Computing
3	Enhance engineering Communication Math skills Software engineering Cyber-security	Gamification	9	Image Processing Virtual Supports	Augmented Reality
4	Designing Drafting Usability Accidents Hazzards Safety	Simulation	10	Optical Fabrication Photo Solidification Fused Deposition Material & Binder Extrusions Powder Bed Fusion Photo Polymerisation	Additive Manufacturing
5	Process Systems Integration	Process Automation	11	Sensors Transducers Signal Capture & Use in digital environment	IoT
6	Data Systems Integration	Data Automation	12	Data Warehousing Computing Engineering Data Mining	Big Data
			13	Improving QWL HTA / SOC Applications	Robotics

Source: Umachandran, (2020),

Conclusion

Teaching leads to a practical advancement, only when it is adept of heading towards an employment prospect. Instructional learning is basically a social progress, life-long growth in which the public ecology directs the role of schooling to make an act of vigor. It is an awareness of that expansion and variation which remains all; at times even impacts beyond life; and its

acquaintance endures to have an inspiration on the student and their relation to one another, recognizing a vibrant period of life demonstrated by persistent reasoning, social, and inner growth. Industry 4.0 involves a variation in the alignment of teachers to be as architects of learning, then as contributors to instruction. To preserve our scholastic expertise and to grow at the rate required by the existing ubiquitous digital learners, a continuous inspection of evolving technologies is required along with the orthodox teaching practices and also suggest desirable changes is the pertinent need to the education. The main benefits of technology-enhanced learning for industry 4.0 education will be seen in the quality of university education and its applicability for making the students ready for industrial employment, life-long knowledge exchange across generations, interdisciplinary application, innovation, risk aversion, and scope for the evolution of entrepreneurial culture.

References

1. Bengio, Y. (2009). Learning Deep Architectures for AI, Technical Report 1312, Universit´e de Montr´eal, Canada, pp. 56.
2. Case, O. (2016), A Reconsideration of Cinema as a Collective Process Between Digital and Organic Networks, Department of Computing and Communications, Lancaster University, pp.233.
3. Dunne, J. P. (2003). 'Practical Reason', in N. Blake, P. Smeyers, RSmith, P. Standish (Eds.) The Blackwell Guide to the Philosophy of Education (London: Blackwell Publishing), p. 197.
4. Ginsberg News., (2020), Community-Engaged Teaching During Covid-19, M Student Life, University of Michigan, U-M COVID-19 Updates, U-M Gateway, The Ginsberg News. Available at: https://ginsberg.umich.edu/article/community-engaged-teaching-during-covid-19.
5. Heng, C. L. (1998). Educational work with factory women in Malaysia, University of Warwick, pp. 311.
6. Jane Green., (2007), Beyond managerial rhetoric: reclaiming what is practical, personal and implicit in the idea of educational accountability, Institute of Education, University of London, pp.322.
7. Javier Echeverría, Andoni Alonso, Pedro J. Oiarzabal., (2010), Knowledge Communities, Conference Papers Series, Center for Basque Studies, University of Nevada, pp.252.
8. Johnson, W. D. (2018). Learning to listen: Knowledge of value in auditory culture, The University Of Chicago, pp.358.
9. Kashtan, M. (2014). Reweaving Our Human Fabric Working Together to Create a Nonviolent Future, Fearless Heart Publications, pp.446.
10. Koohang, A., Bourhis, D. A., & Jacob, R. (2006). Towards a Typology of Virtual Communities of Practice Line, *Interdisciplinary Journal of Information, Knowledge, and Management*, Volume 1, 2006, pp.25. Available at: http://www.ijikm.org/Volume1/IJIKMv1p069-093Dube.pdf
11. Lyotard, J. F. (1984). *The postmodern condition: A report on knowledge* (Vol. 10). U of Minnesota Press.
12. Mayr. F. P. (2010). Conscious Using Relatedness. Systemic Conflict Transformation in Political Constellations, International Studies in Peace, Conflict and Development, University Jaume I Castellón de la Plana, pp.367.
13. Mcdaniel, R. (2017). How is the current political climate impacting your interactions with your students?, Monday, April 3, 2017 in Commentary, News, Resource, Vanderbilt University. Available at: https://cft.vanderbilt.edu/2017/04/how-is-the-current-political-climate-impacting-your-interactions-with-your-students/.
14. Mogoş, R., Bodea, C., Dascălu, M., Safonkina, O., Lazarou, E., Trifan, E., Nemoianu, I. V. (2018). Technology Enhanced Learning for Industry 4.0 Engineering Education, Rev. Roum. Sci. Techn.– Électrotechn. et Énerg. , Bucarest, Vol. 63, 4, pp. 429–435.
15. Mohd, C. K., Shahbodin, F., & Pee, C. H., (2014). Personalized Learning Environment (PLE) Experience in the 21st Century: Review of Literature.
16. Mosco, V. (2014). To the cloud big data in a turbulent world, Routledge , pp.240.

17. Phelps, R. (1993). Nieman Reports at Harvard university, Vol XLVII, No. 3 Fall 1993. Available at: https://niemanreports.org/wp-content/uploads/2014/04/Fall-1993_150.pdf

18. Richard, E. W. (2020). Foundations of Learning and Instructional Design Technology The Past, Present, and Future of Learning and Instructional Design Technology, pp.1221.

19. Santiago B.J., Ramírez J.M., Rodríguez-Reséndiz J., Dector A., García RG, González-Durán J.E. & Sánchez F. F. (2020). Learning Management System-Based Evaluation to Determine Academic Efficiency Performance, Sustainability 2020, 12, 4256; doi:10.3390/su12104256.

20. Sharma, S. K., Shailendra, C. Palvia, J., & Kumar, K. (2017). Changing the landscape of higher education: From standardized learning to customized learning, Journal of Information Technology Case and Application Research, 19:2, 75-80, DOI: 10.1080/15228053.2017.1345214.

21. Talmadge. C., & Gale, J. (2016). Introduction to Data Visualization Techniques Using Microsoft Excel 2013 & Web-based Tools, Tufts Data Lab 1, pp.15. Available at: https://sites.tufts.edu/gis/files/2016/02/Introduction_to_Data_Visualization.pdf

22. Umachandran, K. (2020). Industry 4.0 Learning Enablers, DOI:10.13140/RG.2.2.19447.24483.

23. Woolf B.P., Lesser V., Eliot C., Eyler-Walker Z., & Klein, M. (2002). A Digital Marketplace for Education. In: Chin W., Patricelli F., Milutinović V. (eds) Electronic Business and Education. Multimedia Systems and Applications Series, vol 20. Springer, Boston, MA. https://doi.org/10.1007/978-1-4615-1497-8_1.