

Innovative Pedagogies in Teaching and Learning: A Strategy for Upskilling and Reskilling Industry-4.0 TVET Workforce

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Abstract:

➤ *Introduction*

The emergence of IR4.0 undoubtedly, caused many remodeling in industrial workforce, and TVET education. These alterations are driven by digital innovations, disruptions and transformation. IR4.0 advent has posed skills mismatch challenges in teaching and learning of TVET, labor market requirements especially in the areas of IoT, AI, robotics and others. It's only innovative pedagogies in teaching and learning that can upskill and reskill IR4.0 TVET workforce.

➤ *Objective*

The study aim is to examine innovative pedagogies in teaching and learning as a strategy for Industry-4.0 (IR4.0) Technical and Vocational Education and Training (TVET) workforce upskilling and reskilling.

➤ *Statement of the Problem*

The composition of employment, nature of tasks carried out at workplaces, and skills requirements in the labor market has changed due to IR4.0 impacts on industrialization, digitization, and AI. Therefore, “how do we respond to this era for quick and smooth transition to IR4.0 skill-equip workforce using TVET system”? The practical option is finding upskilling and reskill strategies for IR4.0 TVET workforce using innovative pedagogies in teaching and learning.

➤ *Methodology*

To achieve this, the study adopted a descriptive research design; Two research questions were raised to guide the study and a total 73 TVET Educators participated in the study. The instrument for data collection was a self-structured questionnaire (URSIR4.0WE); and data collected were analyzed by the researcher using SPSS software V20. A reliability coefficient of 0.89 was established.

➤ *Results and Findings*

The study identified among others, blended TVET distance learning with workplace learning; learning in technology-enhanced classrooms and workshops; on-the-job training supplemented with classroom, and distance and online learning; and fully distance and online learning as innovative pedagogies in teaching and learning that can foster digital IR4.0 skills among TVET workforce.

➤ *Conclusion*

The study summarized that stimulation of professional development of TVET Educators, by strengthening training programs with emphasis on: digital skills on AI, virtual reality and clouds computing; redesigning of TVET curriculum for demand-driven courses for IR4.0; Partnership between government, industry and TVET institutions; long-term strategic teaching plan for ICT integration in TVET system and others are the best strategies for IR4.0 TVET workforce upskilling and reskilling.

Keywords: *Innovative Pedagogies, Teaching and Learning, Upskilling and Reskilling, Industry-4.0 & Technical and Vocational Education and Training (TVET) Workforce.*

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I. INTRODUCTION

The use of conventional chalk-talk method in teaching and learning of TVET in the classroom can only provide basic knowledge of science and technology. The approach can no longer serve the present-day reality, they are traditionally impractical, outdated, and has limited scope [1]. The reason why modern teaching in education is the need of the hour, is because it creates a literate society, and in the process of educating the society, the teachers themselves serve the functions of motivation, instructional guides, and in most cases, they become major learners' motivators [2]. The concept of innovative pedagogy in teaching and learning requires modern teaching methods that will assist in building or developing a productive understanding of basic science and technology. [1] mentioned some of the elements of contemporary teaching methods as: learner-centered, task or activity-based, resource-based, interactive and integrative in nature and peer collaboration.

Technical and Vocational Education and Training (TVET) in extension to the general education, are those facets of the educational processes involving, the study of technologies and related sciences; acquisition of practical skills and attitudes; and understanding and knowledge related to occupations in various sectors of economy and social life. TVET philosophy is centered on "learning by doing" which is the pillar of skill development [3] [4] [5]. According to [6] TVET have different names in different countries and regions such as: Apprenticeship Training, Vocational Education, Technical Education, Technical-Vocational Education (TVE), Occupational Education (OE), Vocational Education and Training (VET), Professional and Vocational Education (PVE), Career and Technical Education (CTE), Workforce Education (WE), and Workplace Education (WE). Despite the nomenclature that is assigned to TVET, the primary focus remains unchanged [6].

The initial perceptions of vocational education are that is the education targeted at occupational learning of lower-level skills mostly termed as "primer skills" instead of "intellectual skills" that is delivered mainly from organized and focused training institutions like the formal educational setting [7] [3]. But of recent, there is paradigm shift in perceptions of TVET. The new TVET is solely responsible in human capital development for industrialization. It is through TVET programs that a country is able to produce the high skilled workers needed to propel the industry revolution 4.0 (IR 4.0) for economic growth [6] [8].

On the importance of TVET to workforce development, Camillid, (1994) in [6] said TVET is an indispensable instrument that helps improve the quality of workforce by increasing mobility, adaptability and productivity. [9]

reported that TVET indirectly contributes to the enhancement of firms' competitiveness in the globalized world. TVET has the capacity to reskill and upskill workforce that will enable greater development and engagement of workforce in intelligence and efficient use of machinery and plants [10].

The development of upskilling and reskilling strategies for industry 4.0 TVET workforce via innovative pedagogy in teaching and learning, will prepare individuals for the new world of work. TVET has the capacity as a role to prepare young and old people with requisite knowledge, skills, and competencies to contribute adequately in the new world of work [9]. A coordinated TVET learner's outcome can aid introduction of new employability skills (upskill) for the unemployed, for new employment; and also upgrade or retrain (reskill) people with newer skills to face the emerging 4th industrial revolution. Innovative changes are inevitable and TVET has a pivotal role to play in bringing about the desired changes [11]. Job-skills mismatch and unemployment is a common phenomenon among countries of the world. According to [8] there are two most notable development issues for the Philippines. They named them as: ill preparation of students for the workforce with the right skills, knowledge and abilities that improve employability, and establishing conditions to stimulate job creation. That is why [5] believed that the twenty-first century of employability skills have to be developed in four core areas: English literacy, IT literacy, work skills, and soft skills. [12] opined that TVET should be an integral path of the education system, even though that is being provided outside the formal education system. Vocational education is the possible solution for reducing the unemployment in highly educated people through skilling [9] [2].

The advent of IR 4.0 initiative undoubtedly, has continued to pose some skills mismatch challenges to the labor market requirements, industry demands, structure of work, and shifts in technological advancements. This movement has driven manual labor practices to machine automations [1] [13]. [14] quoted an International Labor Organization (ILO) (2020) report saying that nearly half a billion people, one in six of the world's working population, "did not have enough work, were looking for but unable to find work, or had given up looking for work". Since then, due to COVID-19, the numbers of those who are unemployed and underutilized have gone up dramatically across the globe [15]. TVET institutions, and community groups offering vocational programs, and many businesses have closed, if open, are prioritizing survival ahead of workplace training. All these are as a result of the wide spread of the virus [14]. According to [16] these has put more pressure on governments, educational institutions, workplaces, and community groups to adopt different approaches in teaching and learning to upskill and reskill workforce.

➤ *Statement of the Problem*

The need for high innovative pedagogies in teaching and learning of TVET is not left out of the challenging impacts of IR4.0. [2] [12] acknowledged that the world is changing very fast due to the industrialization, digitization, artificial intelligence and modernization, therefore, highly skilled and trained workforce, and huge investment in TVET are required to meet the challenges of the changing world. [17] agreed that the world of work is undergoing rapid and immense alteration due to technological developments. [4] reported that one of the most pressing problems before TVET professional teachers now is to teach learners skills on technology that has not been invented. [18] quoted a report on global workforce placements saying in 2015, around the globe, 38% of employers are finding it difficult in filling key job openings as a result of skill mismatch. He said in Asia and other parts of the world, this figure is higher, reporting about 48%.

The scenario above, has placed the tasks of innovative pedagogies of teaching and learning of IR4.0 skills on TVET for meeting workforce reskilling needs. [19] said this trend, will keep affecting the composition of employment, the nature of the tasks carried out at workplaces, and the skills required in the labor market, if nothing is urgently done to reskill, and upskill the TVET workforce for the new 4th industrial revolution. Therefore, the greatest worry now is “how do we respond to this era for quick and smooth transition from IR4.0 to IR5.0 skill-equip workforce using TVET system as a way out”? The right answer is to think out reskill strategies for IR4.0 TVET workforce through innovative pedagogies in teaching and learning.

➤ *Purpose of the Study*

The purpose of this study was searching for innovative pedagogies in teaching and learning as strategy for reskilling industry-4.0 TVET workforce. Specially, this study intends to explore:

- Innovative pedagogies in teaching and learning for IR-4.0 TVET workforce reskilling.
- Strategies for reskilling IR-4.0 TVET workforce.

➤ *Research Questions*

To realize the objective of study, the following research questions were posed as a guide:

- What are the innovative pedagogies in teaching and learning for IR-4.0 TVET workforce reskilling?
- What are the strategies for reskilling IR-4.0 TVET workforce?

➤ *Significance of the Study*

The results from this study will be beneficial to TVET educators and practitioners, policy makers, industry, public and private sectors, national skills networks and international partners’, students, TVET education/skill regulatory bodies, future research and the general society.

II. LITERATURE REVIEW

➤ *Innovative Pedagogies in Teaching and Learning of TVET*

The bottom-up innovation pedagogical approach in teaching and learning of TVET is apt for adoption to capture the skills needs of industrial workforce. This approach will promote skill creativity and innovations among TVET students; and it will identify and distribute best practices of business, and industry cooperation in TVET [3]. There is need for TVET institutions to respond not only to the changing skills demands, but also to equip students with the necessary skills to manage new types of work environment through classroom teaching and learning. Innovative skills in the areas of: creativity, social skills, collaboration, problem-solving and independent learning skill are important for the students to function and contribute in the IR4.0 agenda after graduation from a TVET program [20]. Therefore, it is important to note that to enhance innovative pedagogy in teaching and learning of TVET, policy and program disruption is inevitable, but the end product will be transformation. Those who are not ready for the disruption suffers the resultant consequences. The mismatch between demand and supply, fast changing labor market, sustainable financing and social recognition of TVET are serious problems in teaching and learning of TVET. [3] [21] opined that innovative pedagogy in teaching and learning of TVET for industry 4.0 workforce skilling, is a new tendency propelled by necessity of present industrial revolution. So, domain independent skills like interpersonal skills, adaptability, creativity, and cognitive skills are required in conjunction to right attitude, values, and work habits [9] [22]. To support this, both TVET teachers and students should be ready to welcome innovations in teaching and learning for development of new attitude towards infrastructure and services for meeting the reskilling and upskilling requirements of Industry 4.0 TVET workforce [23] [7].

A shift from the traditional rigid TVET training system to a more flexible and open one in order to meet the fast-changing skills requirements of the industries is the way forward. And adaption of TVET curricula to better prepare students for the future of work [24] [3]. As asserted by [25], there are four fundamental changes common in a normal society. He mentioned them as: democratization, urbanization, globalization and technological innovation. As an innovative pedagogical strategy of teaching and learning of TVET, Pramod said teaching and learning should be shifted from monologue (play or performance by one actor) to dialogue (talk of any kind between two or more people); and education should be connected with earning and happiness. And that the practice of the “three Cs” (content, context and community) in teaching and learning of TVET is apt for skill development. Content has its core knowledge and skills; context makes learning suitable and since it has to be applied in a context; while community adds the element of learning through networking [25] [26]. So, to successfully re-skill or up-skill a workforce, remodeling of educational policies, facilities, and the teachers are very paramount [20] [27]. Educational instructional facilities such as classroom, laboratories, and workshops must be refashioned to enhance

interaction and easy transfer of skills and knowledge from the teacher to the learner. Newest equipment and highly skilled instructor in classroom situation are needed to enable students train and master the latest technologies in the newly acquired capital equipment [23] [20].

Technological innovations evoke a range of emotions, creativity and thinking that brings the world closer together and helps solve some of the greatest challenges. [11] [33] opined that TVET has a role to play in preparing students and existing workforce's readiness for an IR 4.0 work environment. Updated curriculum, widely recognized standards and qualifications, practical training through apprenticeship, quality trainers with latest industrial practices, modern infrastructure facilities and others are some of the characteristics of a good and innovative TVET system [28] [27]. [13] suggested areas requiring pedagogical innovation in teaching and learning TVET as: digital skills, Artificial Intelligence, virtual reality, clouds computing, cyber security, block chain and others. The strategy of teaching and learning of TVET aimed at preparation of learners for future of work by digital transition is an appropriate measure for innovative pedagogy in TVET. This will promote digital literacy skills among the TVET students; and will prepare long-term strategic skill plan for ICT integration in TVET system; prepare TVET institutions with enough computer devices and internet connectivity.

The pedagogy of teaching and learning of TVET in many countries is modifying according to IR4.0 especially, with respect to curriculum development and delivery approaches. [6] cited Malaysia taken steps to convert some of its technical schools into vocational schools. With this conversion, the teaching and learning of TVET for upskilling and reskilling of workforce starts with green technology driven TVET curriculum re-design, equipped with modern skill training approaches in alliance with the industry challenges, and current job-market demand. And also, with the introduction of technologically enhanced instructional recourses for the delivery of the re-developed curriculum [5] [22]. Designing curriculum for demand-driven courses for IR 4.0 is necessary for workforce reskilling and upskilling. Curricula offered at the TVET institutions require urgent review in order to respond to the current workplace demand [26]. [24] suggested two strategies to realize this as development of a future workforce strategy that will create a common understanding of IR 4.0 and its impact on the education systems, and labor markets; and also, to strengthen close social partnership between government, industry and TVET institutions to make it an effective mechanism for TVET in the IR 4.0. In the opinion of [20] before successful implementation of an innovative pedagogy in teaching and learning of TVET, the young and the old must be imparted with knowledge, skills, and attitudes, including some personality traits for global competitiveness. The inputs of curriculum redesign, newer textbooks, teaching material, equipment and qualify human resources (trained staff) deploy into teaching and learning of TVET can foster innovation for proper skilling of IR 4.0 workforce, and at the same time, enhance quality assurance of the skill system [21].

Also to enhance innovative pedagogy of teaching and learning of TVET, [24] recommended that TVET teachers need reskilling and upskilling to keep them abreast with the latest ICT technological development. This can be realized through organization of in-service teacher training, workshops and seminars to train and educate teachers in the system to bridge the ICT skills variation among teachers and technical support staff [9] [24]. [26] recommended strongly the use of ICT technology in teaching and learning process of TVET. The conduct of capacity building orientation and re-orientation for TVET teachers and manager will enhance maximization of the use of new technology, and the adaptation of teaching materials for ICT-enabled delivery [24]. Also, the stimulation of professional development of TVET educators is vital for workforce reskilling and upskilling strategy. [24] stated that this can be realized through formulating performance standards for TVET teachers as part of quality assurance in TVET; strengthen TVET educators training program with more emphasis on innovations, creativity, critical thinking and problem-solving skills; and provision of opportunities for industrial attachment and immersion for TVET educators. Finally, for a good and innovative pedagogy in teaching and learning of TVET to deliver appropriate upskill and reskill, there must be up-to-date curriculum, practical training, learning environment, good infrastructure, widely recognized standards and quality trainers [13].

The TVET programs prepares learners to acquire knowledge, alongside master practical and soft skills. Practical and soft skills can be up to 80% of a program and may be impossible to develop online amidst pandemics [15] [14]. Therefore, as an innovation, most TVET teaching and learning programs need to include face-to-face learning in workshops or workplaces to practice and master these skills, which makes it challenging to continue offering TVET when educational institutions and businesses are closed. However, parts of TVET programs can be moved online and offered by distance (CL, 2020). The strategy of blending distance learning with workplace learning has proven effective for nearly 200 years since Pitman began teaching shorthand by correspondence in 1840 [14]. In 1910, in response to a typhoid epidemic, Australia introduced its first distance TVET to train health inspectors by correspondence while they continued to work. Today, examples of blended learning for TVET are evident across the world in workplaces, formal educational institutions, and community settings [29]. The practice of building competence in knowledge, practical and soft skills through a combination of face-to-face and technology enabled learning experiences according to [29] [14] is referred to 'blended TVET'. [14] further clarify that distance learning is where the blend allows learners to develop competence online or in their workplace without attending a physical campus appearance. To further innovative tendency in teaching and learning of TVET, [14] assured that it is possible in the current crisis, 'as-distance-as-possible' TVET can still continue its selected components, upskilling and reskilling of essential and displaced workers in their workplaces, while observing physical distancing guidelines. It also offers the potential to rethink traditional TVET models to be able to reduce costs and increase

flexibility, and thus reach marginalized and remote learners, including those working in the informal sector as suggested by [16] [14]. With this, there will be better opportunities to build stronger TVET systems in case of future disruption emanating from health-related issues like infections, pandemics, reactions from climate change, and civil wars.

➤ *TVET Blended Models and Innovative Phases*

The present-day innovative pedagogy in teaching and learning of TVET demand, has prompted the development of models of blended TVET. [14] classified them into three broad models as: (a) Learning in classrooms and workshops, with enhanced technology; (b) On-the-job training, supplemented with classroom, and distance and online learning; and (c) Fully distance and online learning. All of these models are placed in their order of increasing distance and flexibility [14]. [16] [14] further suggested four innovative phases through which education systems might move in response to COVID-19.

The phase one was “rapid transition to emergency remote learning and teaching”, which focuses on deployment of emergency remote teaching, rather than optimal blended learning. They cited examples of the open Polytechnic of New Zealand, that instantly makes its online learning platform freely available to other New Zealand training organizations; also the instance of the Zambia’s government effort to immediately install COL’s OER in Zambia’s Technical Vocational Teachers College’s existing LMS to train TVET teachers, where a train-the-trainer model was adopted to train at least one online expert for each public TVET institute for skills facilitation, who then train more than 800 TVET teachers.

The second phase was the “extended transition during continued turmoil”. The key emphasis on this phase was how to rapidly respond to chaotic environments. The phase 2 examples include the effort of the National University of Samoa to modify its face-to-face exam assessment for TVET courses, and through the process was able to move to competency-based assessment based on online portfolios of evidence. Again, another instance is the Shanghai, China establishment of a team of TVET teachers to develop online courses that were then delivered via several educational technology platforms including establishment of a new TV station for TVET. According to [14], they also developed simulation software to support practical skills development in some courses like network security. Also, the Sweden’s crisis package for jobs and transition which included increased funding for TVET, and also for distance education providers was another example of the second phase.

The third phase was centered on “laying the foundation for a new normal”. This phase emphasis on unity of purpose among governments, institutions and industry on a clear vision for blended TVET. Instances of the third phase, was the New Zealand collapsing all its existing polytechnics and industry training organizations into a single institute that will offer all classroom, on-the-job, and online training with a centralized online learning design and development team; and also, a suite of technology solutions to meet the needs of

learners, educators and employers. Another example, was the Kenyan government development of a blended TVET strategy, that nationalizing the learning management system of the Kenya Technical Trainers College, national TVET teacher training in online learning and central hosting of online courses for national TVET qualifications. While the fourth phase was “embed the new normal”. The final phase was about embedding and normalizing new ways of working, in line with the agreed strategy and building on lessons learned from Phase 3.

➤ *The 4th Industrial Revolution Workforce*

The industry 4.0 revolution (IR 4.0) emergence comes with many sectional remodeling in the industrial workforce. [27] reported that the fragmentations are driven by innovation, disruption and transformation. The transformation is a global phenomenon leading to modification in patterns of employment and qualifications. [4] opined that only occupational skill is not enough to survive in the 21st century and that new set of transversal skills are needed. [21] [4] summarized the component areas of challenges of the IR4.0 as: cyber physical system, internet of things, artificial intelligence, cloud computing, augmented reality simulation and modelling, and robotics. Although, Scholars have some mixed argument about robotization as part of the ongoing IR4.0 transformations. Some said inevitably robotization could lead to less demand for human labor, while some maintained that that robotics could engender productivity gains in situations where factories are losing most of their workers [30].

The IR 4.0 requires upskilling and reskilling of workforce that is multi-skilled, and not non-skilled, which can provide both technological, social, and business innovation [9] [27]. In the perception of [11] IR 4.0 has changed the way we live, work and interacts with each other. [11] further emphasized on the implications of IR 4.0, saying its emergence has caused increase in demand of highly qualified skilled workers, master craftsman, technicians and engineers. She mentioned some of the top skills to be possessed by TVET professionals to able to reskill workforce as: problem solving, critical thinking, creativity, people management, coordinating with others, emotional intelligence, judgment and decision making, service orientation, negotiation and cognitive flexibility. Swati, (2020) further highlighted some of IR4.0 skill related issues such as upskilling, reskilling, continuous learning, mind-set change and re-imaging.

➤ *IR-4.0 Upskilling and Reskilling Strategies for TVET Workforce*

One of the future directions for development and maintaining of positive shifts in TVET skilled workforce for IR 4.0 is through coordinated innovative pedagogy of teaching and learning of TVET programs. [24] asserted that to fuse innovation in teaching and learning of TVET in order to foster reskilling and upskilling of workforce for IR 4.0, strengthening of TVET relevance through teaching/learning and promotion of employability skills is very key. The declaration maintained that this can be achieved through reaffirmation of the importance of employability skills in the face of structural change like the IR 4.0, and ensure that new-

age workers are ready to take advantage of new opportunities resulting from IR 4.0; and pursue a balance between responding to vocational and employability skills that will be useful throughout their working lives [9] [24]. In the view of [31], it is obvious that individuals with technical skills may not gain employability skills. [31] explained employability skills as: key skills, key competencies, core skills, basic skills, essential skills, and employment know-how. The Commonwealth of Australia (2002) in [6] opined that these skills are not only to gain employment, but also to progress within an enterprise to achieve one's potential and contribute successfully to the enterprise's strategic goals. Employability skills comprises basic skills necessary for getting, keeping, doing well on a job, and possibly remaining productive on the job whereby those with employability skills will have a far better chance of making their way to the top [19] [22]. [14] asserted that mere fundamental and occupational skill is not enough for industry 4.0, but transversal skill / generic skill / learning to learn skill; together will give you employability skill. Employable skills are primary driver of economic growth, that is why Canadian colleges focus on the development of three types of skills: essential skills, technical skills, and job-specific skills [9]. Moy, (1999) in [6] went further to enumerate reasons for generic skills as: increase in competitive global market, rapid technological change, new forms of work and work organization, the evolution of knowledge-intensive economies characterized by an increased focus on the service sector, and the customization of products and services. Above all, as stated by Hughes and Stoner, (2001) in [6] concluded that the focus of employment skills is to help avoid social exclusion of certain groups or individuals.

The research of [8] on developing a skilled workforce through TVET, showed that 45% of participants in TVET programs, choose TVET to gain employment, 38% is to gain skills, while 7% are of the opinion that TVET is for skills enhancement (reskilling) or upgrading (upskilling). They reported that the Technical Education and Skills Development Authority (TESDA) of the Philippine, has already begun work on pedagogical innovation of teaching and learning of TVET through projects such as green skills competency development, online learning for TVET, programs for women in TVET, career guidance, and local and international TVET skills competitions as contained in TESDA, 2016 report. Also, [8] explained that other TVET strategies are in the areas of policies and programs reforms as contained in TESDA 2016e, which are designed to reduce poverty, expand access, and up-skill and re-skill participants for new industrial job challenges. [11] recommended sector focused programs, skill centers and learning factories on campus, close industry collaboration, work integrated programs with yearly internships and competency-based teaching-learning pedagogy and skill assessment as part of reskilling and upskilling strategies.

The strategy for promotion of work-based apprenticeship and internship in teaching and learning of TVET by institutions will improve reskilling and upskilling and should be encouraged. The way to succeed this according to [24] is to award stipend and scholarship; grant scholarship

to the weaker section of the society; create the framework leading to multi-stakeholder with private sector partnership in TVET; award scholarship for encouraging youth, including girls for Work-based Apprenticeship programs; allocation of appropriate annual budget to TVET and consider the establishment of a TVET fund. Also, according to [19] stipulation of incentives terms for companies to become engaged in TVET and provide opportunity for work-based apprenticeship and internship and ensure their enforcement; and expansion of apprenticeship programs and enhance their quality by providing more guidance to participating companies and students. In the opinion of [32] the strategies for achieving transversal skills in TVET are: integration of the entire education system, including general, professional, technical and vocational education, establishing linkages between school and industry, integration of vocational education with liberal education, lifelong learning approach, provision for vertical and horizontal mobility for graduate, integration of traditional skills with the modern skills, ensuring maximum involvement of all the education at all level to prepare the students for future labor market.

As an upskilling and reskilling strategy, [6] suggested that industries should not leave the responsibility of skilling workforce in the hands of TVET educators and practitioners from the academia only. Rather, policy makers, industry, public and private sectors, national networks and international partners should join hands in training and retraining of workforce in related TVET skill development programs. And also, reskill already engaged manpower through on-the-job vocational trainings to enhance their skills upgrade for industry 4.0 [17] [22]. In order to facilitate and sustain this initiative, the government at specific level should set-up a trust fund for this purpose, so that costs incurred by employers in training and retraining of workforce can be claimed from this fund [7].

Another skill development strategy suggested by [24] [7] is to encourage multi-sector stakeholder's partnership in TVET skill development. They said this will enhance policy coherence through stakeholder engagement, to keep TVET relevant and build bridges between the world of learning and the world of work. According to [24] the reskilling and upskilling innovative pedagogy strategy of teaching and learning in TVET should provide skills for work by strengthening close social partnership between government, industry and TVET institutions to make it an effective mechanism for TVET in the IR 4.0. According to [22] aligning skill-based training curricula with the needs of business and industry and make them uniform across TVET Institutions; and encouragement of professionals and specialists from the industry to become part-time TVET teachers are innovative pedagogical strategy for reskilling and upskilling. Apart from these assertions, [18] outlined revision of TVET curriculum, recruitment and training of competent staff, infrastructure and equipment upgrades, program evaluation, tracer study, supervision and monitoring, feedback management to develop a new standard or baseline, and recommend changes based on learning.

III. METHODOLOGY

The study adopted a descriptive survey design and was conducted in three tertiary Vocational and Technical Education institutions and industries in Rivers State, South-South region of Nigeria. The population for the study comprised of 60 identified TVET Educators, and 13 public and private sectors industry practitioners making a total of 73 respondents. The institutions are: Ken Saro-wiwa Polytechnic, Bori, Rivers State University, Port Harcourt, and Ignatius Ajuru University of Education, Port Harcourt; and three manufacturing industries (National Fertilizer Company Nig. Ltd, Onne; RIV Biscuit Co. Nig. Ltd, Industrial Layout, and Port Harcourt Flour Mills Ltd, Industry Road) all in the city of Port Harcourt, Nigeria. As a result of the manageable size of the study population, the entire subjects (73) was used as sample population for the study; hence, no sampling technique was adopted. The instrument for data collection was a self-constructed questionnaire tagged “Upskilling and Reskilling Strategies for IR4.0 Workforce Enhancement” (URSIR4.0WE). The URSIR4.0WE was developed in the order of modified Likert-4-point rating scale of: Strongly

Appropriate, Appropriate, Inappropriate, and Strongly Inappropriate with numerical values of 4, 3, 2 and 1 respectively. Two Experts as TVET practitioners validated the instrument. Comments and suggestions from the Experts were accepted and built into the final copy of the instrument. The reliability index of the instrument was established using Cronbach Alpha Coefficient to ascertain the internal consistency at 0.89 through trial test of 20 copies of the instrument at University of Nigeria, Nsukka, Enugu state outside the study region. The instrument was personally administered by the researcher directly to the subjects. Out of 73 copies of the instrument distributed, 70 were completed by the respondents, and successfully retrieved measuring about 96% return rate which was used for data analyses. The Statistical Package for Social Science (SPSS) software V.19 was used to analyze the data obtained from the questionnaire. The statistical instrument used for analyzing the research questions were the mean. The decision rule holds that, any mean rating with 2.50 and above, was regarded as appropriate strategy for upskilling and reskilling, while any mean rating below 2.50 was regarded as inappropriate strategy.

IV. RESULTS AND FINDINGS

The results of data analysis of the study are presented in Tables 1 to 2 below.

➤ Research Questions 1

What are the innovative pedagogies in teaching and learning for IR-4.0 TVET workforce reskilling?

Table 1 Mean Responses of Respondents on Innovative Pedagogies

S/n.	Innovative Pedagogies in Teaching and Learning	\bar{X}	SD	Remark
1.	TVET innovative teaching/learning areas are digital skills, AI, virtual	3.54	0.74	Appropriate
2.	Innovative blended TVET distance learning with workplace learning	3.32	0.84	Appropriate
3.	Learning in technology-enhanced classrooms and workshops	3.10	1.05	Appropriate
4.	On-the-job training with classroom, distance and online learning	3.45	0.60	Appropriate
5.	Fully distance and online learning	2.99	0.92	Appropriate
6.	TVET competency-based teaching/learning and skill assessment	2.74	0.61	Appropriate
7.	Innovate teaching and learning of TVET by projects	3.33	1.02	Appropriate
8.	Promotion of online learning for TVET	2.55	0.61	Appropriate
9.	Organization of local and international TVET skills competitions	2.89	0.73	Appropriate
10.	TVET teaching/learning with dialogue rather than monologue	3.23	0.91	Appropriate
11.	Teaching with developed models of blended TVET	2.81	1.15	Appropriate
12.	Teach TVET with newest equipment and skilled instructors	3.33	0.65	Appropriate
13.	Designing curriculum for demand-driven courses for IR 4.0	2.67	1.07	Appropriate
14.	Delivery of redesigned curriculum with newer textbooks, teaching material, equipment and qualify human resources	3.19	0.93	Appropriate
15.	Organization of in-service teacher training, workshops and seminars to train and educate TVET teachers	2.63	0.69	Appropriate
16.	Organization of capacity building orientation and re-orientation for TVET teachers and manager	3.69	0.74	Appropriate
17.	Use ICT Technology for TVET instructional delivery system	3.48	0.54	Appropriate
18.	Shift from the traditional rigid TVET training system to a more flexible and open one to meet industries requirements	3.77	0.72	Appropriate
	Grand Mean and SD	3.27	0.81	Appropriate

Source: Researchers’ Field Survey; 2024.

Table 2 revealed a grand mean and standard deviation score ($\bar{X} = 3.27$, $SD = 0.81$) for innovative pedagogy in teaching and learning of TVET. The respondents highly

indicated that innovative pedagogy item 18, “Shift from the traditional rigid TVET training system to a more flexible and open one to meet industries requirements” ($\bar{X} = 3.77$, $SD =$

0.72) was a major innovation pedagogy, and was very appropriate for teaching and learning of TVET. This was followed by “Organization of capacity building orientation and re-orientation for TVET teachers and managers” (\bar{X} = 3.69, SD = 0.74); and the least was “Promotion of online learning for TVET” (\bar{X} = 2.55, SD = 0.61). The entire findings showed that the eighteen proposed innovative

pedagogy in teaching and learning of TVET were appropriate; and will enhance IR4.0 workforce upskilling and reskilling.

➤ *Research Questions 2*

What are the strategies for reskilling IR-4.0 TVET workforce?

Table 2 Mean Response of Respondents on Upskilling and Reskilling Strategies

S/n.	Strategies for Reskilling IR4.0 TVET Workforce	\bar{X}	SD	Decision
1.	Reaffirmation of employability skills in the face of structural change	3.20	0.79	Appropriate
2.	Promotion of TVET employability skills among workforce	3.12	0.88	Appropriate
3.	Partnership between government, industry and TVET institutions	3.02	1.06	Appropriate
4.	TVET sector focused programs	3.05	0.57	Appropriate
5.	Creation of TVET skill centers and learning factories on campus	3.23	0.92	Appropriate
6.	TVET work integrated programs with yearly internships	2.60	0.66	Appropriate
7.	Stipend and scholarship for work-based apprenticeship programs	3.00	1.07	Appropriate
8.	TVET framework for multi-stakeholder and private sector partners	2.55	0.69	Appropriate
9.	Adequate annual budget allocation to TVET programs	2.84	0.73	Appropriate
10.	Reskilling and upskilling of TVET teachers	3.19	0.92	Appropriate
11.	Stipulation of incentives terms for companies that engaged in TVET	3.44	0.98	Appropriate
12.	Enable opportunity for work-based apprenticeship and internship	3.28	0.69	Appropriate
13.	On-the-job vocational trainings to enhance skills upgrade	2.77	1.08	Appropriate
14.	Skill-based training curricula with the needs of business and industry	3.18	0.99	Appropriate
15.	Revision of TVET curriculum	2.75	0.64	Appropriate
16.	Recruitment and training of competent staff	3.41	0.74	Appropriate
17.	Infrastructure and equipment upgrades	3.83	0.56	Appropriate
18.	Program evaluation, tracer study, supervision and monitoring	2.74	0.76	Appropriate
19.	TVET curricula should prepare students for present and future work	3.66	0.56	Appropriate
	Grand \bar{X}	3.10	0.80	Appropriate

Source: Researchers’ Field Survey; 2024.

Table 1 indicated a grand mean and standard deviation score (\bar{X} = 3.10, SD = 0.80) for workforce upskilling and reskilling strategies for IR4.0. The respondents, strongly showed that item 17 “Infrastructure and equipment upgrades” (\bar{X} = 3.83, SD = 0.56) was a major strategy, and was very appropriate for IR4.0 workforce upskilling and reskilling. This was followed by “Adapted TVET curricula should prepare students for present and future work” (\bar{X} = 3.66, SD = 0.56); and the least was “Creation of TVET framework for multi-stakeholder and private sector partnership” (\bar{X} = 2.55, SD = 0.69). All the results revealed that the nineteen suggested workforce upskilling and reskilling strategies were all appropriate.

➤ *Discussion of Findings*

Table 1 suggested that the nineteen-workforce upskilling and reskilling strategies for IR4.0 are all apt. These findings are in agreement with the opinion of [9] [24] that re-emphasizing on the need for employability skills in the face of structural change, award of stipend and scholarship; and allocation of appropriate annual budget to TVET will likely enhance skills upgrade. [8] mentioned that Philippine has already begun work on pedagogical innovation of teaching and learning of TVET through projects such as green skills competency development, online learning for TVET and others. [11] recommended sector focused programs, skill centers and learning factories on campus as reskilling and upskilling strategies. Also, On-the-job vocational trainings;

aligning skill-based training curricula with the needs of business and industry will enhance skills upgrade for industry 4.0 as stated by [17] [22].

Tables 2 found eighteen innovative pedagogies in teaching and learning of TVET. This is in line with the assertions of [4] [13] who suggested areas requiring pedagogical innovation in teaching and learning of TVET as: digital skills, internet of things, artificial intelligence and others. [14] also said that strategy of blending distance learning with workplace learning has been effective in the last 200 years. [14] went further to classify models of blended TVET into three as: learning in classrooms and workshops, with enhanced technology; on-the-job training, supplemented with classroom, and distance and online learning; and fully distance and online learning. [25] concludes that teaching and learning should be shifted from monologue (play or performance by one actor) to dialogue (talk of any kind between two or more people).

V. CONCLUSION

The study concludes that disruption is inevitable, but the end product will be transformation; and it’s only those who are not ready for the disruption suffers the resultant consequences. Hence, the study concludes that to foster innovative pedagogy in teaching and learning of TVET, the traditional believe that TVET “cannot be delivered by

alternative means should be erased". A well-designed blend of TVET, particularly when combined with workplace learning can upskill and reskill workforce. Stimulation of professional development of TVET Educators by strengthening training programs with emphasis on innovations, creativity, critical thinking and problem solving can also reskill and upskill workforce. Redesigning of TVET curriculum for demand-driven courses for IR4.0; promotion of digital literacy among TVET students at all levels; long-term strategic teaching plan for ICT integration in TVET system; equipment of TVET institutions with computer devices/internet connectivity; organization of in-service teacher training, workshops and seminars to train/retrain teachers on ICT skills variations; the use of ICT technology for instructional delivery of TVET program; and the use of modern skill-driven teaching methods as good strategies for upskilling and reskilling of IR4.0 workforce.

As an implication for the study, if the upskilling and reskilling strategies are adapted; and the innovative approaches of teaching and learning TVET are given full attention by relevant stakeholders, then IR4.0 workforce who have lost their jobs as a result of skill mismatch, or who are looking for one, but lack required skills, can get a job or go back to job after been skilled.

REFERENCES

- [1]. Sujata, M. (2021). Modern teaching methods: It's time for the change. Retrieved from <https://eduviocce.in/category/article/>
- [2]. Mudasiru, O.I. (2023). Strengthening TVET in Nigeria to meet the industry 4.0 needs in the changing world of works. *World Journal of Advanced Research and Reviews*, 2023, 19(01), 580–587. Article DOI: <https://doi.org/10.30574/wjarr.2023.19.1.1338>
- [3]. Barnett, K. & Ryan, R. (2005). Vocational education and training in Australian schools: Issues for practitioners. *International Education Journal*, 5: 89 – 104.
- [4]. Shyamal, M. (2020). Major trends impacting future of jobs and new vision for TVET in 21st century. Keynote address I presented at the national conference on re-imagining TVET for the changing world: Perspectives and practices. Organized by the PSS Central Institute of Vocational Education (PSSCIVE) on 11 and 12 February, 2020 in Bhopal. Retrieved on 10th July, 2021 from www.psscive.ac.in
- [5]. Sunil, D. (2020). Employability skills for employment A paper presented at the national conference on re-imagining TVET for the changing world: Perspectives and practices. Organized by the PSS Central Institute of Vocational Education (PSSCIVE) on 11 and 12 February, 2020 in Bhopal. Retrieved on 10th July, 2021 from www.psscive.ac.in
- [6]. Ab. Rahim, B. (2011). Preparing Malaysian youths for the world of work: Roles of technical and vocational education and training (TVET). Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&as_vis=1&q=preparing+malsian+youth+for+the+world+of+work+&btnG=#d=gs_qabs&u=%23p%3DXnHuOJRLFW0J
- [7]. Afeti, G. (2006). Strategy to revitalize technical and vocational education and training (TVET) in Africa. Background document for the African Union's TVET Experts' meeting, 13-14 December 2006, Addis Ababa.
- [8]. Kiran, S. B., Mark, M. D., & Jose, L. D. E. (2018). Developing a skilled workforce through technical and vocational education and training in the Philippines. Retrieved 14th July, 2021 from https://doi.org/10.1007/978-3-319-50911-2_28
- [9]. Asian Development Bank (ADB) (2015). The role of community colleges in skills development lessons from the Canadian experience for developing Asia. Retrieved from <https://openaccess.adb.org>
- [10]. Budhrani, K., & Jose, L. E. (2013). Online vocational education: A Philippine experience. *The Asia CALL On Line Journal, Proceedings of Asia CALL 2012*. Retrieved from <http://asiacall.info/acoj/budhrani-k-s-espirtu-j-l-d-2013/>.
- [11]. Romulita, A. (2020). A prologue to TVET 4.0 and responding to the challenges of industry 4.0: Perspectives for policy formulation. A paper presented at the national conference on re-imagining TVET for the changing world: Perspectives and practices. Organized by the PSS Central Institute of Vocational Education (PSSCIVE) on 11 and 12 February, 2020 in Bhopal. Retrieved on 10th July, 2021 from www.psscive.ac.in
- [12]. Jandhyala, B.G. T. (2020). Focusing on transversal skills in TVET. A paper presented at the national conference on re-imagining TVET for the changing world: Perspectives and practices. Organized by the PSS Central Institute of Vocational Education (PSSCIVE) on 11 and 12 February, 2020 in Bhopal. Retrieved on 10th July, 2021 from www.psscive.ac.in
- [13]. Basab, B. (2020). Skills for international mobility of workforce. A paper presented at the national conference on re-imagining TVET for the changing world: Perspectives and practices. Organized by the PSS Central Institute of Vocational Education (PSSCIVE) on 11 and 12 February, 2020 in Bhopal. Retrieved on 10th July, 2021 from www.psscive.ac.in
- [14]. Commonwealth of Learning (2020). Strategies for blended TVET in response to COVID-19. Retrieved from https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.thecommonwealth.io/wp-content/uploads/2020/07/StrategiesforblendedTVETCOVID19.pdf&ved=2ahUKEwiVKNvBoYjyAhXx7OAKHWGDBO0QFjACegQIDhAG&usg=AOvVaw1SY_VDem_BmPDq5rUMoreR&cschid=1627561564466
- [15]. Alkema, A. & Neal, T. (2019) ODL and workplace learning TVET programmes in New Zealand. COL: Vancouver. Retrieved from <http://oasis.col.org/handle/11599/3529>
- [16]. O'Keefe, L., Rafferty, J., Gunder, A., Vignare, K. (2020). Delivering high-quality instruction online in response to COVID-19: Faculty playbook. Every

- Learner Everywhere. Retrieved from <http://www.everylearnereverywhere.org/resources>
- [17]. Rajesh, P. K. (2020). Employability skills and up-skilling/re-skilling of workforce. A discussion session at the national conference on re-imagining TVET for the changing world: Perspectives and practices. Organized by the PSS Central Institute of Vocational Education (PSSCIVE) on 11 and 12 February, 2020 in Bhopal. Retrieved on 10th July, 2021 from www.psscive.ac.in
- [18]. Ramahari, L. (2020). TVET for global competitiveness: Need for 21st century. Keynote address II presented at the national conference on re-imagining TVET for the changing world: Perspectives and practices. Organized by the PSS Central Institute of Vocational Education (PSSCIVE) on 11 and 12 February, 2020 in Bhopal. Retrieved on 10th July, 2021 from www.psscive.ac.in
- [19]. Ganemulle, L. D. W., & Vathsala, W. (2024). Institutional implementation of Industry 4.0 competencies in TVET programs in the Indo-Pacific: Critical success factors. *Journal of Vocational, Adult and Continuing Education and Training*, 7(1):1–27. <http://doi.org/XXX>
- [20]. Hyland, T. (2002). On the upgrading of vocational studies. *Educational Review*, 5: 287–296.
- [21]. Amegah, A. (2023). Business without social responsibility is business without morality: Employment engagement in upper secondary technical and vocational education and training schools in Ghana. *Journal of Vocational Education & Training*, 75(2):391–415. Available at: <https://doi.org/10.1080/13636820.2021.1879904>.
- [22]. Ridzwan, C. R., Ruhizan, M. Y., & Faizal, A. Y. (2014). Skilling for job: A grounded theory of vocational training at industrial training institutes of Malaysia.
- [23]. Holler, S., Brändle, M. & Zinn, B. (2023). How do South African TVET lecturers rate their digital competencies, and what is their need for training for a digital transformation in the South African TVET sector? *Journal of Vocational, Adult and Continuing Education and Training*, 6(1):25. Available at: <https://doi.org/10.14426/jovacet.v6i1.314>.
- [24]. Bhopal Declaration (2020). A communique from the national conference on re-imagining TVET for the changing world: Perspectives and practices. Organized by the PSS Central Institute of Vocational Education (PSSCIVE) on 11 and 12 February, 2020 in Bhopal. Retrieved on 10th July, 2021 from www.psscive.ac.in
- [25]. Pramod, B. S. (2020). Disruptive Innovations in the TVET eco-system: Challenges and opportunities. A paper presented at the national conference on re-imagining TVET for the changing world: Perspectives and practices. Organized by the PSS Central Institute of Vocational Education (PSSCIVE) on 11 and 12 February, 2020 in Bhopal. Retrieved on 10th July, 2021 from www.psscive.ac.in
- [26]. D'Amico, M.M., Grant, B., Morgan, S.G., Katsinas, J., Lucas, A. & Michael, T. M. (2017). A national analysis of noncredit Community College education: Enrollment, funding, accountability, and contextual issues. *Community College Journal of Research and Practice* 41 (4–5): 288-302. <https://doi.org/10.1080/10668926.2016.1251349>.
- [27]. Dahiru, S. M. & Sarimah, I. (2014). The needs for employability skills integrations in electrical technology education curriculum of Federal Universities of technology, Nigeria. A paper presented at the 4th World Congress on Technical Vocational Education and Training (WoCTVET); with theme: "TVET Capacity Development: Career & Life Skills for 21st Century", Held on 5th- 6th November, 2014 at Hotel Equatorial Malacca, Malaysia.
- [28]. Marzuki, M., Yusof, R., Yusof., R & Musa, K. (2022). Evaluating the TVET financial allocation based on the polytechnics and community colleges students' enrolment: A preliminary analysis. *International Journal of Academic Research in Progressive Education and Development*, 11(2):1267–1284. Available at: <http://dx.doi.org/10.6007/IJARPED/v11-i2/13911>.
- [29]. Härtel, M. (2017). Germany: BIBB in Using ICTs and blended learning in transforming TVET. Ed. Latchem, C. UNESCO: Paris and COL: Vancouver. Retrieved from <http://oasis.col.org/handle/11599/2718>
- [30]. Odd, B. U. & Tom, S. (2019). Skills and employment under automation: Active adaptation at the local level. *International Journal for Research in Vocational Education and Training (IJRVET)*. Retrieved on 20th July, 2021 from <http://www.ijrvet.net>
- [31]. Allen Consulting Group (2010). Development of a strategy to support the universal recognition of employability skills across schools, VET, higher education and the broader community. Access on 18 July, 2021 at, <http://www.allenconsult.com.au/employabilityskills/>
- [32]. Raihan, T., & Zoraida, A. (2024). Shaping Industry 4.0 Ready Talent: TVET Experts' Strategies in Content Selection - NGT and ISM Approach. *International Journal of Institute of African Studies*. 25(1):1-30.
- [33]. Swati, M. (2020). Transforming TVET for industry 4.0 building skills for work and life presentation. A paper presented at the National Conference on Re-imagining TVET for the changing world: Perspectives and practices. Organized by the PSS Central Institute of Vocational Education (PSSCIVE) on 11 and 12 February, 2020 in Bhopal. Retrieved on 10th July, 2021 from www.psscive.ac.in