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Developing A Conceptual Framework of Teaching Towards Education 4.0 In TVET Institutions

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Abstract

Education 4.0 inspired by Industrial Revolution 4.0 (IR4.0) has become a buzzword among researchers in educational sector. The educational system must reinvent quickly to adapt to the demands of IR4.0 because the future of jobs required highly trained workers to be able to meet and solve all aspects of challenges engendered by IR4.0 technologies. It seems the future of job at risk of automation. In order to prepare the coming generations with all aspects of skills demanded by IR4.0, this study aims to analyze and identify the gaps in the literature based on the six mentioned sections in this study to prepare educators towards Education 4.0. Thus, the study has identified the gaps in the reviewed literature and it concludes that educators must have a reference base to assist themselves in teaching towards Education 4.0. This study adopted 11 frameworks as references base to generate a conceptual framework of teaching for TVET Institutions, particularly for Engineering Technology. The aim of the conceptual framework of teaching for educators is to improve the quality of teaching and to prepare educators teaching towards Education 4.0 in TVET Institutions in Malaysia.

Keywords **:** *Teaching and learning, Education 4.0, Conceptual framework, TVET Institutions*

I. INTRODUCTION

There are four stages of the industrial revolution that started from Industrial Revolution 1.0 to Industrial Revolution 4.0. Previous studies of [1],[2] have revealed that the first industrial revolution spanned from about 1760 to around 1840 by the invention of water and steam engine in mechanical production [1],[2]. The second industrial revolution started in the late 19th century to the early 20th century which from about 1870 to around 1914. Throughout the century, this second revolution used electric power to create mass production. The third revolution called the computer or digital revolution because the used of electronic and information technology i.e computer and internet. Over the past decades, the world has seen the stunning transformation from the first industrial to the third industrial revolution. Next revolution is fourth industrial revolution merely known as Industrial Revolution 4.0 (IR4.0) or Industry 4.0 is the discovery of various new technologies such as automation, Internet of Things (IoT), analysis and big data, simulations, system integration, robotics and cloud utilization that will accelerate the development of the modern world landscape [3].The concept of the Fourth Industrial Revolution is ubiquitously being used in industry, research, academic and business. According to [4], Industry 4.0 technologies have been adapted and successfully contributed to economic and social development but its implementation in the educational system is still in an explored issue. Now, we are already living in the Fourth Industrial Revolution that has been characterized by the emergence of artificial intelligence, Internet of Things(IoT), robotics, nanotechnology, cyber-physical systems, 3-D printing, quantum computing etc. Those advanced technologies have been implemented in educational systems to evolve from traditional education to Education 4.0.

II. LITERATURE REVIEW

This paper is structured in five sections which are the impact of Industrial Revolution 4.0 (IR4.0); relationship of IR4.0 with Education 4.0; technology enhance teaching and learning; roles of educators towards Education 4.0; and framework for Education 4.0. Recently, the authors have reviewed these related sections from various resources to identify the gaps in these sections.

A. Impact of Industrial Revolution 4.0 (IR4.0)

The common issues and challenges regarding Industry 4.0 is a lack of digital culture, training, and knowledge-based on worldwide context [5].

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According to [6], inadequate knowledge or training is one of the most important challenges faced by Industry 4.0, which is highlighted that the occupational sectors are in a risk of automation. In other concern, fresh graduates who excel academically have issues in adaptability, multitasking, decision-making, and problem-solving skills in the workplace. On the worst side, the consequences of Industry 4.0 undoubtedly increase the unemployment rate. Factors that contribute to unemployment are lack of employability skills and experience [7],[8]. Other unemployment factors amongst TVET graduates are lack of job experience, lack of labour market information and poor employability skills such as communication [9] Besides, TVET graduates also lack in problem-solving and decision making, lifelong learning and competencies [10].Hence, transformation in the teaching process is a must to produce students to be work-ready graduates for them to face the challenge of the IR4.0 era.

In either case, research by [11] stated, in the United State, it is expected that within the next 10 to 20 years, about 47% of all jobs will be replaced by automation. Obviously, there will be a shortage of skills instead of a shortage of jobs because the technological advances required new skill sets in the workforce of the future and it must be constantly upgraded in response to the demand for new skills. The skills that are relevant in the IR4.0 era are technological skills, programming skills, and digital skills (includes data analytics and cybersecurity skills) [12]. Besides, creativity, complex problem solving, critical thinking, social and cognitive skills are prominent to fill the requirements of IR4.0 [13]. Hence, updated skills and new skills will be a fundamental requirement in IR4.0 because technologies have created massive changes in industries and demanded skills development. There is an utter need for students to upgrade their skills due to mismatch of current skills with the skills of the IR4.0 era and the increase of employability rate. In order to develop employability skills, the role of educators by acting as facilitators amongst students will bring awareness about employability skills, encourage self-analysis in students about their strengths and capabilities and lastly, attract students to participate in activities to support those strengths and capabilities [14]. Consequently, it creates the greatest challenge to educators on how to provide knowledge and skills that will serve students for better and long-term jobs. A similar revolution in technology is required in an educational system especially in Higher Education to meet the needs of industries to ensure the best possible educators and students experience. Technologies are often described as a medium of collaboration to enable educators and students to actively engage with solving problems in authentic environments to support their teaching and learning [15]. Moreover, the use of technologies challenges the role of Higher Education, especially in Technical Vocational Education and Training (TVET) sectors.

Bare in mind that the quality of TVET education plays a crucial role in economic growth and it should not be neglected [16]. In Malaysia, TVET is a new action aimed at enhancing the image and quality of education to uplift Malaysia towards the status of World Class Education. Based on the Eleventh Malaysia Plan (11MP), the government has transformed an education system which focuses on four areas, improving the labour market efficiency to boost economic growth, transforming TVET to meet industry demand, strengthening lifelong learning to improve skills and system quality education for better student understanding and industry excellence. However, the transformation must be in line with the competency of educators and their understanding of Education 4.0 for educators to effectively facilitate the acquisition of IR4.0 demanded skills to work-ready graduates.

B. Relationship of IR4.0 with Education 4.0

Since those technologies continue to evolve the world, all aspects of human lives will be facing new challenges, especially in teaching and learning. The effect of IR4.0 changed educational experience in teaching and learning to respond to the IR4.0, which has been noted by researchers [17],[6].Accordingly, the technology-enhanced teaching and learning is known as Education 4.0, which is inspired by Industry 4.0 aims to improve the digital technological competencies across all fields and to enhance the use of digital technologies in teaching and learning [18],[6]. Besides, Education 4.0 is a current trend of teaching to produce students that have abilities, skills, and information to defeat smart robots [19]. It is emphasized that the acquisition of technology-supported teaching and learning is currently in high demand [17],[20].

Furthermore, educational institutions should be exposed to Education 4.0 in the teaching and learning process where the use of technology has

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widely been used in an educational context. According to [21], the use of technology provides a lot of advantages in the educational context which leads to the increasing number of interested and attentive educators to integrate the emerging technologies in teaching and learning. If the technology harnessed correctly in an educational system, it could be powerful tools for educators to develop appropriate learning and teaching environments. Besides, it can create a more realistic and practical approach in teaching and learning thus resulting in great student learning outcomes. In the use of technology, it empowers educators by giving them tools that make their jobs easier, which in turn improves student learning outcomes. Moreover, students have better access and relationships with various resources and tools because those tools and technologies help students learn much better and effectively than previous teaching and learning methodologies.

Education 4.0 might create teaching experience similar with working experience by creating a similar environment for both through the use of technologies and tools. Education 4.0 might involve various stakeholders such as educators, industries, communities, and governments. The use of technology in the learning process must be dynamics and allow interaction between stakeholders so that students can have experiential learning [22] Higher Educational institutions are ideally placed on educating the workforce and allowing students to grow with technological competences for their needs in the innovative era. Technology embedded in education will radically transform jobs and competence profiles. Therefore, it is necessary to engage in advanced technologies by integrating an innovative method to enhance the teaching and learning process [23].

World Economic Forum (Jan 2020) highlighted eight critical characteristics and skills to define high-quality learning demanded by the Fourth Industrial Revolution for Education 4.0, which are global citizenship skills; innovation and creativity skills; technology skills; interpersonal skills; personalized and self-paced learning; accessible and inclusive learning; problem-based and collaborative learning; and lifelong and student-driven learning. These are keys driven for students to thrive in the future of work and adapt to economic and social needs. As aforementioned skills above, education plays one of the key roles to prepare those skills for students to cope with IR4.0. Besides, the use of technology needs to be designed with awareness to facilitate teaching and learning and give impact on skills development. It is a challenge for educators in implementing the use of technologies into sustainable teaching practice towards Education 4.0.

In addition, learning material and curriculum must be aligned and continuum improvement of the suitability between these two to determine the success of learning. The curriculum is a blueprint of actions in teaching and learning that creates students' experience of learning for a whole program of study [24]. Students' experience of learning reflects on the effectiveness of the curriculum in understanding and managing students' expectations. Nowadays, students are able to take ownership over their learning process and create their own learning experience. Technology as a learning material or tool able to support multiple tasks and activities in teaching and learning by exploring new pedagogical options. In spite of the assertion, curriculum must be designed according to the students learning process instead of technologies and its availability [24]. Educators and students are interconnected via a wide range of information technologies that can supplant traditional teaching and learning. Educators no longer as curator and purveyor of knowledge but as facilitators or instructors.

Besides, the integration of technologies and pedagogies needs to be implemented in teaching and learning strategies [25]. To address these challenges, it requires systematic reformation in education to close ties between learning material and curriculum and not just focus on technology yet also requires alignment between policy and other components to enhance technology in teaching and learning. Therefore, educators must engage constructively with technologies by recognizing the ways of using these technologies with students to support teaching and learning. Substantial changes in curriculum are required to allow students to develop capacity in the rapidly emerging technologies.

C. Technology-Enhanced Teaching and Learning

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According to 2016 Universities and Colleges Information Systems Association (UCISA) Report, technology-enhanced teaching and learning defined as '*Any online facility or system that directly supports learning and teaching that includes a formal Virtual learning environment, e-assessment, or e-portfolio software, or lecture capture system, mobile apps or collaborative tools that support students learning*' [26]. It should be noted that problem-based learning, work-based learning, and technology-enabled learning are teaching and learning approaches that can create opportunity for employability because those learning approaches equipped students with related skills in the rapid and unpredictable changes workplace environment [27].Otherwise,[28] emphasize learning approaches such as online learning, virtual learning, social learning, open learning and blended learning is highly recommended in the era of IR4.0. Along with game-based learning, gamification, augmented and virtual realities are gradually into teaching and learning approaches[29].

If all the learning approaches are prepared sufficiently on the skill requirements for IR4.0, teaching and learning towards Education 4.0 will succeed. Clearly, the learning approaches play one of the key roles for the future development of Education 4.0. Therefore, educators should have innovative strategies and modern learning strategies to enhance students' engagement in the learning environment. In the technology-supported learning environment, Massive Open Online Courses (MOOCs) are widely used in teaching and learning for distance education. MOOCs are free online courses which are available to access by anyone with a smart device and internet connection.

Indeed, it promises to solve problems regarding teaching loads, expensive tuition fee, and unemployment for skill demands also a platform for skills development and strengthen an existing professional career and offer flexibility for distance learning [30],[31]. On the other hand, SPOCs (Small Private Online Courses) are also one of the platforms that offer the same interest as MOOCs that provide online distance learning [30]. Researchers [30] informed that online learning is an open window to develop modern forms of teaching for the next generation of students who are digital natives. Distance learning is a suited process of learning that is required by IR4.0 towards the development of Education 4.0. But, the majority of MOOCs participants are from the United States, France, and Australia and reported that participants are amongst educators with extensive teaching experience and an active interest in web-based learning design [32].Moreover, MOOCs require students to be self-directed learning more than in traditional courses which students need to be fully responsible for both their learning sessions and their homework [33]. Also, it encourages educators to design an effective learning assistance to motivate learners to persist in learning by engaging students in problem-solving instructional strategy or group discussion to create cooperative learning. Educators must be prudent to attract students' satisfaction and killing discomfort that affects discontinuation learning using MOOCs. Previous research by [34] has shown that instructor-learner interaction, instructor support and instructor feedback in MOOCs have a positive impact on students retention and course content on perceived effectiveness.

Nevertheless, there is a lack of empirical studies referencing VET MOOCs strategies as VET pedagogy relies heavily on skills acquisition rather than MOOCs delivery [35],[36]. Furthermore, researchers [35] have identified six functional approaches that promoted retention and engagement of learners, which are good quality instructional course design, well-developed assessment tasks aligned with course objectives, opportunities for learners to collaborate, instructor commitment to timely contextualised communication, certificate for course achievement. and lastly pathways to further study. Improving retention and engagement of learners is a challenge for VET MOOCs as technology advancements transform teaching and learning pedagogy. Therefore, further research must investigate students' perceptions on MOOCs learning towards Education 4.0. There are eight course design factors for VET MOOCs to gain learner retention and engagement which are short course durations, manageable workloads, non-compulsory learning tasks, peer discussion opportunities, instructor involvement, auto-graded assessments, statements of attendance, and supplementary learning pathways [36]. Therefore, it might be interesting for VET MOOCs to be one of the prominent online courses in TVET education towards Education 4.0.

In an emerging technology of IR4.0, blended learning has become a favourable approach in teaching. Blended learning is described as a combination of traditional face-to-face learning with online learning. [37] highlighted four challenges in

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the online component of blended learning for educators, namely technological literacy and competency challenges, online video challenges, technological operation challenges, and educators belief challenges. If these challenges are well overcome, it will create benefits to educators to be technological competence, use and manage technology effectively for teaching, and create attractive learning materials.

Out of the blue, the Corona Virus Disease (COVID-19) was first reported in Wuhan, China in December 2019 has spread to almost all countries and become a global pandemic issue [38].To encounter the spreading, governments have imposed quarantines and travel restrictions on a massive scale. These restrictions also applied to all educational institutes in response to the need for social distancing. In fact, in-class learning such as teaching conferences, workshops and laboratory activities should be avoided and moved to information technology platforms to facilitate teacher-student interaction [39] .Given all of these sudden changes, there is still a need to maintain educational mission where remote learning has become the solution even few educators lack the expertise and experience using technologies effectively [40].There are many research areas impacted by Covid-19 and one of them is the information technology revolution. According to [41], this information technology revolution has been used during this crisis as new learning modules, conducting online classes, and conducting virtual labs. Meanwhile, [40] suggested using free open online platforms to aid learning during self-distancing such as virtual learning and meeting through WebEx, Zoom or GotoMeeting and harnessing information through their institution databases. Virtual learning platforms have remarkably reshaped and innovated on how teaching and learning may be conducted through these platforms [42]. Amid the Covid-19 pandemic, enormous online platforms such as Canvas, Zoom, and Google Drive are currently engaging on blended learning and the successful depends on the stability of internet connections and comfortableness running those platforms [43]. Similar capabilities can be accessed through WebX, WebEX, skype Google Meet for educators and students to have a live video feed, so educators can see who is currently attending and see responses of the students. E-learning is also one of the online education to continue learning during the quarantine period that has been used by most leading countries in the US, UK, India, China and South Korea [44]. These distance learning platforms such as Google Classroom, Coursera, Udacity etc allow students engagement from any location and to keep students in line with education [45].

The outbreak of Covid-19 has pushed the limits of technologies used in the online experience. E-learning acts as a supportive online platform for educational institutions while governments handle this situation. Technologies of Industry 4.0 have a capability to perform daily life work during Covid-19 crisis in education aspects such as used virtual reality for training purposes, distance education, remote and online learning [46]. Adopting blockchain technology in e-learning systems is one of IR4.0 technologies that can solve issues like insufficient user interactivity and system interoperability in the e-learning systems [47]. During this crisis, digital technologies provide multiple resources for teaching and learning processes in remote areas. Another learning opportunity is through web-based learning for knowledge sharing and reviewing literature via subscription to journals [48]. At this period of crisis, web-based learning platforms are available for free access. [49] has highlighted Industry 4.0 technologies that may be useful to solve this Covid-19 crisis. A few of those listed technologies can be implemented in educational aspects in order to maintain the educational mission, which are:

- Virtual reality (VR): It is a digital technology that provides a simulated experience which is immersive, realistic, and 3D dimensional environments that visualize almost the same or different from the working world. Its applications include video games, 3D games and educational training. Another application is virtual conferencing, it would improve accessibility for remote by reducing costs and travel distances [49] Virtual reality has been an excellent tool for communication and collaboration where it provides an opportunity for people to work together in real time. VR promises to provide an immersive and engaging experience with its application especially in education. Plus, VR has a potential to provide participant enthusiasm in educational activity, create authentic experiences, an opportunity for constructivist learning, enhance creativity and easily visualise difficult models [50].
- Holography: It is a 3D photography and the record is called a hologram. It presents a 3D view with changing perspectives and It can conduct conferences and live events where people can attend live streaming at the same time just by

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staying at home.

- Cloud computing: It is a digital technology which involves the delivery of computer system resources over the internet such as servers, storage, databases, networking, intelligence etc. People have been able to continue their digital lives with the help of applications like Zoom, Slack, Netflix through services such as Amazon Web Services, Microsoft Azure, and Google Cloud.
- 3D scanning: It is used to convert the physical part in CAD digital data. Its output is used for the analysis of real world objects for collecting data about its shape and appearance. 3D scanners are useful in developing video games and movies. The applications of this technology are virtual reality, motion capture, robotic mapping, and industrial design.

By properly implementing these technologies, it would help to enhance education aspects and would provide a lot of innovative ideas and solutions towards Education 4.0. COVID19 pandemic crisis has forced educational institutions to implement teaching and learning through technologies. Once this crisis has been solved, the coming months will likely see a maturation of educators in conducting teaching and learning through a variety of technology applications.

Advanced Industry 4.0 technologies in the workplace will require a certain learning method for engineering professionals such as learning factory or known as teaching factory. Teaching factories can make substantial contributions to address the need of industries and employees for achieving the goal of Industry 4.0. Challenges facing in a workplace i.e lack of skills for Internet of Things (IoT) [51]; employees are not prepared for successful use of Industry 4.0 [52] can be mapped through teaching factories.

Learning factory is an effective approach in developing theoretical and practical knowledge in a real-life industrial environment [53],[54],[55]. Thus, it offers knowledge and skills improvement for students as students are able to tackle processes and technologies involved in their learning that are based on real-life industrial environments. As aforementioned above, the concept of learning is focused on problem-based learning and experimental related to real-life industrial environments. One of the factory automation modules is Festo Didactic 4.0, it enables technology transfer, university and company level education in many different engineering disciplines and covers up consulting activities on Industry 4.0 topics [56]. This platform could foster collaboration of practitioners and educators on the development and testing of new technologies. Students need to be prepared for work-ready graduates for the changed job profile by getting acquainted with plenty of new technologies related to Industry 4.0.

D. Roles of Educators Towards Education 4.0

Besides that, the readiness of educators is a demand to make changes in teaching to face the IR4.0 era. Unfortunately, there are several problems, which are Internet connection is often at snail's pace, availability of network connection, students enrolled in virtual learning dropped out of their learning due to the absence of human factors [57]. Therefore, educators must be active, skilled, and experienced in using innovative technologies and tools to provide support and need for students in teaching and learning. Students will gain benefits from learning with technologies if proper alignment of the technologies is done with pedagogy combined with teacher's efficiency in integrating it. According to [58], educators in TVET should have digital skills for effective instructional delivery as well as assessment of instruction. TVET educators not only need to be expert in their subject area but need to have up-to-date skills in technologies relevant to meet the changing technological world of work. In the IR4.0 era, educators play as an instructor in a technology-supported learning environment. Instructional support is prominent to encourage students to persist in their learning [59].

Teaching and learning in context of technologies required competency-based as a basic approach for transformation in education. Competency is a collection of related knowledge, skills, and attitudes of a person to perform any specific task [29]. Competency in educators will bring success in teaching and give meaningful learning experience to students. Furthermore, this transformation can be achieved by having professional development programs for educators to develop their competencies in preparing students to be work-ready graduates [60]. According to [61], educators are currently moving towards technological advancement teaching approaches.

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E. Framework For Education 4.0

Several preference documents involve the use of ICT, digital, and media in teaching and learning for stakeholders such as educators, students, policy developers and others can use as a reference to improve the quality of education system namely:

- UNESCO ICT Competency Framework (ICT-CF) for Teachers. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has created UNESCO ICT Competency Framework (ICT-CF) for pre- and in-service teacher on the use of ICTs across education system [62]. This framework is a response to recent technological advances in education and learning.
- European Pedagogical ICT Licence (EPICT). It certifies teachers'digital competences based on the European Framework DigCompEdu. See www.epict.org. EPICT offers in-service training for the continued professional development of teachers by focusing on the pedagogical integration of ICT in the teacher practice [63].
- Technological, Pedagogical, and Content Knowledge (TPACK). This framework is the interconnection and intersection of technology, pedagogy, and content knowledge [64]. The purpose of this framework is to successfully use technology in teaching and learning.
- Common Digital Competence Framework for Teachers (CDCFT). This framework is a reference framework for the improvement of digital competences for teachers [65] and made up of five competence areas and their 21 competencies defined in six proficiency levels. This framework is an adaptation from European Digital Competence for citizens (DidComp) and European Digital Competence Framework for Educators (DigCompEdu).
- European Competence Framework for Educators (DigCompEdu). This framework is an initiative for the development of educators'digital competence in Europe. It is a set of digital competences to seize the potential of digital technologies for educators in their profession to enhance the education system [66].
- Australian Professional Standards for Teachers. These standard provide a framework to prepare, support, and develop teachers professional expertise. These standards are grouped into three domains of teaching which are professional knowledge, professional practice, and professional engagement. Also, the standards comprise seven standards which outline teachers' practise [67].
- ISTE Standards for Teachers. These standards as a guideline for educators in the use of technology resources and skills to create innovation in teaching and learning, enrich their professional practice and deliver positive influences to students, colleagues and community. These standards comprise five standards which are: facilitate and inspire student learning and creativity, design and develop digital age learning experience and assessments, model digital age work and learning, promote and model digital citizenship and responsibility, and engage in professional growth and leadership. Each standard contain list of performance indicators required by educators to perform in their work practice [68].
- eTQF Teacher ICT Competency Framework. The framework aims to support the development of teachers competency in the use of ICT in education. The framework comprises four sections which are ICT, pedagogy, curriculum and assessment, and teacher professional development. Each section contain four levels that represent the progression of teacher competency[69].
- Technology-Enhanced Teaching Self-Assessment Tool (TET-SAT) Practical Guidelines for Teachers. TET-SAT is a tool developed by MENTEP, Mentoring Technology-Enhanced Pedagogy project. TET-SAT assesses four digital competency areas which are digital pedagogy, digital content use and production, digital communication and collaboration, and digital citizenship. Also, there are fifteen sub-areas of Technology-Enhanced Teaching competence [70].
- ICT-Enhanced Teacher Standards for Africa (ICTeTSA). It provides a framework for teacher professional development by using Information and Communication Technologies (ICTs). The framework comprises six domains which are engaged in instructional design processes, facilitate and inspire student learning, innovation and creativity, create and manage effective learning environment, engage in assessment and communication of student learning, engage in professional development and model ethical responsibilities, and lastly understanding the subject matter for use in teaching [71].
- Media and Information Literacy Curriculum for Teachers. It consists of two parts which are curriculum and competency framework and core and non-core modules. In this study, researchers

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focus on curriculum and competency framework that help teachers understand and explore about media and information literacy thus engage with them. The framework consists of six key curriculum areas which are policy and vision, curriculum and assessment, pedagogy, media and information, organization and administration, and lastly teacher professional development. This framework adapted from UNESCO ICT Competency Standards for Teachers, 2008 [72].

- Professional Digital Competence Framework for Teachers. This framework consists of two aims which are for professional development and the actual practice of the profession. This framework can be used as a reference for teacher professional development and improve the quality of teacher education. It consists seven competence areas namely, subjects and basic skill, change and development, school in society, interaction and communication, ethics, leadership of learning processes, and lastly pedagogy and subject didactics [73].
- TVET 4.0 Framework (2018-2025). It consists of six thrusts and supported by eleven strategies to achieve six expected outcomes in TVET education to be dynamic and competitive education system [74].

III. DISCUSSION

The Fourth Industrial Revolution presents a set of challenges to the educational sector in preparing students to be well-equipped with updated skills for them to make the right career decisions and thrive at work. Educational institutions focusing on TVET institutions should embrace an education revolution in their teaching and learning known as Education 4.0. Research by [75],[29],[76] highlighted 6 attributes to create success in teaching with the support of technology are intentional, content centrality, authentic work, active inquiry, construction of mental models, and collaborative work. All these attributes will be successful with the support of technology. Other important attributes of Education 4.0 are flexible learning, personalized learning, digital learning, project-based, mentoring become significant, practical application, and ownership of student, and constant evaluation [77],[78],[79]. All those attributes are necessary to adequately to meet the need of Education 4.0. Undoubtedly, if the technology harnessed well in the teaching and learning, it would define high-quality of teaching and learning system. Issues and challenges such as lack of digital culture, inadequate knowledge and training, lack of experience in handling advanced technologies and tools would be overcome because skills demanded by IR4.0 are covered in teaching and learning.

IR4.0 will wholly transform workers'job and competence profiles for the autonomous industry thus it is necessary to provide training for professional development for educators to upskill and update their skills set. Educators in TVET institutions that focus more on practical works than mathematical practices must be more competence in handling technology as learning materials and tools. Instead of the application of technology in teaching and learning, pedagogy and curriculum must be aligned with the students learning process to elevate students' engagement in the learning environment.

IV. CONCLUSION

This study highlighted encouragement to cultivate a new mindset and skillset to fill the void of challenges created by IR4.0 in education. The educators should be willing to adapt to these changes and able to attract students' interest in teaching and learning. On the other hand, the COVID 19 outbreak has accelerated reformation of education systems towards Education 4.0 in the uses of cloud-based platforms, internet, and other related technologies into educational systems. [80] consent about the Covid19 outbreak and urge educators to encourage students towards online self-directed learning, conduct multi-dimensional learning evaluation, and credit student online achievement. The COVID19 has brought huge disruption to the educational system in the way of delivery curriculum and pedagogy. In this sense, educators required further professional development to shift from the traditional educational system to Education 4.0. To provide a professional reference base for the implementation of teaching towards Education 4.0, a conceptual framework should be developed. Therefore, this study advocates developing a conceptual framework which could support teaching and learning towards the future education system. The development of the conceptual framework is a strategy to implement digital technology in teaching and learning for educators to construct their teaching strategies. Currently, there is no standardized framework of teaching and learning in the Higher Education especially in TVET Institutions that aligned with digital innovations for educators towards Education 4.0. Therefore, researchers have adopted all frameworks in this study as references to generate a conceptual framework in order to be harnessed in a pedagogical environment specific for TVET Institutions. As the main reference, [29] recommended looking at UNESCO work discussion and direction on education in this new era of teaching and learning. UNESCO ICT Competency

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Framework was launched in 2008 to help educational policymakers and curriculum developers identify the skills educators need to harness technology in education and has been widely studied on lower and secondary school [81] but only a few studies have been carried out on higher education [82]. In this regard, this study undertakes initiatives to develop a conceptual framework for TVET Institutions towards Education 4.0 that acts as the best reference for educators to upskill educators to face challenges created by IR4.0. The suggested conceptual framework as displayed in Figure 1.

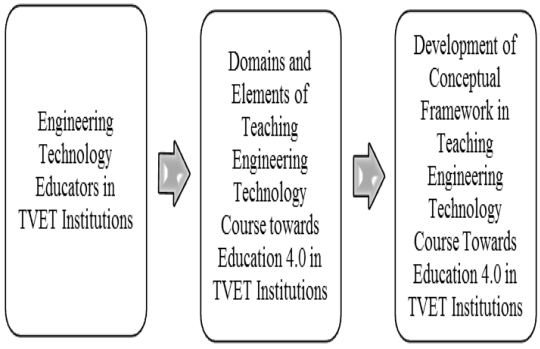

Figure 1: Conceptual Framework

As shown above, a three-step process is adopted in this paper. Firstly, Engineering Technology educators in TVET Institutions are selected as participants for this survey. After that, domains and elements of teaching Engineering Technology course towards Education 4.0 will be created from data analysis through analysis documents, semi-structured interviews with experts, and PLS-SEM. Lastly, the development of a conceptual framework in teaching Engineering Technology Course Towards Education 4.0. This conceptual framework is a suggested framework for teaching towards Education 4.0 in TVET Institutions. It is expected that the conceptual framework can help educators to prepare teaching and learning that are in line with the development of online-based technology and information. Hopefully, the conceptual framework will be a paradigm shift of teaching towards Education 4.0 and to improve the qualities of TVET students.

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