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STEM for Sustainable Skills for the Fourth Industrial Revolution: Snapshot at Some TVET Colleges in South Africa

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Abstract

Technological advancement is a major driver of the economic growth and has raised living standards enormously (though unevenly) across the globe. Digital technologies radically transform the structure of organisations and employment models, including teaching and learning. Youth and people who lack high-level technological and interpersonal skills are becoming vulnerable due to digital automated jobs. There is a need for targeted and strategic skills, and STEM that is responding to the changing technological world. The digital revolution and an increasing demand for designing and manufacturing are driving the growth of the creative sector, which extends from arts to science and technology and involves cultural creativity and innovation. Science, technology, engineering and mathematics (STEM) students should be equipped with designing and making skills for the twenty-first-century jobs. There is growing polarisation of labour market opportunities between high- and low-skill jobs, unemployment and underemployment especially among young people. Globally, almost 75 million youth are officially unemployed. This chapter presents the driving forces for new jobs and skills for the future. The chapter also outlines the contribution of STEM knowledge and skills for digital literacy from basics to an advance level. The implication of digital literacy for the fourth industrial revolution is highlighted. The empirical part of this chapter presents results based on the investigation done on the vocational educational and training practices at three TVET colleges in one province in South Africa. The study focused on vocational pedagogic and didactic practices, workshop material and equipment for practical training, work-integrated learning and integration of theory and practice in vocational subjects. This investigation is a case study to gauge the extent of readiness of some TVET colleges for the fourth industrial revolution. The methodology of collecting data was questionnaires, interviews and observation. The participants of the study were students and lecturers. On the basis of these data, the paper determines the extent of readiness of TVET as well as CET colleges in the country. The paper recommends measures to position the TVET and CET colleges for the fourth industrial revolution.

Keywords: STEM, TVET, CET, fourth industrial revolution, digital literacy

1. Introduction

It is no secret that South African youth are facing massive challenges in terms of their education, employment and career growth. At the third quarter of 2019, South African unemployment rate has increased to 29% as compared with 26.5% in the first quarter of 2017. Youth unemployment has been inordinately high for many years in South Africa and is one of the country's major socioeconomic challenges [1]. Cross-country comparisons regularly affirm that South Africa's unemployment rates are among the highest in the world. In 2013, the youth unemployment rate was 63% of the youth labour force (3.2 million individuals). By international comparison, the ratio of youth to adult unemployment is fairly similar for other countries that are economically comparable to South Africa. However, the overall unemployment rate is far higher than in other emerging markets [2]. Of the 10.2 million individuals aged between 15 and 24 years, one-third are not in employment, education, or training (and are often referred to as "NEETs") *ibid.*

2. Material and research methods

This study is underpinned by the global and national literature in current trends on the forces that determine new jobs and skills for the fourth industrial revolution. This chapter presents the contribution of STEM education in upskilling and reskilling of people for the fourth industrial revolution.

This chapter also presents the empirical findings from three TVET colleges in one province in South Africa. The empirical part focused on vocational pedagogic and didactic practices, workshop material and equipment for practical training, work-integrated learning (WIL) and integration of theory and practice in vocational subjects. The empirical part of this chapter presents findings from a case study to gauge the extent of readiness in some TVET colleges for the fourth industrial revolution. The methodology of collecting data was questionnaires, interviews and observations. The participants of this study were students and lecturers, who were selected purposefully. The total number of students who completed the questionnaire was 119. These students were studying National Technical Education (NATED) and National Curriculum Vocational (NCV). This implies that there were 39 students for NATED N5 Industrial Electronics from College A, 31 students studying National Curriculum Vocational 1 Information Processing from College B and 49 students studying N5 Electrotechnics (NATED) from College C. NCV and NATED (N1–N6) courses are part of two main national curricula for TVET Colleges in South Africa. Each of these national curricula consists of several vocational subjects for various occupations. Interviews were done with the college lecturers who were observed in the classroom, and students completed the questionnaires. Observation of lessons of the subjects mentioned was done at each of the three colleges.

The questionnaire surveys were underpinned by the following sub-research questions:

RQ1: What are the vocational and didactic methods used in classrooms and workshops?

RQ2: What are relevant workshop materials and equipment for teaching and learning vocational subjects?

RQ3: How are the theory and practices integrated in the teaching and learning of vocational subjects?

RQ4: What partnership exists between TVET colleges and industries for WIL?

The results of this study helped to understand (1) the present vocational and didactic practices at TVET colleges, (2) the degree of TVET college readiness for the fourth industrial revolution and (3) the state of financial support for the reskilling and skilling of youth and adults for the fourth industrial revolution.

3. Literature review

3.1 Awareness of the forces for new jobs and skills for the future

Technological advancement is a major driver of the economic growth and has raised living standards enormously (though unevenly) across the globe. Digital technologies radically transform the structure of organisations and employment models. However, there is a growing fear of “technological unemployment” as technology become dominant in the economy. Such fears were experienced repeatedly through history in response to new technologies.

Technological change has reshaped the workplace continually over the past two centuries since the industrial revolution. The speed with which automation by digital technologies is developing today and the scale at which they could disrupt the world of work are largely without precedent. In the long term, technology has increased the productivity of workers and driven very substantial increases in living standards [3].

A 2011 study by McKinsey’s Paris Office found that the Internet had destroyed 500,000 jobs in France in the previous 15 years but at the same time had created 1.2 million new jobs. This was a net addition of 700,000 or 2.4 jobs created for every job destroyed. Digital technology integration is having an amplifying effect on the institutional change. As new technologies come online and existing jobs are displaced, society will be under greater pressure to adapt and learn new skills. Jobs and employment models are continually changing with technology, owing to consumer preferences. These developments have been reshaping through the industrial revolution. New jobs, requiring new skills, are being created in manufacturing, mining, as well as the service sector industries. There is nothing new about continual change in the types of jobs people do and how they are done. Throughout history, governments, industries and society have been failing to make important choices about how to reskill human resources for the transition workforces into the future. One important difference about today’s change is that we have many lessons to learn from. Many lessons have been learned about labour force transitions from the industrial revolution in the nineteenth century. In the knowledge economy, employability is directly related to relevant education and training [4]. Knowledge economy is based on knowledge and information [5], which forms the intellectual capital of organisations [6] and is a driver for growth and employment across industries [7]. Knowledge-rich industries, including professional, scientific and technical services, show rapid economic growth. Higher-skilled jobs are more complementary with technology and innovation, increasing productivity and earnings [8]. Patent growth is one of the indicators of technology innovation and growth in the knowledge economy [5, 9, 10]. These trends and projections highlight the importance of technical and vocational education for those who are yet to enter the labour market [11].

The advances of technology, digital connectivity and globalisation and the rise of new economic structures are creating new forms of jobs and employment models over the coming 20 years. We are witnessing a unique combination of forces that

leads to much more rapid development and restructuring of labour markets in the near future than previously experienced.

As compared to previous technologies such as electricity and telephones, the rate at which new digital technologies are being developed and adopted is much faster [12]. The Internet and its accompanying technologies have been a game changer for many industries. They may be yet to unleash their full disruptive potential, owing to the establishment of the Internet infrastructure in both rural and urban areas. Unlike the first, second and third industrial revolutions, where the geographic limitation affected the flow of products and labour, the digital technology revolution (fourth industrial revolution) also known as internet change everything (ICE) has no geographical barriers. The new global Internet-enabled workforce employs new skills and competes with the local workforce, in just about anywhere in the world [13]. With the device connectivity, computing power, data volumes, e-commerce, social media use and other indicators of digital technology growth, we experience exponential growth both in terms of adoption and functionality. Employment models and jobs are significantly impacted by the connectivity. Most of the opportunities and risks associated with the “Internet of things” are yet to transpire. Essentially, the digital technology offers access to a whole new world of connectivity that is on 24/7 basis and that in itself is changing the way people work and live day to day.

IoT contains a variety of connected objects. The “Internet of things” is exploding. It is made up of billions of “smart” devices—from miniscule chips to mammoth machines—that use wireless technology to talk to each other (and to us). Our IoT world is growing at a breathtaking pace, from 2 billion objects in 2006 to a projected 200 billion by 2020. That will be around 26 smart objects for every human being on Earth. IoT is the combination of low-cost, low-power processors with “real-world” electronic sensors and wireless network connectivity being added to a wide range of electrical devices.

Mobile broadband and Internet access show the most rapid growth in developing countries. However, the divide between developed and developing countries remains vast, with mobile broadband penetration reaching 84% in the former and only 21% in the latter [14]. These digital divides need to be addressed in order to ensure that as many people as possible are able to access affordable, efficient mobile communication networks and the associated development opportunities, including employment.

The future of digital technological advancement holds exciting opportunities for the way we work, consume and interact and also poses challenges. Youth and people who lack high-level technological and interpersonal skills are becoming vulnerable due to digital-automated jobs. There is a need for targeted and strategic skills, education and training that are responding to the changing technological world. Supporting individuals in the application of transferable skills will be a key priority as we foster a sustainable and more productive economy. High-level technical skills in STEM education is required to underpin a successful economy. Technological digitisation and automation of our activities will have profound effects on the future labour markets. What are the deep-seated technological trends? And how can we prepare to maintain high standard of living in the country? The impact of these trends and the resulting skills must be better understood so that the appropriate STEM education and training is put in place to provide a prosperous and innovative economy for the emerging type of employees of tomorrow.

Increase of digital technology-automated systems is raising the complexity of tasks and the need for higher-level skills for entry-level positions. An increased STEM knowledge and skill levels in digital technology is imperative to access new jobs. Many middle- and high-skilled jobs are being automated. The consequence is the likelihood of a raised STEM skill training and education bar for entry into many professions and occupations.

3.2 Contribution of STEM knowledge and skills to digital technology jobs

The world of work is in a state of flux, which is causing considerable anxiety to everyone. There is growing polarisation of labour market opportunities between high- and low-skilled jobs and unemployment and underemployment especially among young people [15]. STEM education curricula at schools and TVET colleges have not kept pace with the changing nature of work, resulting in many employers saying they cannot find enough workers with the skills they need [16]. Education and training institutions should stop educating students for jobs and occupations that do not exist. The future requires workers to think creatively, work collaboratively, deepen their emotional IQ and integrate technology into everything they do [17]. It is unfortunate that even the best public and private schools still maintain an outdated focus on memorisation and following directions (ibid). To prepare students relevant to this technological era, schools must regularly make technology an integral part of their teaching, learning and assignments. Technology is becoming an even more common part of the workplace.

Science, technology, engineering and mathematics (STEM) knowledge is associated with 75% of the fastest growing occupations, innovations and wage premiums [15]. A technology- and knowledge-driven economy needs workers trained in science, technology, engineering and mathematics. The majority (70%) of employers in developed countries (e.g. Australia) characterise employees with STEM skills as the most innovative. About 75% of the fastest growing occupations require STEM knowledge and skills (ibid). The digital revolution and an increasing demand for designing and manufacturing are driving the growth of the creative sector which extends from arts to science and technology, creativity and innovation [18]. The new generation of workers often referred to as digital natives appears to be creative and looking for opportunities to express their creativity. Designing and making objects in STEM as creative thinking is expected to become increasingly important as a contributor to the national economy and the job market. Existing and new jobs are likely to require a creative approach to perform nonroutine tasks and solve problems, while future workers are likely to appreciate an opportunity to act creatively. STEM skills and knowledge are required for work in a growing range of existing occupations in the future and will also contribute to the creation of new professions within the digital technology era [16]. However, current trends demonstrate the lack of interest and poor performance in STEM. Furthermore, STEM subjects and related vocational courses and occupations (e.g. mechanical and civil) are still traditionally seen as more male-dominated work. There is declining trend in STEM knowledge and interest [19]. This situation needs to be resolved to meet future workforce of vocational and technology needs. STEM education should provide employees, both males and females, with essential skills that promote innovation and productivity and support economic growth.

4. Data analysis and discussion

Student questionnaire results on vocational educational and training practices at three TVET colleges.

This section presents data collected from questionnaires administered to three TVET colleges. The data is presented in four tables. **Table 1** shows the biographical data of students at the three colleges combined. **Table 2** presents data on relevant workshop materials and equipment for teaching and learning vocational subjects. Data on **Table 3** provide students' views on the integration of theory and practice in the subjects. The data in **Table 4** provide information on the partnership between

Gender	<i>f</i>	%
F	31	26
M	88	74
Blanks	0	0
Age group		
18–20	39	33
Above 20	80	67
Blanks		
Total	119	100

Table 1.
Biographical data of students from three TVET colleges.

RQ1 Vocational pedagogy and didactics	<i>F</i>	%	<i>F</i>	%	<i>f</i>	%	<i>f</i>	%	Mean	SD
The VET pedagogy aims to enhance the students' capacity as independent thinker	7	6	10	8	101	85	1	1	2.77	0.59
The VET pedagogy is providing me with “a learning experience that is social, passionate and inspiring worker”	6	5	8	7	105	88	0	0	2.83	0.49
The emphasis is on “how” and “why” of the learning rather than the “what” only	9	8	47	39	57	48	6	5	2.30	0.82
The learning outcomes of the teaching and learning are very clear to students	6	5	17	14	96	81	0	0	2.76	0.53
The teaching and learning process is mainly by doing and reflection in vocational subjects	8	7	27	23	82	69	2	2	2.59	0.69
The teaching and learning engage students practically in performing a task through interaction	24	20	20	17	75	63	0	0	2.43	0.81
Sometimes I rely on sources other than my lecturer to know how some tasks are done	14	12	24	20	80	67	1	1	2.54	0.73
The teaching and learning utilise authentic hands-on practical activities that are true reflection of workplace activities	34	29	16	13	63	53	6	5	2.14	1.00
Vocational didactics focuses on competences and characteristics of a specific vocation or occupation	17	14	53	45	47	39	2	2	2.22	0.75
Relevant teaching and learning method is always applied for different types of vocational subjects	12	10	16	13	91	76	0	0	2.66	0.65

Table 2.
Vocational and didactic methods used in classrooms and workshops.

TVET colleges and industries for WIL. The details of data, analysis and related interpretations are presented below.

4.1 Biographical data of students from three TVET colleges

Table 1 presents data on the biographical data of students.

Table 1 shows that most students (88%) were male. It is not surprising, because the country is still going through transformation from the traditional male-dominated vocational education and training. The belief that mechanical, electrical

Rating	Disagree		Neither		Agree		Blanks		Mean	SD
	<i>f</i>	%	<i>F</i>	%	<i>f</i>	%	<i>f</i>	%		
RQ2 Relevant workshop materials and equipment for teaching and learning vocational subjects										
I know the purpose of all materials and equipment available in this workshop	51	43	37	31	30	25	2	2	1.81	0.82
I consider that all materials and equipment in this college are able to prepare me for industry work	33	28	21	18	65	55	0	0	2.27	0.87
Lecturers are competent in the use of material and equipment that will prepare me for industrial work	27	23	25	21	67	56	0	0	2.34	0.82
The use of electricity-reliant equipment helps us to adapt quickly to current machinery in the world of work	21	18	19	16	79	66	0	0	2.49	0.78
I sometimes fail to complete practical activities due to the lack of adequate material	51	43	17	14	51	43	0	0	2.00	0.93
Sometimes I do use other materials and equipment other than prescribed in the task because the appropriate ones are not available	40	34	24	20	55	46	0	0	2.13	0.88
Sometimes I rely on sources other than my lecturer to know how some tools and equipment work	29	24	24	20	66	55	0	0	2.31	0.84
Materials and equipment that we use during practical are a true reflection of what we are taught during theory lessons	25	21	24	20	81	68	0	0	2.66	0.30

Table 3.
Workshop materials and equipment for teaching and learning vocational subjects.

and civil occupation is for male students is still prevalent at most TVET colleges but is slowly disappearing. Hopping [19] argues that STEM education should provide both males and females with essential skills that promote innovation and productivity to support economic growth. There is still high inequality in the country due to the previous dispensation.

It is common to find most students in the group above 20 years, because most of them are from post matric (grade 12—age 20) focusing on preparing for occupations for workplaces. These groups will be studying NATED programmes, while the younger ones will be studying NCV courses.

4.2 Vocational and didactic methods used in classrooms and workshops

The questionnaire results in **Table 2** show students agreeing to effective vocational and didactic approaches to the teaching and learning in the classroom. For instance, 85% of students agreed that “The VET pedagogy aims to enhance their capacity as independent thinker”. This is agreeing with [20] that educators will need a different pedagogy and skill during the fourth industrial revolution. Further, nearly one-third (63%) of students agreed that the teaching and learning engage them practically in performing a task through interaction. However, there was no complete agreement by students (39%) that vocational didactics focuses on competences and characteristics of a specific vocation or occupation. There were a considerable number of students (45%) who did not agree nor disagree on this indicator. The mean of 2.77, 2.83 and 2.66 shows an inclination towards and agreement in those indicators.

Rating	Disagree		Neither		Agree		Blanks		Mean	SD
	<i>f</i>	%	<i>F</i>	%	<i>f</i>	%	<i>f</i>	%		
RQ3 Integration of theory and practices in the teaching and learning of vocational subjects										
There are challenges that I face in developing the necessary skills and knowledge for social and economic development	21	18	23	19	75	63	0	0	2.45	0.78
The theoretical knowledge gained influences how I learn vocational subjects	9	8	27	23	81	68	2	2	2.57	0.70
The educational content is sufficiently relevant to the needs for qualifications in the actual vocations	7	6	30	25	82	69	0	0	2.63	0.59
The curriculum guides how to integrate theory of vocational subjects with practical exercises in workshops	30	25	29	24	60	50	0	0	2.25	0.83
The curriculum based on an adequate understanding of how vocational knowledge is constituted and developed	7	6	42	35	69	58	1	1	2.50	0.65
There is coherence between the classroom, the college workshop and the workplace and between subjects	23	19	48	40	47	39	1	1	2.18	0.77
Students are satisfied with the opportunities given by the educational structure and curriculum framework	31	26	21	18	67	56	0	0	2.30	0.86
Guidance is provided during placement periods	23	19	20	17	76	64	0	0	2.45	0.80
Lectures, assignments and work in the school workshop systematically related to placement periods	22	18	30	25	67	56	0	0	2.38	0.78
Theoretical knowledge is used to provide occupational relevance to work-related areas	7	6	24	20	85	71	0	0	2.61	0.71

Table 4.
Integration of theory and practices in the teaching and learning of vocational subjects.

4.3 Relevant workshop materials and equipment for teaching and learning vocational subjects

Table 3 indicated that more than half of students (51%) disagreed that they know the purpose of all materials and equipment available in the training workshops. Most of the students (65%) agreed that they consider all materials and equipment in the college to prepare them for workplaces. This is contrary to [16] who states that educational systems have not kept pace with the changing nature of work, resulting in many employers saying they cannot find enough workers with the skills they need. Further, unemployment rate in South Africa increased to 27.7% in the first quarter of 2017 from 26.5% in the previous period [1]. From the findings in **Table 2**, students seem to be positive about equipment and materials in the training workshops. The observations at the colleges investigated also do not agree with students’ positive opinion about equipment and material at the college.

4.4 Integration of theory and practices in the teaching and learning of vocational subjects

At TVET colleges teaching and learning of vocational subject should focus more on practical skills. As a result the integration of theory and practice should be in the

core of teaching and learning of occupational subjects. **Table 4** provides students' views on the integration of theory and practice in the subjects. Majority (75%) of students agree that there are challenges they face in developing the necessary skills and knowledge for social and economic development. Three quarters (68%) of students agreed that the theoretical knowledge gained influences how they learn vocational subjects. Similarly 68% of students agreed that lectures, assignments and work in the school workshop systematically related to placement periods. These results do not correspond very well with existing studies that most of the youth in the country are unemployed and that schools and colleges are busy training students for jobs that do not exist [1, 16].

4.5 What partnership exists between TVET colleges and industries for WIL?

Partnership with relevant industries and placement of work-integrated learning or work-based learning is an integral part of vocational education and training. For most of South African colleges, work-based learning is not adequately practised due to the lack or poor partnership with industries. This question sought information from students on the degree of partnership and work-integrated learning during their vocational education and training. **Table 5** shows that less than half of students (43%) agreed that various partnerships exist between TVET colleges and industries at regional and international levels. It is interesting that more than a quarter (33%) of respondents neither agreed nor disagreed. Nearly half of students (24%) disagreed that various partnerships exist between TVET colleges and industries at regional and international levels. **Table 5** also shows that half of students (50, 54, 51, and 55%) agreed on the importance of partnership in vocational education and training. However, there were a considerable number of students who neither agreed nor disagreed. This implies that partnership and WIL is lacking or poor at colleges.

Rating	Disagree		Neither		Agree		Blanks		Mean	SD
	F	%	F	%	F	%	F	%		
RQ4 What partnership exists between TVET colleges and industries for WIL?										
Various partnerships exist between TVET colleges and industries at regional and international levels	29	24	39	33	51	43	0	0	2.18	0.80
TVET colleges form partnerships with industries to ensure responsiveness to local and international community needs	25	21	35	29	59	50	0	0	2.29	0.79
These partnerships influence the successful labour market outcomes such as ensuring quick absorption of graduates into the workplace	28	24	27	23	64	54	0	0	2.30	0.83
Partnerships influence the successful labour market outcomes such as upgrading machinery and equipment	25	21	33	28	61	51	0	0	2.30	0.79
Partnerships influence the successful labour market outcomes such as improving supply of middle-level skills	20	17	33	28	66	55	0	0	2.39	0.76
Partnerships influence the successful labour market outcomes such as reducing skill shortages and mismatches	31	26	35	29	53	45	0	0	2.18	0.82

Table 5.
Partnership between TVET colleges and industries for WIL.

5. Interview results from lecturers

Interviews were conducted with lecturers of students at the three colleges. The participants responded to questions related to (1) vocational pedagogy and didactics, (2) equipment and materials in the workshops, (3) integration of theory and practice and (4) partnership with workplaces and WIL. Therefore the themes of results are organised in term of these four elements.

5.1 Vocational pedagogy and didactics and integration of theory and practice in the classroom/workshops

The lecturer teaching electrical engineering responded that there was no integration of theory and practice.

The researcher asked: “Is there any practical you do on your subject?”

Lecturer: “No, it’s just theory”.

The teacher says that there are no workshops for practical. The teaching is mostly based on textbook.

Lecturer: “I teach them theory most of the time, and the practical they must do on their own”.

The type of practical the teacher was referring to was calculations of electrical quantities using calculators.

I asked the teacher the question: “Do you have practical?”

The lecturer/teacher responded: “No, I mean calculations”.

The teacher who was teaching Computer Practice N5 in the same college states that students spend much time in the practical of the computer, because theory was too short.

Lecturer: “Our theory is very short so most of the time we concentrate on practical”.

However, the teacher complained that the content of the subject she was teaching was outdated because it was never revised since 1999. It is not surprising why employers cannot employ most students from colleges because of this mismatch of knowledge and skills [1] [16]. This mismatch was also confirmed by the teacher as follows:

Lecturer: I am only concentrating on the textbook, for example financial management students they are doing computer practice they are doing calculations yet when they go to the corporate they come back saying what we teach them it’s not relevant to their work place due to the system each company may use as individual. The teacher states that she requires continuous professional development because he/she is not a professional teacher.

For instance, the teacher said: “More training for me because I am not a professional teacher so I don’t know how to deal with the behaviour of students”.

At the third college, the lecturer who was teaching Electrotechnics emphasised that he was always bringing practical components when teaching, as a way of integrating theory and practice.

Lecturer: “Sometimes you see now in the class I do have machines. Even there you can check I do have machines. My subject is based too much on machines and other components of electrical. I do bring some, like conductors that I do have, whatever subject it requires based on the chapter which I’ll be teaching”.

The lecturer in this subject (Electrotechnics) also stressed the fact that the content is outdated, and it is going to be reviewed. The NATED curriculum taught at TVET colleges was introduced by the apartheid regime and has not being reviewed. [21] argues that too much bureaucratic red tape and unnecessary detail

will retard technological changes in the country. There is great need to fast track TVET transformation in order to meet the needs of workplaces in skill provision. The existing TVET colleges are failing to produce skilled youth because of the bureaucratic red tape in terms of funding.

5.2 Partnership with workplaces and WIL

On the issue of partnership and WIL, the lecturer mentioned that she/he was not involved in that; however the teacher said that partnership is much relevant especially in the subject he/she was teaching because it is a practical subject.

The teacher responded: “No, I am not involved in that field, but I know sometimes companies offer our students learnership”.

The lecturer mentioned that workplaces for students to do practical are very rare.

Lecturer: “Yes, and we don’t have places that you can go do practicals”.

The lecturers continues: no, no we need that, we need it and who ever can help us and the students would like it, they keep on asking me always, they say why we are not placed, and I got no answer. It is clear that these colleges do not have equipment and materials, because they do not do practicals.

5.3 Observation of training workshops

The study made observation in the practical workshops and during teaching. The observation schedules included (1) workshop/learning environment layout conducive for teaching and learning vocational subjects, (2) all material and equipment fully functional, (3) safety kits and utilities visible for all, (4) adequate working spaces provided around electrical power supply for normal operating and maintenance tasks in the workshop, (5) availability of materials to be used relevant for instruction and (6) natural and artificial lighting promoting effective functioning of practical lessons.

The above pictures show some training venues for students in the Electrotechnics and Automotive occupations, respectively. The materials observed that are used for practical are not corresponding with the latest technologies. For instance, most students are still trained using vehicle carburetor, while modern cars are using fuel injectors. It is not surprising that majority of youth trained from TVET colleges are not employable at most workplaces. Employers are complaining that the current education graduates are not work ready [21]. In a study by [21], in an interview, a manager uttered that education should “...give us a finished package” or “at day one be absolutely perfect”. There is shortage of public/private training providers to provide knowledge and skills, education and training for the fourth industrial revolution such as IoT, AI, cloud computing, 3D printing and robotics/coding/programming [21].

A study by [22] indicates that one-third of industry experts in the USA had no confidence that education and training would evolve rapidly enough to match demands of technological advancement by 2026.

6. Conclusion

This chapter succeeded in presenting a review of literature demonstrating that rapid technological advancement is the major driver of the economic growth and has raised living standards enormously across the globe. From the review of literature, it can be concluded that there is a need for targeted TVET occupational skills,

which are responding to the changing technological world. There are a number of recommendations made from the empirical findings presented in this chapter. It is concluded from the findings of this study that vocational pedagogy and practical skill training are not responding to workplaces and lead to high unemployment of youth. It is recommended that there should be massive upskilling and reskilling of TVET college teachers in various occupational fields. The findings also revealed that there are minimum or no practical activities at most of the colleges, hence no integration of theory and practice in vocational subjects. This study found that the curricula offered at the TVET colleges are irrelevant and require urgent review in order to respond to the current workplace. The teachers/lecturers at colleges require reskilling and upskilling to keep abreast with the latest technological development. Financial support from SETAs and related funders is required urgently to reskill TVET/CET college lecturers with fourth industrial revolution occupational skills. Short courses within occupational skills such as plumbing, welding, CNC programming, 3D additive manufacturing, robotics and IT are required at massive skills to combat unemployment, inequality and poverty. Bureaucratic red tapes and long procurement process should be removed if the country is serious about the fourth industrial revolution.

Although this study does not claim to be generic with the results, the empirical conditions can be found to be similar in many TVET/CET colleges in the country. More clinical studies are required at TVET colleges, as this study did not cover all colleges and their campuses in the nine provinces. The researcher acknowledges some good reform and transformation in some colleges, however very small, given the majority of youth with no relevant skills for employment.

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